Sekolah Dasar: Kajian Teori dan Praktik Pendidikan
Volume 34, No. 01, Mei 2025, hlm. 129–144

Tersedia Online di http://journal2.um.ac.id/index.php/sd
ISSN 0854-8285 (cetak); ISSN 2581-1983 (online)

Problem-Based E-Module for Enhancing Fifth-Grade Critical Thinking in Integrated Science and Social Studies

Muhammad Ilham Setiadi*
Dwi Yulianti
Fatkhur Rohman
Rangga Firdaus
Master of Education for Elementary School Teacher, Faculty of Education, Universitas Lampung – Jl. Prof. Dr. Ir. Sumantri Brojonegoro, Bandar Lampung City, Lampung, Indonesia
*Muhammad Ilham Setiadi, E-mail: setiadimuhammmadilham@gmail.com

Paper received: 30-03-2025; revised: 18-05-2025; accepted: 23-05-2025

Abstract
This research project originated from an examination of the requirements of both teachers and students in their learning experiences. Its primary goal was to develop a sound, usable, and impactful problem-based e-module to improve critical thinking abilities in fifth-grade Integrated Science and Social Studies (IPAS). The study followed a Research and Development (R&D) framework, specifically the ADDIE model's five stages: Analysis, Design, Development, Implementation, and Evaluation. Participants were carefully chosen using purposive sampling to align with the research aims. Data was gathered through validated and reliable assessments and subsequently analyzed with an independent t-test, which showed a significant result ($p < 0.001$). The findings clearly demonstrate that the developed problem-based e-module is an effective tool for cultivating critical thinking skills in fifth-grade integrated science and social studies education.

Keywords: *e-module*; *PBL*; *critical thinking*

INTRODUCTION

Education is one of the key pillars of a nation's progress, as it is through the education sector that generations rich in knowledge and equipped with creative and high-quality thinking skills are formed—individuals who will become the future leaders of the nation. A high-quality education system will produce capable generations, enabling Indonesia to be more adaptive to rapid technological advancements and more competitive on the global stage. The government, as the policymaker, has an important task to achieve this, one of which is by innovating the curriculum (Innovations in the curriculum include the integration of technology in the learning process, project-based learning approaches, and the development of various skills in students to meet the demands of 21st-century education (The 21st century challenges and opportunities necessitate comprehensive innovation across Indonesia's education system. Consequently, teachers play a crucial role in fostering 21st-century skills like critical thinking and problem-solving (part of the 4-C skills) to develop students' complex competencies and help them adapt to ongoing advancements (The demands of modern times and the rapid pace of technological advancement have changed how teachers guide students to constantly adapt to various technological developments in an effort to improve the quality of education (In its efforts to meet 21st-century demands, the Ministry of Education, Culture, Research, and Technology has adopted 'Kurikulum Merdeka' as a key policy (.

The Merdeka Curriculum seeks to empower students to freely develop their interests and potential, while accommodating diverse learning styles. This is intended to create an enjoyable learning environment, nurturing qualities such as courage, independence, sociability, good manners, politeness, and competence (Prasetyo, 2024; Priyadi et al., 2024; Rusmiati et al., 2023). The Merdeka Curriculum, which is currently implemented in Indonesia's education system, demands that learning activities focus on students, also known as Student Centered Learning. The optimal implementation of the student-centered learning approach in the learning process can create positive behavioral changes in students and makes it easier for teachers to innovate (Setiawan et al., 2021; Utari & Muadin, 2023). One of the learning models that can be applied and integrated with the Student Centered Learning approach is the PBL model. Implementing the PBL model provides various positive impacts on students, particularly in developing higher-order thinking, critical thinking, and creativity through independent learning. Through these activities, students effectively solve contextual problems. Experts affirm that PBL is well-suited for 21st-century education, as previous research consistently demonstrates its positive effect on improving students' critical thinking and problem-solving abilities. Critical thinking skills involve students' ability to logically analyze, consider, and determine solutions. As part of High Order Thinking Skills (HOTS), critical thinking enables students to utilize all their knowledge to solve problems, with the final outcome serving as a benchmark for their intellectual level.

Research conducted in V.A classes at two schools, UPT SDN 1 Parerejo and UPT SDN 1 Mataram, shows that students in these schools still have low levels of critical thinking skills. Several factors contributing to low critical thinking skills are still traditional learning activities, students' difficulty in understanding the materials included in IPAS (Ilmu Pengetahuan Alam dan Sosial/ Integrated Science and Social Studies) V textbooks, and the lack of use of techniques that can make it easier for students to learn IPAS materials in learning activities. This study aims to enhance fifth-grade students' critical thinking skills by developing and implementing a Problem-Based Learning (PBL) e-module. This innovative e-module departs from conventional methods by integrating PBL principles into an interactive digital format, featuring contextual IPAS-aligned problems. Its novelty lies in blending digital learning technology with structured problem-solving tasks specifically adapted for elementary students' cognitive levels, offering a practical solution for achieving 21st-century learning objectives.

This research enriches scientific knowledge in the field of education by providing empirical evidence regarding the effectiveness of integrating digital technology and inquiry-based pedagogy in IPAS learning at the elementary school level. These findings not only address the need for relevant digital learning resources but also fill the literature gap related to utilizing such resources for developing high-order thinking skills in elementary school students. The primary contribution of this research is in two fundamental aspects. First, in terms of product, this research presents a PBL e-module in a mobile application format designed to be directly downloaded and installed from the *Google Play Store* on Android devices. Second, from a scholarly perspective, this study uniquely examines the effectiveness of integrating the PBL model with this mobile e-module in the specific context of IPAS for fifth-grade elementary school students, an area that has been insufficiently explored in educational literature. Thus, this research not only fills methodological and practical gaps by providing an accessible digital learning media with the potential to improve learning quality but also advances knowledge in educational technology and pedagogy by providing strong empirical evidence on how a fully integrated PBL-based e-module

can effectively foster critical thinking skills in elementary school students in a relevant environment.

