Jurnal Bidang Pendidikan Dasar
Vol 10 No 1, January 2026, pp 73 - 83
Available at:
http://ejournal.unikama.ac.id/index.php/JBPD

The effect of project-based e-modules on fifth-grade students' critical thinking in magnetic force and motion

Henny Pusporini*, Surayanah, I Wayan Dasna

Universitas Negeri Malang, Jl. Semarang No. 5, Malang, East Java, 65145, Indonesia
*henny.pusporini.2221038@students.um.ac.id**

Abstract: *This study used a quantitative quasi-experimental design with a nonequivalent control group involving 56 fifth-grade students from two public elementary schools in Blitar Regency, Indonesia. The experimental group (n = 28) learned through a Project-Based Learning (PjBL)-based e-module developed with the Heyzine Flipbook platform, while the control group (n = 28) used government textbooks. Cluster sampling selected intact classes. The intervention lasted eight meetings on magnetic force and motion. Pre- and post-tests measured critical thinking skills. The e-module followed six PjBL stages and integrated multimedia elements (animations, videos, simulations, quizzes). Instruments included a critical thinking test, a 25-item motivation questionnaire, and observation sheets. All instruments were expert-validated with strong reliability (Cronbach's α > 0.80). Data were analyzed using descriptive statistics, independent samples t-test, and two-way ANOVA at a 0.05 significance level.*

Keywords*:* e-module, project-based learning, critical thinking, learning motivation, science education

Introduction

The integration of digital technology in elementary education has become increasingly important in responding to the demands of 21st-century learning. Science education, in particular, requires instructional approaches that not only deliver conceptual knowledge but also develop higher-order thinking skills and positive learning attitudes. However, classroom practices in elementary schools still tend to emphasize textbook-based instruction and teacher-centered explanations, which limit students' opportunities to actively construct knowledge and develop critical thinking skills.

Project-Based Learning (PjBL) is rooted in constructivist theory, which views learning as an active process of knowledge construction through meaningful experiences. PjBL engages students in solving authentic problems, designing projects, conducting investigations, and reflecting on outcomes. Through these stages, students are encouraged to analyze information, evaluate evidence, and formulate reasoned conclusions, processes that are closely aligned with critical thinking indicators. Empirical studies have consistently reported that PjBL improves higher-order thinking skills because it situates learning in contextual and inquiry-based activities.

In the 21st century, education increasingly emphasizes the development of essential competencies that prepare students to navigate a complex and interconnected world. Among these are the "4Cs" Critical Thinking, Creativity, Communication, and Collaboration which enable students to analyze information critically, approach problems innovatively, collaborate effectively, and communicate ideas clearly. Mastery of these skills is considered vital for academic success as well as future professional and societal challenges. Critical

https://doi.org/10.21067/jbpd.v10i1.12802

thinking is defined as the ability to interpret, analyze, evaluate, infer, and explain information logically and systematically. In science learning, critical thinking is essential for understanding abstract concepts, testing ideas, and solving problems scientifically. Despite its importance, national and international assessments indicate that students' scientific literacy and higher-order thinking skills remain relatively low. This condition signals the need for innovative instructional models that explicitly facilitate critical thinking development.

In addition to cognitive aspects, learning motivation is a key determinant of students' academic success. Motivation influences attention, persistence, and the willingness to engage in cognitively demanding tasks. Theoretically, students with higher motivation are more likely to employ deeper learning strategies and demonstrate stronger critical thinking performance. Therefore, instructional innovation should address both cognitive and affective dimensions simultaneously.

Previous studies have shown that PjBL enhances critical thinking, while other research has demonstrated that electronic modules improve learning motivation and engagement. However, these studies generally examine PjBL or digital media separately. Research integrating PjBL within an interactive electronic module and simultaneously analyzing its effect on both critical thinking and learning motivation especially at the elementary school level remains limited (Herlina et al., 2020). Moreover, the interaction effect between instructional media and students' motivation levels has rarely been investigated. Research highlights the importance of incorporating ICT tools, such as e-modules, into educational practices to cultivate these 21st-century skills. By utilizing digital platforms, educators can create dynamic learning environments that foster active participation, teamwork, and critical thinking (Khasanah et al., 2017; H. Pratama & Prastyaningrum, 2016). Beyond improving learning outcomes, technology integration equips students with the capabilities required to thrive in an increasingly digital and fast-changing world.