Previous research has extensively discussed the potential use of e-modules in learning activities and the effectiveness of the PBL model in developing the skills possessed by students. For example, a study conducted by Islahiyah et al. (2021) shows that the implementation of e-modules can enhance students' mathematical problem-solving abilities at the senior high school level. Meanwhile, a study conducted by Jayanti & Pertiwi (2023) demonstrates the success of the PBL model integrated with the use of e-modules in developing students' analytical skills and curiosity at the senior high school level. Furthermore, research conducted by Pujiono et al. (2024) emphasizes that the use of PBL-based e-modules has been proven to improve critical thinking skills among senior high school students. This research is in line with these findings, although there are some fundamental differences such as the educational level of students used as research samples, the subjects studied using e-modules, and the students' abilities that were successfully improved. Overall, the use of e-modules has proven effective in various contexts. However, there is still a significant gap in understanding how e-modules can be optimally integrated with PBL models to specifically improve critical thinking skills of fifth-grade students in the context of IPAS subjects. Previous research has not comprehensively examined the synergy between e-module design centered on authentic problems and its impact on the development of high-level cognitive skills, especially at the elementary school level.

Another fundamental difference lies in the form of the e-module product produced. The developed e-module product is in the form of an application that can be directly downloaded from the *Google Play Store* and installed on Android devices. This is different from the e-module products produced in previous studies, which generally took the form of websites, applications that could only be accessed and installed if the link was shared, or links that could be accessed through a browser in the form of a flipbook. Therefore, this research aims to bridge that gap, offering an innovative PBL e-module product in a mobile application format that is easier to access, and providing empirical evidence of its effectiveness.

METHOD

This research utilizes a research and development (R&D) approach, focusing on either generating a novel product or enhancing an existing one. The study follows the ADDIE framework, which includes five distinct phases: Analysis (needs assessment), Design (product blueprinting), Development (product creation), Implementation (product application), and Evaluation (product assessment). The primary objective is to develop an e-module suitable for use at UPT SDN 1 Parerejo and UPT SDN 1 Mataram.

Design

This research employed the ADDIE model framework to create a PBL e-module tailored for fifth-grade students learning IPAS. The researcher followed a multi-stage process to bring the product from conception to readiness. The initial Analysis phase involved examining the current Merdeka Curriculum requirements in Indonesia, assessing student needs within IPAS learning contexts, and analyzing the subject matter to establish the importance of an e-module covering eye anatomy/function, the vision process, and common vision problems. Through classroom observations and teacher interviews during this phase, the researcher identified that existing

learning methods were not fully effective because they lacked technological integration to aid student comprehension.

Next, the design phase involved creating the e-module's blueprint using *Canva*, leveraging its design templates, graphic elements, and fonts to ensure an attractive, user-friendly interface. Engaging cartoon-style characters and a comic-style layout were incorporated to foster enjoyment and confidence, enhancing the learning experience. The intentional use of encouraging language further promoted a positive, student-centered atmosphere conducive to critical thinking and active learning. In the Development stage, the e-module was built using *Thunkable*, where *Canva*-designed visuals (PNG) were compiled into a functional mobile app (APK) via block-based coding. A 14-item pretest-posttest and a questionnaire were developed, followed by validation from six experts (content, media, and language specialists). Revisions were made based on feedback before a limited trial with 12 fifth-grade students to assess practicality. Successful results led to a large-scale trial to measure the e-module's impact on critical thinking skills. Furthermore, the Evaluation phase analyzed the e-module's effectiveness after large-scale implementation, comparing pretest-posttest results to measure critical thinking improvements. Statistical analysis confirmed significant gains, demonstrating the module's adaptability across different schools. Expert validation (6 experts) and student trials confirmed feasibility and practicality, proving the success of this structured, problem-based approach in enhancing integrated Science and Social Studies learning.

Throughout this study, feasibility was confirmed by 6 expert validators (2 content, 2 media, 2 language). Practicality was assessed through trials with a total of 12 students from the participating schools. The e-module's feasibility was assessed through expert validation, while its practicality was evaluated based on student responses. The feasibility and practicality scores are interpreted based on a specific classification range, as shown in Table 1 and Table 2:

Table 1. Product Feasibility Score Classification

No	Score (%)	Category
1	90% X < 100%	Very Worth It
2	80% X < 90%	Worthy
3	70% X < 80%	Decent Enough
4	60% X < 70%	Not Feasible
5	0% X < 60%	Totally Not Worth It

Source: (Lubis et al., 2023)

Table 2. Practicality Criteria Guidelines

Index Practicality (%)	Criteria
80% < X 100%	Very Practical
60% < X 80%	Practical
40% < X 60%	Practical Enough
20% < X 40%	Less Practical
0% < X 20%	Not Practical at All

Source: (Putri et al., 2024)

The following Figure 1 is an image that illustrates the ADDIE process used in this study:

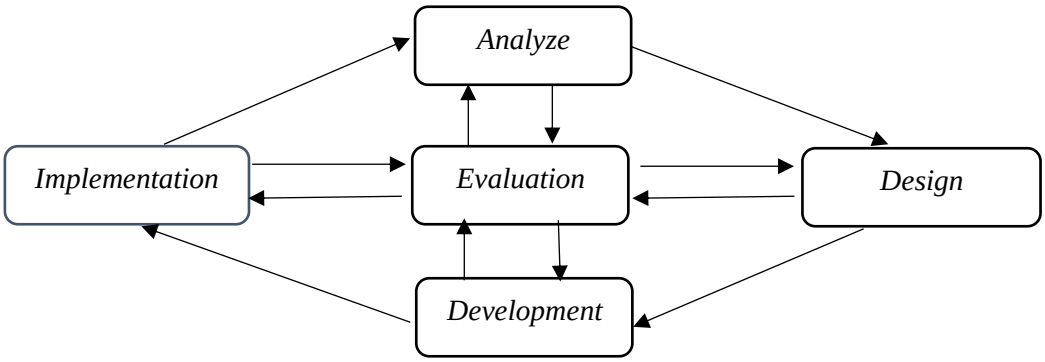

Figure 1. Research Design of ADDIE (Tegeh et al, 2015)

Population and Sample

The study's population included fifth-grade students from elementary schools in Cluster 3 and Cluster 6, located in Gadingrejo District, Pringsewu Regency. To select the sample, purposive sampling was employed, a technique that relies on logical justifications and adherence to predefined criteria relevant to the research objectives. Based on these considerations, the sample was finalized to include 35 Grade V students from UPT SDN 1 Parerejo (specifically, 20 from class VA and 15 from class VB) and 44 Grade V students from UPT SDN 1 Mataram (equally divided with 22 in class VA and 22 in class VB). Class VA from each school was designated as the experimental group, while Class VB served as the control group.

Sampling Technique and Instrument Development

This study gathered data through observations, structured interviews, questionnaires, and documentation (Saranto & Kinnunen 2009). Observations were conducted before large-scale trials to understand typical learning activities of fifth-grade teachers and students. Structured interviews with teachers from both schools aimed to pinpoint challenges in IPAS Chapter 1, topic B “Seeing because of the Light”. To validate the developed e-module, competent material, media, and language experts, along with student respondents, completed Likert-scale questionnaires, thereby ensuring the product's validity and practicality. Documentation captured all research activities and information collected throughout the study. Researchers used a test instrument consisting of fourteen questions whose validity and reliability had been tested to determine the improvement in critical thinking skills of class V students through the pretest and posttest stages. The results of the validity test show that all question items are declared valid because they have a calculation value that is in the range 0.722-0.874 and the results are greater than the 0.361 table. The results of the reliability test are within very high criteria, according to the reliability test, which produces a calculated result of 0.959.

RESULT AND DISCUSSION

Development of Product

This research aimed to enhance fifth-grade students' critical thinking skills in their Science curriculum, specifically for Topic B: 'Seeing because of the Light.' The development

process followed the ADDIE model and involved creating a PBL-based e-module using *Canva* for layout design and *Thunkable* for app development. *Canva* was used to design an engaging, student-friendly interface (see figure 2), while *Thunkable* enabled the conversion of visual designs into a functional mobile application.

Figure 2. Product Design Menu Interface Created with *Canva*

Thunkable is a free, web-based platform used to develop the e-module into a functional Android application through a simple drag-and-drop interface. Its accessibility made it suitable for educational contexts, allowing the research team to convert *Canva* designs into an interactive learning app without advanced programming skills. Functionality was added using *Thunkable*'s blocks mode (see figure 3), which uses visual programming to define logic and behavior, allowing developers to connect actions and responses in a structured yet accessible way.

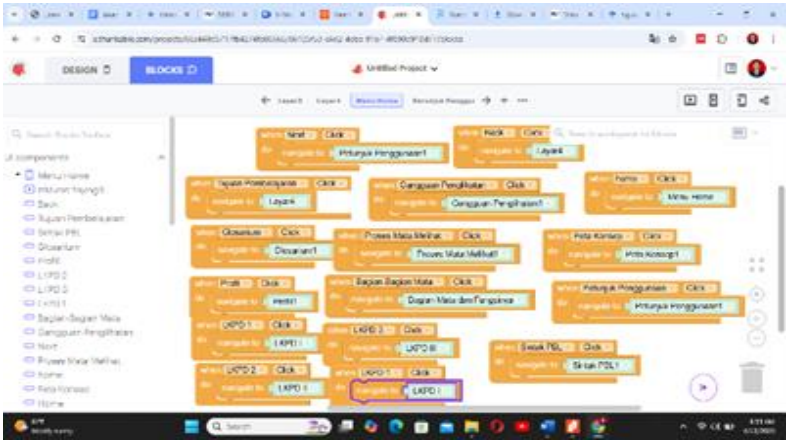

Figure 3. Design and Blocks Menu Interface in *Thunkable*

Airtable is an online database platform used in this study to store and manage student data and responses from the e-module activities. Its spreadsheet-like interface allowed efficient organization of key information, including student identities, submitted answers, timestamps, and submission status. The database supported real-time access and collaboration during testing and evaluation phases, making it a practical tool for managing the research data collected throughout the implementation of the e-module.

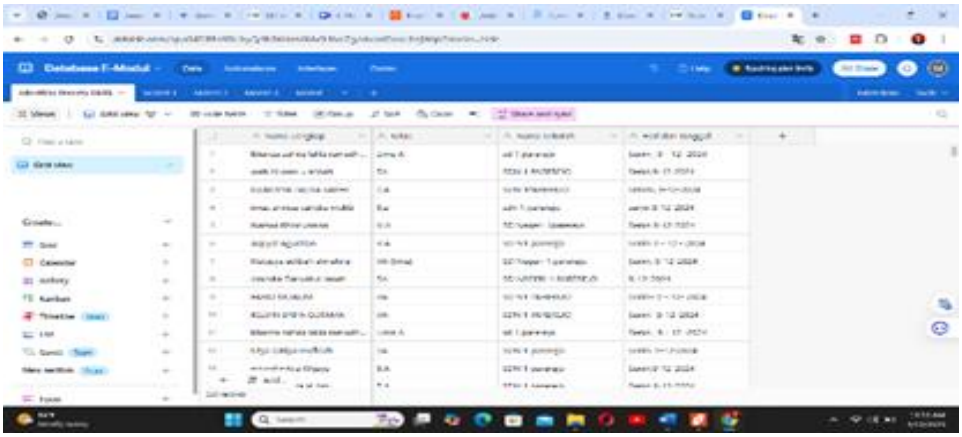

Figure 4. Database Stored Within *Airtable*

Google Form is an online tool used in this study to create and distribute digital worksheets aligned with the e-module material. It allowed students to respond to descriptive questions covering three subtopics related to the lesson on light and vision. Each worksheet was presented in a clean, structured interface where questions were listed clearly and students could type answers directly into text fields (see figure 5). The platform also supports multimedia integration and real-time data collection, making it effective for capturing and organizing student responses. All submissions were automatically stored and could be reviewed through the 'Responses' tab, enabling efficient tracking and analysis during the evaluation phase.