Several studies have emphasized the potential of digital media in overcoming such challenges. Recent findings demonstrate that interactive flipbook-based e-modules, when combined with PjBL, enhance students' critical thinking and motivation by engaging them in collaborative investigations, experimentation, and reflection activities (Endaryati et al., 2021; Erdi et al., 2022). This method fosters deeper scientific concept mastery while remaining consistent with the Merdeka Curriculum's focus on contextual and learner-centered education. However, despite its promising outcomes, research on the integration of e-modules with PjBL at the elementary school level, especially in science topics such as magnetic force and motion, remains limited.

This study introduces a novel approach by evaluating the effectiveness of PjBL integrated e-modules featuring interactive flipbook elements. These e-modules aim to simultaneously enhance critical thinking skills and student motivation in elementary science education, specifically focusing on the topic of magnetic force and motion (Pratama et al., 2018; Herawati & Muhtadi, 2020). The integration of interactive features such as animations and simulations within the e-modules allows students to visualize and engage with scientific concepts in a dynamic and meaningful way, thereby fostering a deeper understanding and interest in the subject matter .

Therefore, this study aims to examine the effect of a PjBL-based electronic module on students' critical thinking skills and learning motivation in elementary science learning, as well as to analyze the interaction between learning media and motivation level. The novelty of this study lies in the integration of PjBL pedagogy into a flipbook-based interactive e-module and the simultaneous empirical examination of its cognitive and motivational impacts in primary science education. This integrated approach provides a more comprehensive framework for

enhancing both higher-order thinking skills and learning motivation in elementary classrooms.

Method

The study was carried out using a quasi-experimental method in the quantitative domain, with a nonequivalent control group as the research design. Such a design was selected because random assignment was not feasible in the elementary school context due to administrative and ethical considerations, yet it still allowed for analyzing the effects of the intervention. The research involved two groups of fifth-grade students from UPT SD Negeri Karangsono 02 (experimental group, n = 28) and UPT SD Negeri Minggirsari (control group, n = 28), with a total sample of 56 students. Both groups undertook a pre-test and a post-test; nevertheless, the experimental class was instructed through a PjBL-based e-module created with Heyzine Flipbook, whereas the control class was taught using standard government-issued textbooks. The research design is presented as follows in Table 1 and Figure 1.

Table 1. Research Design of the Study

Group	Pre-test	Treatment	Post-test
Experimental	O_1	X_1: PjBL-based e-module (Y_1: Motivation)	O_2
Control	O_3	X_2: Conventional textbook (Y_2: Motivation)	O_4

Note. O_1 and O_3 = students' critical thinking and motivation scores before treatment (pre-test); O_2 and O_4 = students' scores after treatment (post-test); X_1 = PjBL-based e-module; X_2 = conventional textbook; Y_1 = motivation in the experimental group; Y_2 = motivation in the control group.

Table 2. Grid of Critical Thinking Skills Instrument

Variable	Indicator	Operational Description	Item Numbers	Total Items	Item Type
Critical Thinking	Interpretation	Ability to understand and clarify scientific information about magnetic force and motion	1, 2, 3	3	Multiple Choice
	Analysis	Ability to identify relationships between magnetic force and object movement	4, 5, 6, 7	4	Multiple Choice
	Evaluation	Ability to assess the validity of arguments or experimental results	8, 9, 10	3	Multiple Choice
	Inference	Ability to draw logical conclusions from data or observations	11, 12, 13, 14	4	Multiple Choice
	Explanation	Ability to justify answers and explain reasoning scientifically	15–20	6	Essay

Table 3. Grid of Learning Motivation Questionnaire

Variable	Dimension	Indicator	Item Numbers	Total Items	Scale
Learning Motivation	Intrinsic Motivation	Curiosity toward science concepts	1, 2, 3, 4	4	Likert 1–5
		Enjoyment in completing science projects	5, 6, 7	3	Likert 1–5
	Extrinsic Motivation	Effort to obtain good grades	8, 9, 10, 11	4	Likert 1–5
		Persistence in completing tasks	12, 13, 14, 15	4	Likert 1–5
		Active participation in group work	16–25	10	Likert 1–5

The instrument grids were developed based on established theoretical frameworks of critical thinking and learning motivation to ensure construct validity. Each indicator was operationalized into measurable items aligned with the learning objectives of magnetic force and motion.

To collect data, several instruments were employed. A critical thinking test consisting of multiple-choice and essay items was administered before and after the intervention to measure students' ability to analyze, evaluate, and solve problems related to magnetic force and motion. A motivation questionnaire using a five-point Likert scale was distributed to categorize students' learning motivation into low, medium, and high levels. In addition, an observation sheet and documentation were used to monitor the implementation of the PjBL syntax, student participation, and classroom conditions. Each instrument was validated by experts prior to use; The reliability analysis indicated strong internal consistency, as the Cronbach's alpha coefficients for both the critical thinking and motivation scales were above 0.80.

The research procedures included pre-testing, treatment implementation, and post-testing in both groups. The experimental class engaged in six stages of PjBL starting with essential questions, project design, scheduling, project execution, assessment, and reflection facilitated through interactive multimedia embedded in the e-module. Meanwhile, the control class followed teacher-centered instruction with conventional materials and exercises. Descriptive statistics were employed to provide an overview of the learning data outcomes and a two-way ANOVA to test hypotheses regarding the effects of the PjBL-based e-module and student motivation on critical thinking ability.

Results and Discussion

The results of the study are presented in several stages: descriptive statistics, assumption testing (normality and homogeneity), hypothesis testing with *t*-tests, and interaction testing using Two-Way ANOVA.

Table 1 displays the descriptive statistics of the post-test results for both the experimental and control groups (M = 82.5, SD = 6.1, n = 28) achieved a higher mean score compared to the control group (M = 70.3, SD = 7.4, n = 28). These findings indicate that

students who were taught using the PjBL-based e-module demonstrated better critical thinking performance than those who learned through conventional textbooks.

Table 4. Post-test Results of Experimental and Control Groups

Group	N	Mean	Stdev
Experimental (Post-test)	28	82.5	6.1
Control (Post-test)	28	70.3	7.4

Note. Experimental group = students using PjBL-based e-module; Control group = students using conventional textbooks.

Results of the independent samples t-test indicated a statistically significant difference across the two groups ($p < .05$), confirming that the use of PjBL-based e-modules had a positive effect on students' critical thinking skills. Furthermore, the Two-Way ANOVA results revealed a significant interaction between learning motivation and instructional media. Students with higher levels of motivation benefited more from the PjBL-based e-module, indicating that PjBL-based e-modules positively influenced students' critical thinking skills. Additionally, the Two-Way ANOVA revealed a significant interaction between learning motivation and instructional media, with highly motivated students gaining the most from the PjBL-based e-module. Sub-skills of analysis and evaluation, compared to those with lower motivation. This interaction highlights the importance of considering both instructional design and student motivation in improving science learning outcomes.

As illustrated in Tabel 1, the experimental group's post-test mean score was substantially higher than that of the control group, further supporting the positive influence of PjBL-based e-modules on students' critical thinking skills.