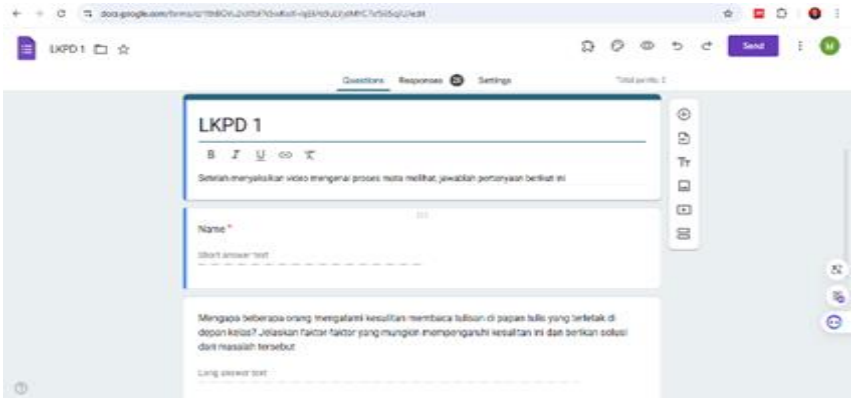

Figure 5. *Google Form* Worksheet Interface

In PBL, a pedagogical approach centered around real-world issues, students work collaboratively in small groups. These groups are given diverse, relevant problems to tackle. The primary objective is to develop their problem-solving skills through group dialogue, allowing each student to acquire fresh insights and knowledge through the experience of resolving these challenges. This study applies the PBL model in the experimental class to evaluate its impact on students' critical thinking skills. The experimental class were given a pretest to measure their initial level of critical thinking skills. After the pretest, the teacher conducted learning activities by fully implementing the PBL model integrated with the use of e-modules. In each learning session, students were faced with authentic problems relevant to the IPAS material. The e-module served as the main medium facilitating students in identifying problems, gathering information, analyzing data, formulating hypotheses, and drawing conclusions—all key stages in PBL. After a series of learning activities using the PBL approach integrated with the e-module, a posttest was

then given to the students. The results of this posttest consistently showed a significant improvement in critical thinking skills in the experimental class, indicating the effectiveness of the combination of the PBL model and e-module in the context of IPAS learning in elementary schools.

Product Feasibility Assessment

This research aims to determine the feasibility of a PBL-based e-module for IPAS learning in Grade V. The feasibility assessment covers three aspects: content, media, and language, each evaluated by two experts in the respective fields. The product is validated through three stages—expert review, revision, and trial—to ensure it meets the criteria for effective classroom use. After these stages, the Aiken's V index is calculated to decide whether the e-module is suitable for use. Based on the feasibility test results, the material feasibility value obtained based on the holistic Aiken index is 0.717, categorized as valid; the media feasibility value is 0.911, categorized as very valid; and the language feasibility value is 0.747, categorized as valid. Therefore, it can be concluded that the e-module produced is suitable for field testing on the experimental class sample.

Product Practicality Assessment

To assess how easy and useful the newly developed product is, a small trial was conducted. This test involved a total of 12 students from the participating schools. Specifically, the group consisted of two students who had scored high, two with average scores, and two with low scores from each participating school. This limited-scale test involved a diverse group of students with varying levels of ability. The findings regarding the product's practicality in this study are presented in the Table 3 below:

Table 3. Student Practicality Test Results

No	Aspect	Percentage	Interpretation
1	Content	84%	Very Practical
2	Media	85%	Very Practical
3	Language	84%	Very Practical
Average		**84%**	**Very Practical**

The practicality assessment, involving six fifth-grade students from the experimental class of each participating school, indicated high usability. The material, media, and language components each received an 84%, 85%, and 84% rating, respectively, all deemed 'very practical.' With an average practicality score of 84%, the product is also considered 'very practical,' concluding its suitability for broader implementation and testing after this initial phase.

Product Effectiveness

To evaluate how well the developed product worked, students' critical thinking abilities were measured using their scores on initial (pretest) and final (posttest) assessments. This allowed the researchers to see how effective the e-module was in enhancing the critical thinking skills of fifth graders. Students from two chosen schools took a pretest with 14 open-ended questions before the e-module was used in their lessons. Following the pretest, the experimental group used the e-module during their learning activities. This was done to measure the degree to which their critical thinking skills improved. In contrast, the control group continued with traditional teaching methods to allow for a comparison of the progress made by both groups. The posttest results,

presented as percentages for each critical thinking skill indicator, are shown in the table 4 and table 5.

Table 4. Results of Critical Thinking Identification of Fifth-Grade Students at UPT SDN 1 Parerejo

No.	Indicator	Control Group Average	Experimental Group Average
1	*Elementary Clarification*	56.67%	67.61%
2	*Basic Support*	64.17%	72.73%
3	*Inference*	60.00%	68.56%
4	*Advanced Clarification*	48.33%	67.80%
5	*Strategies and Tactics*	59.58%	71.02%
Average		57,75%	69,54%

Table 5. Results of Critical Thinking Identification of Fifth-Grade Students at UPT SDN 1 Mataram

No.	Indicator	Control Group Average	Experimental Group Average
1	*Elementary Clarification*	50.00%	65.91%
2	*Basic Support*	58.52%	71.02%
3	*Inference*	46.21%	66.67%
4	*Advanced Clarification*	46.59%	70.08%
5	*Strategies and Tactics*	51.70%	78.69%
Average		50,60%	70,47%

The identification of critical thinking skills in both UPT SDN 1 Parerejo and UPT SDN 1 Mataram shows a consistent trend of higher scores in the experimental classes that used the e-module compared to the control classes. For the Elementary Clarification indicator, UPT SDN 1 Parerejo's control class scored 56.67% while its experimental class scored 67.61%; similarly, UPT SDN 1 Mataram's control class scored 50% and the experimental class 65.91%. On the Basic Support indicator, Parerejo's control and experimental classes scored 64.17% and 72.73%, respectively, while Mataram scored 58.52% and 71.02%. For the Inference indicator, Parerejo recorded 60.00% from control class and 68.56% from experimental class, while Mataram showed 46.21% (control) and 66.67% (experimental). In the Advanced Clarification indicator, Parerejo's control class averaged 48.33% and the experimental class 67.80%; Mataram followed with 46.59% (control) and 70.08% (experimental). Lastly, for the Strategies and Tactics indicator, Parerejo scored 59.58% (control) and 71.02% (experimental), while Mataram showed 51.70% (control) and 78.69% (experimental). Overall, both schools demonstrated significant improvements in all indicators of critical thinking skills when the e-module was implemented in the experimental classes.

Hypothesis Testing

In this study, the independent t-test was used to measure the difference in means between two independent or unrelated sample groups. This test was conducted on the experimental and control classes in two selected schools, and the results of the hypothesis test are presented in the Table 6 and Table 7 below:

Table 6. Result of *Independent Sample T-Test* at UPT SDN 1 Parerejo

	Group	N	Mean	Std. Deviation	Std. Error Mean
Score	Experimental Group	20	76.60	10.505	2.349
	Control Group	15	47.27	11.241	2.902

		F	Sig.	T	df	Sig (2 tailed)
Score	*Equal Variance Assumed*	.022	.882	7.935	33	<.001
	Equal Variances Not Assumed			7.856	29.137	<.001

Table 7. Result of *Independent Sample T-Test* di UPT SDN 1 Mataram

	Group	N	Mean	Std. Deviation	Std. Error Mean
Score	Experimental Group	22	71.36	13.329	2.842
	Control Group	12	50.32	9.524	2.030

		F	Sig.	t	df	Sig (2 tailed)
Score	*Equal Variance Assumed*	7.108	.011	6.026	42	<.001
	Equal Variances Not Assumed			76.026	38.009	<.001

Based on the results of the descriptive analysis, the experimental class at UPT SDN 1 Parerejo achieved an average score of 76.60, while the control class scored 47.27. A similar pattern was observed at UPT SDN 1 Mataram, where the experimental class scored an average of 71.36, compared to 50.32 in the control class. These results indicate an improvement in student learning outcomes. Therefore, it can be concluded that the use of PBL-based e-modules has a significant positive effect on enhancing the critical thinking and problem-solving skills of Grade V students. Furthermore, the hypothesis test (as shown in the following table) yielded a significance value of < 0.001, which is lower than $\alpha = 0.05$. This means that H_o is rejected and H_a is accepted.

DISCUSSION

The findings from both schools clearly demonstrate that students in the experimental classes, who were exposed to the PBL-based e-modules, outperformed those in the control groups. This outcome can be explained through the lens of constructivist learning theory, which underpins the Problem-Based Learning (PBL) approach used in the e-module. According to this theory, knowledge is actively constructed by learners through experiences that engage them in meaningful problem-solving. The PBL model places students at the center of the learning process, encouraging them to collaborate, investigate real-world problems, and reflect critically on their findings.

Development of a PBL E-Module

This Research and Development study employed a structured e-module design using *Canva* and followed the iterative ADDIE model for development. The ADDIE model's sequential and reflective process ensures product feasibility by refining each phase, providing a robust framework for creating adaptive learning devices and infrastructures that optimize outcomes. Each phase in ADDIE builds upon the improvements of the previous stage, ensuring the final product meets feasibility standards. This structured process also includes specific steps for selecting and designing media that align with research objectives, supporting the creation of adaptive and effective learning tools. Crucially, the e-module integrates a Problem-Based Learning (PBL) model, a vital step given its effectiveness in empowering students to solve real problems, challenging their logic, and fostering critical analysis. PBL's constructivist nature enhances scientific literacy by promoting independent learning and problem identification, which are essential for developing critical thinking skills through topics like environmental pollution. As a constructivist approach, PBL supports the development of students' scientific literacy by encouraging active problem-solving and deep understanding. The resulting e-module, a structured independent teaching material equipped with supporting components, offers significant positive impacts for both teachers and students. By leveraging technology, becomes a structured and comprehensive learning resource tailored to students' unique needs, presenting complex concepts in an engaging manner to enhance understanding and motivation, while also supporting teachers and students in achieving effective and innovative learning.

Feasibility of the PBL E-Module

The results of the feasibility test obtained through the material, media, and language validation stage show that the product is suitable for implementation in a wide-scale trial activity, with percentage details obtained at this stage including 72% in the material feasibility test with the feasible category, 91% in the media feasibility test with the very feasible category, and 75% in the language feasibility test with the feasible category. Based on these results, the experts involved in this research agreed that the use of PBL-based e-modules is suitable for use in learning activities in class V, especially in eye anatomy, eye seeing processes, and various visual impairments. This process aims to ensure that the produced e-modules are of high quality and meet the criteria as a feasible learning product. The instrument used in expert validation is a closed questionnaire with a rating scale. In this activity, the validators provide assessments, critiques, and constructive suggestions to identify shortcomings and errors in the e-modules being developed. This feedback becomes an important foundation for researchers to make necessary improvements, so that the e-modules become products that are ready and suitable for implementation in the learning process. Validation tests involve six experts from three relevant fields of expertise, with each field represented by two competent lecturers in their respective fields.

Effectiveness of the PBL E-Module

Statistical analysis uses the independent sample t-test and obtained results that the average percentage aligns with critical thinking skills in the experimental class that uses e-module in learning activities, which is higher compared to the control class that does not use e-module in learning activities. Thus, it can be concluded that the use of e-modules is effective in enhancing students' critical thinking skills. These results are also consistent with several previous studies

conducted by earlier researchers, where the use of e-module in learning activities has a positive impact on students, such as presenting interactive learning situations that connect material with real-world contexts and facilitating students in the process of understanding concepts. Furthermore, the use of e-module also allows students to optimize their learning activities according to their individual abilities and learning styles, enabling each individual to focus on problems and the process of finding solutions. The integration of e-module in learning is a way to accommodate the diverse learning styles of students, making it an important resource in facing challenges and achieving 21st-century educational goals.

Implications for Practical Activities

The research findings offer several beneficial implications for enhancing educational practice. Teachers are encouraged to develop technological skills to create and use e-modules, which are proven to simplify abstract material and boost critical thinking. Education authorities at the regency or city level should support teacher development through training programs, such as e-module creation workshops. Teachers who attend can then share their knowledge and act as peer tutors to help colleagues learn the process—from understanding what an e-module is to producing one. Lastly, school principals ought to motivate teachers to enhance learning quality via various activities, including online training and peer skill-sharing, to promote collective professional development.