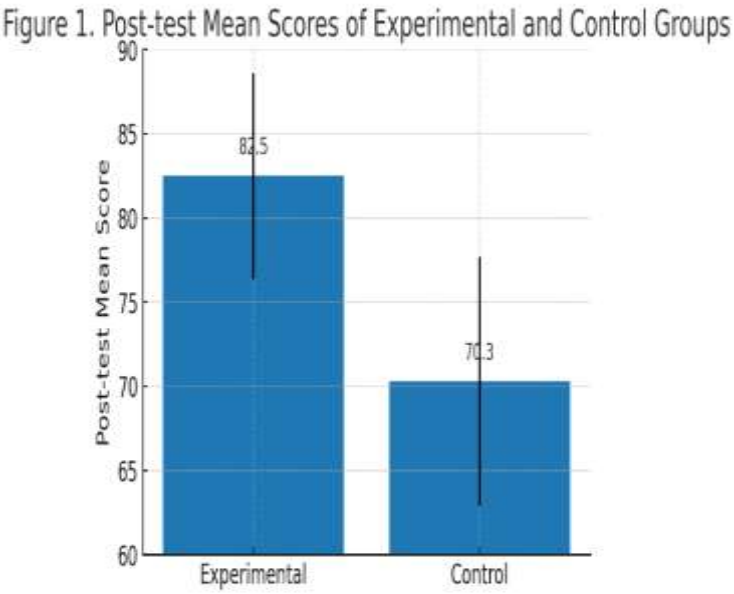

Figure 1. Post-test mean scores of experimental and control groups

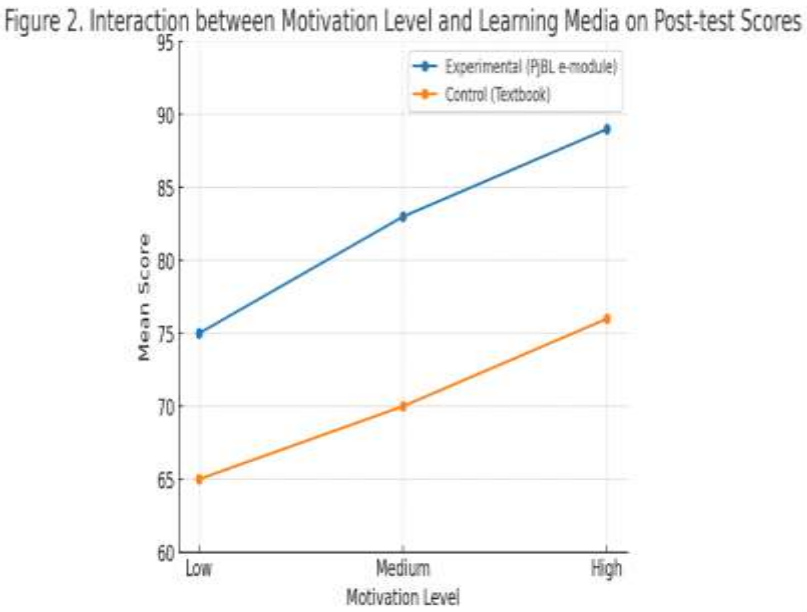

Figure 2. Interaction between motivation level and learning media on post-test scores.

Taken together, these findings demonstrate that the PjBL-based e-module not only improved students' overall critical thinking skills but also interacted positively with learning motivation, yielding the greatest benefits for highly motivated students.

Tabel 5. Two-Way ANOVA Results on Critical Thinking Skills

Source	SS	df	MS	F	Sig. (p)
Learning Media (X)	1456.321	1	1456.321	12.457	.001*
Motivation (Y)	1632.147	2	816.073	13.924	.000*
X × Y Interaction	984.236	2	492.118	8.413	.004*
Error	5987.341	50	119.747		
Total	10059.210	55			

Note. SS = Sum of Squares; df = degrees of freedom; MS = Mean Square; F = F-ratio; $p < .05$ indicates significant results.

The Two-Way ANOVA results in Table 2 reveal that both learning media and student motivation significantly influenced critical thinking skills. The main effect of learning media was significant, $F(1, 50) = 12.46$, $p = .001$, showing that students using the PjBL-based e-module outperformed those using traditional textbooks. Likewise, motivation had a significant main effect, $F(2, 50) = 13.92$, $p < .001$, with highly motivated students achieving higher critical thinking scores across both media. Notably, a significant interaction was found between learning media and motivation, $F(2, 50) = 8.41$, $p = .004$, indicating that the PjBL-based e-module was most effective for students with higher motivation.

The findings demonstrate that the PjBL based e-module significantly improves students' critical thinking skills compared to conventional textbook instruction. This result supports constructivist learning theory, which emphasizes active knowledge construction through inquiry and meaningful tasks. By engaging students in project-based activities, the e-module facilitates analysis, evaluation, and problem-solving processes that are essential components of critical thinking. The significant main effect of motivation confirms that motivated students tend to achieve higher cognitive outcomes . From a motivational

perspective, students with higher intrinsic and extrinsic motivation are more persistent and cognitively engaged in complex learning tasks. This aligns with previous findings that learning motivation enhances deeper information processing and academic performance. Unlike previous studies that examined PjBL or digital modules separately, this study integrates both approaches and empirically analyzes their interaction with motivation. Therefore, this research contributes to a more comprehensive understanding of how digital project-based learning environments foster both critical thinking and learning motivation in elementary science education.

The interaction effect between learning media and motivation indicates that the effectiveness of the PjBL-based e-module is influenced by students' motivational levels. Students with high motivation benefited more from the intervention, suggesting that instructional innovation and learner characteristics work synergistically in shaping learning outcomes. This finding strengthens previous research on PjBL and digital learning by demonstrating that cognitive and affective variables should be considered simultaneously. In addition, the significant main effect of motivation underscores the critical role of learner characteristics in academic success. Students with higher motivation levels consistently outperformed their less motivated peers, regardless of the instructional media used. This finding resonates with (Hapsari & Airlanda, 2018; , who emphasized that motivated learners are more engaged, persistent, and capable of tackling complex cognitive tasks. In the context of science education, motivation acts not only as a driving force for participation but also as a catalyst for critical thinking, allowing students to approach problem-solving tasks with greater perseverance and creativity. Thus, motivation should be considered an integral factor in the design and implementation of instructional strategies.

Most importantly, the interaction between learning media and motivation demonstrates that the effectiveness of PjBL-based e-modules is not uniform but is amplified among highly motivated learners. This interaction effect reflects Kristian, (2024) and finding that motivation enhances not only engagement but also the transferability of critical thinking skills to new and varied contexts. Such evidence highlights the scientific novelty of this study: while previous research tended to investigate the effects of either learning media or motivation independently, this study reveals the synergistic relationship between the two (Santosa, 2024). The implication is clear future instructional designs should not only focus on developing pedagogically sound digital resources but also incorporate strategies to foster and sustain students' motivation (Halimah & Winarni, 2021; Mohd Ikhwan & Azlina, 2019; Delita et al., 2022). By doing so, educators can maximize the cognitive and affective benefits of digital innovation in science learning.

The results of this study indicate that the use of a Project-Based Learning (PjBL)–based e-module significantly enhances students' critical thinking skills compared to conventional teaching methods. This finding is consistent with previous research, which has shown that PjBL effectively promotes higher-order thinking skills, increases student engagement, and fosters deeper conceptual understanding. (Wadah et al., 2022; Haleda, 2025). The interactive nature of the flipbook-based e-module further contributed to students' motivation, enabling them to explore learning materials independently and collaboratively in ways that traditional methods could not support. The integration of PjBL with flipbook-based e-modules has shown significant potential in enhancing students' critical thinking skills in science education. A meta-analysis by Rahman, (2018) revealed that PjBL, particularly when combined with ethnoscience approaches, has a high effect size (0.827) on fostering critical thinking among students . This finding underscores the efficacy of PjBL in promoting higher-order cognitive

skills, aligning with previous studies that highlight its role in improving student engagement and conceptual understanding (Antari et al., 2023; Purnomo et al., 2019).

The utilization of flipbook-based e-modules further amplifies these benefits by providing an interactive and accessible learning platform. Research by Charina Wadah et al., (2022) demonstrated that such e-modules, when integrated with external features like Google Forms and YouTube, facilitate self-directed learning and enhance student engagement. These modules support various learning styles and promote active participation, which are crucial for developing critical thinking skills (Andini et al., 2021; Ningtyas et al., 2020). In light of these findings, educators are encouraged to adopt PjBL-based flipbook e-modules as a means to create more engaging and meaningful science learning experiences (Fatimah & Bramastia, 2022; Antari et al., 2023). Curriculum developers and policymakers should consider incorporating these innovative tools to align with the demands of 21st-century education, fostering environments that cultivate critical thinking and collaborative skills among students.