Despite successfully enhancing students' critical thinking skills, this research encountered several challenges. Issues included variations in Android device specifications, network quality, and students' e-module operational proficiency. Moreover, the e-module's reliance on internet connectivity led to disruptions during power outages or telecommunication issues. Given the study's scope of only two schools, its findings have limited generalizability. Consequently, future researchers should prioritize developing offline-compatible Android e-modules to mitigate connectivity problems. future studies should aim to develop e-modules that can be accessed offline to reduce such technical barriers. It is also recommended that future research involve a larger and more diverse sample to produce more representative findings, enabling broader generalization, greater accuracy, and increased ability to detect significant effects.

CONCLUSION AND RECOMMENDATIONS

Conclusion

This study shows that students' critical thinking skills in Grade V of elementary school can be improved by using PBL-based e-modules taught in IPAS materials. The results of a feasibility test conducted by experts consisting of material experts, media experts, and linguists showed that the taught problem-based e-modules were valid and ready for use. The results of the effectiveness analysis also show that e-modules can improve students' critical thinking skills, but there are several problems that prevent wider access to e-modules.

Recommendations

Research findings demonstrate that using PBL e-modules in science lessons significantly boosted the critical thinking abilities of fifth graders at two specific elementary schools. This suggests that teachers should consider incorporating these digital resources into their teaching methods to enhance both their effectiveness and student learning. To make these e-modules even

better, future research should focus on addressing the current limitations and further refining them.

REFERENCE

Ahdhianto, E., Masula, S., Thohir, M. A., & Khotimah, K. (2024). Pengembangan E-modul Berbasis PBL untuk Meningkatkan Keterampilan Pemecahan Masalah dan Berpikir Kritis Siswa Sekolah Dasar. *Jurnal Math Educator Nusantara: Wahana Publikasi Karya Tulis Ilmiah Di Bidang Pendidikan Matematika*, *10*(1), 167–178. https://doi.org/10.29407/jmen.v10i1.22376

Alda, M. (2023). Pengembangan Aplikasi Pengolahan Data Siswa Berbasis Android Menggunakan Metode Prototyping. *Jurnal Manajemen Informatika (JAMIKA)*, *13*(1), 11–23. https://doi.org/10.34010/jamika.v13i1.8216

Alda, M., Limbong, R. B., Rambe, A. I. P., & Adhita, A. (2022). Perancangan Aplikasi Pengelolaan Stok Menggunakan Kodular Designing An Application For Stock Management Using Kodular And Airtable. *Teknologi: Jurnal Ilmiah Sistem Informasi*, *12*(2), 8–15. https://doi.org/https://doi.org/10.26594/teknologi.v12i2.3261

Antonius, A., Huda, N., & Suratno, S. (2022). Pengembangan E-Modul Interaktif Pembelajaran Gambar Teknik Berbasis Keterampilan Kreatif Untuk Siswa Smk. *Jurnal Manajemen Pendidikan Dan Ilmu Sosial*, *3*(2), 1090–1102. https://doi.org/10.38035/jmpis.v3i2.1347

Aprina, E. A., Fatmawati, E., & Suhardi, A. (2024). Penerapan Model Problem Based Learning Untuk Mengembangkan Keterampilan Berpikir Kritis Pada Muatan IPA Sekolah Dasar. *Didaktika: Jurnal Kependidikan*, *13*(1), 981–990. https://doi.org/https://doi.org/10.58230/27454312.496

Arifin, Z. (2017). *Mengembangkan Instrumen Pengukur Critical Thingking Skills Siswa pada Pembelajaran Matematika Abad 21* (pp. 92–100). Jurnal THEOREMS (The Original Research of Mathematics). https://doi.org/http://dx.doi.org/10.31949/th.v1i2.383

Arova, R. B., Rosidi, I., Muharrami, L. K., Qomaria, N., & Fikriyah, A. (2024). Uji Kelayakan E-Modul Berbasis Web Menggunakan Situs Google sites Pada Materi Zat Aditif Dan Adiktif. *Jurnal Natural Science Educational Research*, *7*(1), 81–84. https://doi.org/https://doi.org/10.21107/nser.v7i1.11967

Asri, K., Haryani, S., Ellianawati, Subali, B., & Widiarti, N. (2024). Pengembangan e-modul IPAS berbasis Problem Based Learning untuk Meningkatkan Keterampilan Berpikir Kritis Siswa SD. *Pendas : Jurnal Ilmiah Pendidikan Dasar*, *09*(03), 90–105. https://doi.org/https://doi.org/10.23969/jp.v9i03.15839

Eugara, A. F., & Efendi, R. (2023). Evektivitas Penggunaan E-module Sebagai Media Pembelajaran Untuk Meningkatkan Hasil Belajar Siswa. *Jurnal Pendidikan*, *32*(1), 19–32. https://doi.org/https://doi.org/10.32585/jp.v32i1.3288

Febriyanti, K. N., & Hidayat, W. N. (2024). Pengembangan Media Pembelajaran Mobile Learning Berbasis Android Berbantuan Thunkable dengan Model Project Based Learning pada Materi CSS Kelas X Program Keahlian PPLG. *Journal of Innovation and Teacher Professionalism*, *2*(2), 184–194. https://doi.org/10.17977/um084v2i22024p184-194

Firanti, F. F., Erviyenni, & Erna, M. (2024). Uji Kelayakan E-Modul Asam Basa Berbasis SSI (Socio-Scientific Issues) Berbantuan Flip PDF Professional. *Jurnal Pendidikan Kimia Undiksha*, *8*(1), 20–28. https://doi.org/10.23887/jjpk.v8i1.70540

Fitriyani, Hidayat, S., & Rusdiyani, I. (2022). Pengembangan E-Modul Berbasis Digital Flipbook Pada Materi Siklus Air Di Kelas V. *Jurnal Riset Pendidikan Dasar*, *05*(2), 116–124.

https://doi.org/https://doi.org/10.26618/jrpd.v5i2.7864

Gufran, G., & Mataya, I. (2020). Pemanfaatan E-Modul Berbasis Smartphone Sebagai Media Literasi Masyakarat. *JISIP (Jurnal Ilmu Sosial Dan Pendidikan)*, *4*(2). https://doi.org/10.58258/jisip.v4i2.1060

Guntar, M. (2023). The Integration Of 21 st Century Learning And Innovation Skills In EFL Classrooms. *English Language & Literature International Conference*, *6*(1), 443–453. https://jurnal.unimus.ac.id/index.php/ELLIC/index

Hapidin, A., Ruswandi, A., & Zaqiah, Q. Y. (2024). Inovasi Kurikulum Sebagai Sebuah Keniscayaan dalam Pendidikan di Indonesia. *JOTTER: Journal of Teacher Training and Educational Research*, *2*(2), 47–57. https://doi.org/https://doi.org/10.71280/jotter.v2i2.400

Heryadi, F. (2021). Penggunaan Google Forms Sebagai Media Pembelajaran Daring Di Masa Pandemi Covid-19 Pada Mata Pelajaran Sejarah Di SMK Negeri 2 Ketapang. *SWADESI: Jurnal Pendidikan Dan Ilmu Sejarah*, *2*(1), 14. https://doi.org/10.26418/swadesi.v2i1.45421

Ilmi, A. R. M., & Puspita, E. (2020). Keterampilan Berpikir Tingkat Tinggi dalam Pembelajaran Sains. *GENAWUAN Jurnal Pendidikan Dan Keguruan*, *02*(01), 1–13.

Islahiyah, I., Pujiastuti, H., & Mutaqin, A. (2021). Pengembangan E-Modul Dengan Model Pembelajaran Berbasis Masalah Untuk Meningkatkan Kemampuan Pemecahan Masalah Matematis Siswa. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, *10*(4), 2107. https://doi.org/http://dx.doi.org/10.24127/ajpm.v10i4.3908

Istiqomah, I., Masriani, M., Rasmawan, R., Muharini, R., & Lestari, I. (2022). Pengembangan E-Modul Flipbook IPA Berbasis Problem Based Learning pada Materi Pencemaran Lingkungan. *JurnalBasicedu*, *6*(5), 9156–9169. https://doi.org/10.31004/basicedu.v6i5.3558

Jaya, H., Hambali, M., & Fakhrurrozi, F. (2023). Transformasi Pendidikan: Peran Pendidikan Berkelanjutan Dalam Menghadapi Tantangan Abad Ke-21. *Jurnal Review Pendidikan Dan Pengajaran*, *6*(4), 2416–2422. https://doi.org/https://doi.org/10.31004/jrpp.v6i4.21907

Juliawan, I. W., Suastini, N. W., Yuliastini, N. K. S., Susanta, I. W., Badriah, R. D. U., & Suharditha, K. (2024). Penerapan Google Form Sebagai Alat Evaluasi Pembelajaran di SDN 5 Kediri. *Sewagati*, *3*(2), 25–30. https://doi.org/https://doi.org/10.59819/sewagati.v3i2.4155

Kimianti, F., & Prasetyo, Z. K. (2019). Pengembangan E-Modul Ipa Berbasis Problem Based Learning Untuk Meningkatkan Literasi Sains Siswa. *Kwangsan: Jurnal Teknologi Pendidikan*, *7*(2), 91. https://doi.org/10.31800/jtp.kw.v7n2.p91--103

Kodariyati, L., & Astuti, B. (2016). Pengaruh Model PBL Terhadap Kemampuan Komunikasi dan Pemecahan Masalah Matematika Siswa Kelas V SD. *Jurnal Prima Edukasia*, *4*(1), 93. https://doi.org/10.21831/jpe.v4i1.7713

Lastri, Y. (2023). Pengembangan Dan Pemanfaatan Bahan Ajar E-Modul Dalam Proses Pembelajaran. *Jurnal Citra Pendidikan*, *3*(3), 1139–1146. https://doi.org/10.38048/jcp.v3i3.1914

Lubis, R. R., Irene, S., Dwiningrum, A., & Zubaidah, E. (2023). Development Powtoon Animation Video in Indonesian Language Learning to Improve Student Learning Outcomes Elementary Schools. *Journal of Computer Science, Information Technology and Telecommunication Engineering*, *4*(2), 23–25. https://doi.org/10.30596/jcositte.v4i2.15990

Maudiyawati, Elfina, Nyolle, Saputra, A., & Akram. (2024). Pemanfaatan Media Google Form Sebagai Alat Pengembangan Media Pembelajaran. *Jurnal Pengabdian Kepada Masyarakat Nusantara (JPkMN)*, *6*(1), 546–553. https://doi.org/https://doi.org/10.55338/jpkmn.v6i1.1.4906

Muavi, M., Mustaji, M., Sumarno, A., Widodo, S., & Bidandari, A. (2024). Pengaruh Model Problem Based Learning (PBL) Terhadap Kemampuan Berfikir Kritis dan Pemecahan Masalah Pada Mata Pelajaran Geografi Siklus Hidrologi Bagi Siswa Kelas X Di SMA Negeri 1 Ketapang Kabupaten Sampang. *JEMSI: Jurnal Ekonomi Manajemen Sistem Informasi*, *6*(2), 791–804. https://doi.org/https://doi.org/10.38035/jemsi.v6i2

Mudrikah, A. (2021). Problem Based Learning as Part of Student-Centered Learning. *Social, Humanities, and Educational Studies (SHEs): Conference Series*, *3*(4), 1. https://doi.org/10.20961/shes.v3i4.53237

Nila, W. T., & Mustika, D. (2022). Pengembangan E-modul Berbasis Model Problem Based Learning (PBL) Materi Organ Gerak Hewan dan Manusia Kelas V. *Jurnal Pendidikan Dan Konseling*, *4*(2), 411–422. https://doi.org/https://doi.org/10.31004/jpdk.v4i2.4129

Nopiani, S., Purnamasari, I., Nuvitalia, D., & Rahmawati, A. (2023). Kompetensi 4C Dalam Implementasi Kurikulum Merdeka Di Kelas Iv Sekolah Dasar. *Didaktik : Jurnal Ilmiah PGSD STKIP Subang*, *9*(2), 5202–5210. https://doi.org/10.36989/didaktik.v9i2.1136

Pramadjaya, A., Septiani, S., Ramadhan, A. S., & Irawan, S. (2024). Pemanfaatan Google Form Sebagai Media Pengumpulan Data dan Evaluasi Pembelajaran di MAN 2 Kabupaten Serang. *Abdi Laksana : Jurnal Pengabdian Kepada Masyarakat*, *5*(3), 565–573.