Moreover, flipbook-based e-modules offer the advantage of integrating multimedia elements such as videos, animations, and interactive quizzes, which help clarify complex scientific concepts and make abstract ideas more tangible for students. By combining visual, auditory, and kinesthetic learning approaches, these e-modules cater to diverse learner profiles, ensuring that each student can engage with the content in a way that suits their individual learning preferences. This multimodal approach not only enhances comprehension but also encourages curiosity, experimentation, and problem-solving key components of critical thinking. In addition, the use of PjBL-based flipbook e-modules promotes collaboration and peer learning through group projects and interactive assignments. Students are encouraged to share ideas, evaluate multiple perspectives, and co-create knowledge, which mirrors real-world problem-solving scenarios. Such experiences not only strengthen cognitive skills but also foster essential social and communication competencies, preparing students to thrive in increasingly collaborative and technologically driven environments. Therefore, the integration of these e-modules represents a strategic approach to modern education, aligning pedagogical practices with both cognitive development goals and the skills required in the 21st century (Ambarwati, 2022).

The results reveal a notable difference between the experimental and control groups that integrating digital learning resources into science education can overcome some of the challenges identified in earlier assessments, such as students' passivity and low performance in scientific literacy (OECD, 2019). By incorporating multimedia elements and interactive tasks, the PjBL-based e-module transformed abstract concepts, such as magnetic force and motion into concrete and contextualized experiences. This transformation resonates with the notion that science learning at the elementary level should emphasize inquiry, problem-solving, and hands-on experimentation rather than rote memorization.

Moreover, the interaction effect between learning motivation and instructional media highlights the importance of considering student characteristics when designing learning interventions. The results revealed that highly motivated students benefited the most from the PjBL-based e-module, particularly in the dimensions of analysis and evaluation. This finding reinforces the argument that motivation acts as a mediating factor in the success of innovative instructional designs (Hapsari & Airlanda, 2018; Antari et al., 2023). It also supports the theoretical view that students' active involvement and persistence in problem-solving activities enhance their ability to apply critical thinking skills in new contexts (Herlina et al., 2020).

The novelty of this research lies in its focus on integrating Project-Based Learning (PjBL) with interactive flipbook-based e-modules in the context of elementary science learning, an area that remains relatively underexplored in the existing literature. Previous studies have shown that digital media, such as e-modules and virtual laboratories, can enhance student engagement and conceptual understanding in science (Vogler et al., 2018; Delita et al., 2022). Similarly, PjBL has been widely recognized for its potential to promote critical thinking, collaboration, and creativity through inquiry-driven tasks (Ergashev & Farxodjonova, 2020). However, most prior research examined these approaches in isolation, focusing either on the development of digital learning resources or the implementation of PjBL as a pedagogical strategy (Novrianti et al., 2025; Hapsari & Airlanda, 2018).

This study demonstrates the synergistic impact of combining both approaches, thereby offering a dual contribution: it leverages the affordances of digital interactivity while embedding them in a project-oriented learning framework. Such integration provides opportunities for students to engage in meaningful inquiry, apply knowledge in real-life contexts, and sustain learning motivation an aspect identified as a key predictor of academic success (Kristian, 2024). These results imply that future curriculum development and teacher training programs should emphasize the integration of pedagogical models with digital resources to improve both cognitive outcomes, such as critical thinking, and affective outcomes, such as motivation and engagement (Hapsari & Airlanda, 2018).

Conclusion

This study provides empirical evidence that integrating Project-Based Learning (PjBL) within an interactive electronic module significantly enhances elementary students' critical thinking skills in science learning compared to conventional textbook-based instruction. Beyond demonstrating a main effect of instructional media, the findings reveal that learning motivation not only independently influences critical thinking outcomes but also strengthens the effectiveness of the PjBL based e-module, as indicated by a significant interaction effect. These results confirm that cognitive development and affective engagement are interconnected dimensions that should be addressed simultaneously in instructional design. The primary contribution of this study lies in offering an integrated digital–pedagogical model that combines constructivist project-based learning with multimedia-supported e-modules and empirically tests its dual impact on higher-order thinking and motivation at the primary education level an area that remains underexplored. Therefore, this research advances the discourse on 21st-century science education by demonstrating that well-designed digital project-based environments can move beyond content delivery toward fostering analytical competence, sustained engagement, and meaningful learning experiences in elementary classrooms.

References

Andini, M. D., Syamsuri, S., Nindiasari, H., & Novaliyosi, N. (2021). Analisis Kebutuhan Pengembangan E-Modul Berbasis Problem Based Learning Pada Materi Peluang. *TIRTAMATH: Jurnal Penelitian Dan Pengajaran Matematika*, *3*(2), 116.

Antari, P. L., Widiana, I. W., & Wibawa, I. M. C. (2023). Modul Elektronik Berbasis Project

Based Learning Pembelajaran IPAS untuk Meningkatkan Hasil Belajar Siswa Sekolah Dasar. *Jurnal Imiah Pendidikan Dan Pembelajaran*, *7*(2), 266–275.

Charina Wadah, S., Miriam, S., Dewantara, D., & Suyidno, S. (2022). The Feasibility of E-Modules Based on Flipbook Pdf Professional to Improve Student Learning Outcomes on Work and Energy Material. *Jurnal Geliga Sains: Jurnal Pendidikan Fisika*, *10*(2), 83.

Delita, F., Berutu, N., & Nofrion. (2022). Online Learning: the Effects of Using E-Modules on Self-Efficacy, Motivation and Learning Outcomes. *Turkish Online Journal of Distance Education*, *23*(4), 0–3.

Endaryati, A., Ragil, I., Atmojo, W., Slamet, S. Y., & Suryandari, K. C. (2021). *DWIJA CENDEKIA: Jurnal Riset Pedagogik Analisis E-Modul Flipbook Berbasis Problem Based Learning untuk Memberdayakan Keterampilan Berpikir Kritis Pembelajaran IPA Sekolah Dasar*. *5*.

Erdi, P. N., Padwa, T. R., Teknologi, P., & Kejuruan, D. (2022). *Penggunaan E-Modul Dengan Sistem Project Based Learning*. https://doi.org/10.24036/javit.v2i1

Ergashev, I., & Farxodjonova, N. (2020). Integration of national culture in the process of globalization. In *Journal of Critical Reviews* (Vol. 7, Issue 2, pp. 477–479). Innovare Academics Sciences Pvt. Ltd.

Fatimah, H., & Bramastia, B. (2022). Literature Review Project Based Learning Berbasis TIK. *EDUKATIF : JURNAL ILMU PENDIDIKAN*, *4*(5), 7347–7356.

Haleda, P. (2025). Pengaruh Model Pembelajaran Project Based Learning Terhadap Kemampuan Berpikir Kritis Siswa Pada Materi Struktur Atom-Nanoteknologi. *Bhb*, *20*, 29–36.

Halimah, A. N., & Winarni, R. (2021). Pengaruh model pembelajaran project based learning terhadap motivasi belajar ipas peserta didik kelas v sekolah dasar. *Ekonomi Bisnis*, *9*, 67–72.

Handrianto, C., & Rahman, M. A. (2018). *LET: Linguistics, Literature and English Teaching Journal ||Volume|| 8 ||Issue|| 2 ||Pages|| 110-129 ||* (Vol. 8, Issue 2). http://jurnal.uin-antasari.ac.id/index.php

Hapsari, D. I., & Airlanda, G. S. (2018). Penerapan Project Based Learning Untuk Meningkatkan Motivasi Belajar Matematika Peserta Didik Kelas V. *AULADUNA: Jurnal Pendidikan Dasar Islam*, *5*(2), 154.

Herawati, N. S., & Muhtadi, A. (2020). Pengembangan modul elektronik (e-modul) interaktif pada mata pelajaran kimia kelas xi ipa sma developing interactive chemistry e-modul for the second grade students of senior high school. *Jurnal At-Tadbir STAI Darul Kamal NW Kembang Kerang*, *1*. http://ejournal.kopertais4.or.id/sasambo/index.php/atTadbir

Herlina, M., Syahfitri, J., & Ilista, I. (2020). Perbedaan kemampuan berpikir kritis dan hasil belajar kognitif dengan model pembelajaran problem based learning berbantuan media audio visual. *Edubiotik : Jurnal Pendidikan, Biologi Dan Terapan*, *5*(01).