Prasetyo, A. (2024). Implementasi Pendekatan Teknologi Dalam Pengembangan Kurikulum Merdeka Di Sekolah Dasar. *Dharmas Education Journal (DE_Journal)*, *5*(1), 32–39. https://doi.org/10.56667/dejournal.v5i1.1044

Priyadi, M. S., Rachmatia, M., Al Hadi, I. A., & Suhariyanti, M. (2024). Kendala Implementasi Kurikulum Merdeka Di Sekolah Dasar. *Griya Cendikia*, *9*(1), 114–121. https://doi.org/10.47637/griyacendikia.v9i1.1094

Puspa, C. I. S., Rahayu, D. N. O., & Parhan, M. (2023). Transformasi Pendidikan Abad 21 dalam Merealisasikan Sumber Daya Manusia Unggul Menuju Indonesia Emas 2045. *Jurnal Basicedu*, *7*(5), 3309–3321. https://doi.org/10.31004/basicedu.v7i5.5030

Putri, R. K., Zaini, M., & Mangkurat, U. L. (2024). *The Validity and Practicality of the Popular Scientific Book "Diversity of Haliau River Fish" Against Students' Critical Thingking Skills*. *5*(2), 125–135. https://doi.org/https://doi.org/10.20527/jbse.v5i2.340

Rahayu, R., Iskandar, S., & Abidin, Y. (2022). Inovasi Pembelajaran Abad 21 dan Penerapannya di Indonesia. *Jurnal Basicedu*, *6*(2), 2099–2104. https://doi.org/10.31004/basicedu.v6i2.2082

Rahmawati, I. (2022). Pengaruh Penggunaan Model Pembelajaran Abad 21 Terhadap Kemampuan Kognitif Peserta Didik Sekolah Dasar. *EDUSAINTEK: Jurnal Pendidikan, Sains Dan Teknologi*, *9*(2), 404–418. https://doi.org/10.47668/edusaintek.v9i2.461

Riskynianyo, H. R., Novita, L., & Windiyani, T. (2024). Pengembangan E-Modul Berbasis Flipbook Materi Manusia dan Lingkungan. *Journal on Education*, *06*(03), 16091–16099. https://doi.org/https://doi.org/10.31004/joe.v6i3.5491

Rismawati, M., Rahmawati, P., & Rindiani, A. B. (2022). Analisis Kemampuan Berpikir Tingkat Tinggi dalam Pemecahan Masalah Matematika Berbasis Higher Order Thinking Skill (HOTS). *Jurnal Cendekia : Jurnal Pendidikan Matematika*, *6*(2), 2134–2143. https://doi.org/10.31004/cendekia.v6i2.1444

Rohim, H. V., Sinensis, A. R., & Effendi. (2024). Uji Kelayakan : E-Modul Praktikum Intersktif Berbasis PBL untuk Meningkatkan Critical Thinking. *U-Teach: Journal Education of Young Physics Teacher*, *5*(2), 91–97. https://doi.org/https://doi.org/10.30599/uteach.v5i2.185

Rusmiati, M. N., Ashifa, R., & Herlambang, Y. T. (2023). Analisis Problematika Implementasi Kurikulum Merdeka di Sekolah Dasar. *Naturalistic: Jurnal Kajian Dan Penelitian Pendidikan Dan Pembelajaran*, *7*(2), 1490–1499. https://doi.org/10.35568/naturalistic.v7i2.2203

Santoso, E., Sugiyanti, S., & Pramasdyah Sari, A. S. (2023). Pengembangan E-modul Berbasis Problem based learning Untuk Meningkatkan Kemampuan Berpikir Kritis Siswa SMP Materi Statistika. *JEID: Journal of Educational Integration and Development*, *3*(2), 103–113. https://doi.org/10.55868/jeid.v3i2.286

Setiawan, T. A., Harsih, L. M., & Kultsum, U. (2021). Analisis Penerapan Model Pembelajaran Problem Based Learning, Direct Instruction, dan Student Centered Learning di Sekolah Dasar dalam Pembelajaran Selama Masa Pandemi. *Jurnal Jendela Pendidikan*, *1*(04), 232–238. https://doi.org/10.57008/jjp.v1i04.58

Sindi, S. L. B., Sofyan Iskandar, & Dede Trie Kurniawan. (2023). Optimalisasi Penerapan Model Pembelajaran Berbasis Permainan dalam Pembelajaran Abad 21 di Sekolah Dasar. *Jurnal Lensa Pendas*, *8*(1), 9–16. https://doi.org/10.33222/jlp.v8i1.2504

Ula, I. R., & Fadila, A. (2018). Pengembangan E-Modul Berbasis Learning Content Development System Pokok Bahasan Pola Bilangan SMP. *Desimal: Jurnal Matematika*, *1*(2), 201. https://doi.org/10.24042/djm.v1i2.2563

Umam, K. (2021). Kurikulum dan Tuntutan Kompetensi Abad 21. *Nusantara : Jurnal Pendidikan Indonesia*, *1*(3), 511–526. https://doi.org/https://doi.org/10.14421/njpi.2021.v1i3-4

Utari, D., & Muadin, A. (2023). Peranan Pembelajaran Abad-21 Di Sekolah Dasar Dalam Mencapai Target Dan Tujuan Kurikulum Merdeka. *Jurnal Pendidikan Islam Al-Ilmi*, *6*(1), 116. https://doi.org/10.32529/al-ilmi.v6i1.2493

Wijayanti, R., Nasution, W. R., & Satria, E. (2025). Inovasi Kurikulum untuk Pendidikan Abad 21 : Tinjauan Literatur. *Jurnal Ilmiah Edukatif*, *11*(1), 175–183. https://doi.org/https://doi.org/10.37567/jie.v11i1.3658

Yunita, H., Meilanie, S. M., & Fahrurrozi, F. (2019). Meningkatkan Kemampuan Berpikir Kritis melalui Pendekatan Saintifik. *Jurnal Obsesi : Jurnal Pendidikan Anak Usia Dini*, *3*(2), 425. https://doi.org/10.31004/obsesi.v3i2.228