Khasanah, B. A., Dwi Ayu, I., Matematika, P., Muhammadiyah, S., & Lampung, P. (2017). *Kemampuan Berpikir Kritis Siswa Melalui Penerapan Modelpembelajaran Brain Based Learning* (Issue 2).

Kristian, N. (2024). Improving The Quality of Indonesian Language Education Through The Development Of Innovative Teaching Modules. *Berajah Journal: Jurnal Pembelajaran Dan Pengembangan Diri*, *4*(5), 1153–1164.

Kristiani, K. D., Mayasari, T., & Kurniadi, E. (2017). Pengaruh pembelajaran STEM-PjBL terhadap keterampilan berpikir kreatif. *Http://E-Journal.Unipma.Ac.Id/Index.Php/Snpf*, 266–274. http://e-journal.unipma.ac.id/index.php/snpf

Mohd Ikhwan, H. I., & Azlina, A. A. (2019). TS25 school teachers' perceptions of differentiated learning in diverse ESL classrooms. *Journal of Education and Social Sciences*, *13*(1), 95–

107.

Ningrum, N. I., & Ambarwati, R. (2022). Development of Flipbook-Based E-Module on Animalia Material as Teaching Material to Train Digital Literacy of Class X High School Students. *BioEdu: Berkala Ilmiah Pendidikan Biologi*, *12*(2), 525–538. https://ejournal.unesa.ac.id/index.php/bioedu

Ningtyas, A. S., Triwahyuningtyas, D., & Rahayu, S. (2020). Pengembangan E-Modul Bangun Datar Sederhana Berbasis Problem Based Learning (PBL) Menggunakan Aplikasi Kvsoft Flipbook Maker Untuk Siswa Kelas III Ayu. *Journal of Chemical Information and Modeling*, *53*(9), 1689–1699.

Novrianti, F., Susanta, A., & Muchlis, E. E. (2025). Pengaruh Model Pembelajaran Project Based Learning (Pjbl) Terhadap Kemampuan Berpikir Kritis Siswa Pada Materi Trigonometri. *Jurnal Pendidikan Matematika: Judika Education*, *8*(2), 226–234.

Pratama, G., Gede, D., Divayana, H., & Sugihartini, N. (2018). pengaruh e-modul berbasis metode pembelajaran problem based learning pada mata pelajaran basis data terhadap hasil belajar dan motivasi siswa (studi kasus : kelas xii rekayasa perangkat lunak di smk negeri 1 negara). In *Jurnal Nasional Pendidikan Teknik Informatika |* (Vol. 7, Issue 2).

Pratama, H., & Prastyaningrum, I. (2016). Pengaruh model pembelajaran project based learning berbantuan media pembelajaran pembangkit listrik tenaga mikrohidro terhadap kemampuan berpikir kritis effect of project based learning with microhydro power plants media on critical thinking skills. *Jurnal Penelitian Fisika Dan Aplikasinya (JPFA)*, *6*(2). http://journal.unesa.ac.id/index.php/jpfa

Purnomo, H., Santosa, B., & Tentama, F. (2019). Implementation of Problem-Based Learning and Group Investigation (Pbl Go-in) To Improve Vocational Students' Competence. *Journal of Vocational Education Studies*, *2*(1), 47.

Santosa, E. B. (2024). Analysis of the Need for Problem-Based Learning E-Modules to Enhance High Order Thinking Skills (HOTS) Among High School Students. *Proceedings of International Conference on Science and Technology for the Internet of Things*, *1*(01), 630–649.

Vogler, J. S., Thompson, P., Davis, D. W., Mayfield, B. E., Finley, P. M., & Yasseri, D. (2018). The hard work of soft skills: augmenting the project-based learning experience with interdisciplinary teamwork. *Instructional Science*, *46*(3), 457–488.