

Mapping Project-Based Learning E-Modules Through a Systematic Literature Review

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Abstract: Electronic modules (e-modules) are widely used learning media that support both classroom and independent study. They offer an alternative for students to learn at home and have evolved by integrating various learning models, including project-based learning (PjBL). This study aims to reveal research trends in the development of PjBL-integrated e-modules from 2016 to 2025 using the PRISMA method. Article data were collected systematically through the Publish or Perish tool on Google Scholar with keywords such as “development,” “electronic module,” “e-module,” and “project-based learning.” From 344 initial articles, 92 met the inclusion criteria for content analysis, and 51 were selected for analysis based on keyword relevance, complete metadata, and citation data. These were visualized using VOSviewer. The results indicate that PjBL-integrated e-modules have significant potential to improve student learning outcomes and engagement. In addition to academic insights, this research offers practical contributions. For teachers, it presents a clear model for implementing interactive, contextualized science learning. For curriculum developers, it provides strategies for integrating 21st-century skills and independent learning into digital tools. Overall, the findings support the development of adaptive, student-centered learning materials aligned with current educational needs.

Keywords: education, e-module, learning media, learning method, project-based learning.

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INTRODUCTION

The development of digital technology in education encourages educators to innovate in learning, such as utilizing learning media and educational resources, including teaching materials. According to Moore, Dickson-Deane, and Galyen (2011), digital learning enables pedagogical transformation through technology, expanding access, improving quality, and strengthening interaction in the learning process. One form of innovation that is often developed is the electronic module, also known as an e-module. E-modules are systematically arranged learning media that can be accessed digitally to achieve learning competencies (Latri, 2023). E-modules have four characteristics, namely self-learning according to instructions (self-instruction), independent (self-contained), stand-alone, and adaptive (adapt) (Syafa et al, 2022). Using e-modules as digital learning media has increased the effectiveness and efficiency of the teaching and learning process (Ally, 2009; Mayer, 2005). E-modules allow flexible and interactive access to materials, supporting a variety of student learning styles (Clark, R. C., & Mayer, 2023).

The e-module innovation also makes it easy for teachers to adapt materials according to the needs of students (Hadianito, 2020). Thus, developing e-modules as digital learning media is a strategic step in facing educational challenges in the 21st century. In line with this, UNESCO (2015) emphasizes the importance of digitizing education to expand access, improve quality, and enhance learner involvement in the learning process. The importance of digital-based learning and the need for digital competencies

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among students is increasing. Research shows that digital learning tools, such as e-modules, can increase student motivation and engagement in the learning process (Kebritchi et al, 2017). Implementing e-modules with multimedia facilities, interactive quizzes, and feedback can help improve concept understanding (Bakia et al, 2012). In addition, e-modules can be accessed anytime and anywhere, thus supporting independent learning and personalized learning (Means et al, 2013). Various studies suggest that the development of e-modules should continue to be optimized to align with today's digital learning needs.

The 21st-century learning emphasizes not only content mastery but also key competencies, including critical thinking, collaboration, creativity, and communication. Project-based learning (PjBL) is an effective model for fostering these skills by engaging students in real-world, collaborative tasks that promote metacognition and self-regulated learning (Bell, 2010; Hmelo-Silver, 2024). PjBL typically follows a structured set of steps, including problem formulation, project planning, monitoring, assessment, and reflection (Sutrisna et al., 2019). When integrated into digital formats, such as e-modules, PjBL offers enhanced learning quality. E-modules designed with PjBL principles support independent and group work, provide structured guidance, and enable ongoing formative assessment (Fini et al., 2018; Halverson, E. R., & Sheridan, 2014). This combination enhances student motivation, contextual understanding, and learning outcomes (Boaler, J., & Staples, 2008; Prastowo, 2002). Several studies confirm the effectiveness of PjBL-based e-modules across various subjects (Chin, C., & Chia, 2024; Kokotsaki, D., Menzies, V., & Wiggins, 2016).

When modules incorporate e-learning and project-based learning, this holds promise, but current studies are by no means comprehensive. Most existing research remains limited to case analyses or partial evaluations, often neglecting the broader picture of design, implementation, and effectiveness (Booth, 2016; Grant, 2011). Therefore, systematic literature reviews are crucial to clarify best practices, challenges, and development directions (Liberati et al, 2009). Despite increasing interest, a fundamental problem persists:

1. How has the integration of project-based learning (PjBL) into e-modules evolved over the last decade in terms of design, platforms, levels of education, and evaluation?
2. What gaps remain in ensuring their instructional quality and effectiveness?

This review attempts to answer these questions by analyzing recent developments in PjBL-integrated e-module design. Theoretically, it aims to uncover design patterns and educational value; practically, it provides insights and references for educators and policymakers in designing 21st-century learning modules aligned with current pedagogical and technological trends.

METHOD

PjBL-based e-module development over the last ten years. SLR is a systematic, explicit, and replicable method for identifying, evaluating, and interpreting all relevant research on a particular question or topic (Gough et al., 2017; Kitchenham, B., Charters, 2007; Liberati et al., 2009). This approach was chosen to synthesize scattered research findings and organize them into a meaningful and structured knowledge map. Data sources were obtained from the Google Scholar database using the Publish or Perish application, covering the period from 2016 to May 2025. The search used the keywords: “development,” “electronic module,” “e-module,” and “project-based learning,” resulting in 344 initial articles. The screening and selection process followed the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines to ensure transparency and rigor (Liberati et al., 2009; Page et al., 2021), and was conducted in four main stages:

1. Identification: All articles retrieved from the keyword search were collected, resulting in 344 records.
2. Screening: Duplicates and non-journal publications (books, theses, dissertations) were removed, and titles/abstracts were reviewed to assess topic relevance.
3. Eligibility: Full-text articles were assessed based on their alignment with the research objective, namely, the development of PjBL-integrated e-modules and the presence of research methodology and outcomes.
4. Inclusion: Articles were selected based on specific quality criteria, such as publication in peer-reviewed journals or conference proceedings, publication year (2016–2025), full-text

accessibility, inclusion of validation results, and relevance to PjBL and e-module development. The detailed inclusion and exclusion criteria are shown in Table 1.

Table 1. Inclusion and Exclusion Criteria

Criteria Type	Inclusion	Exclusion
Publication Type	Journals and Conferences	Book, Thesis, Dissertation, other
Year of publication	2016-2025	Less than 2016
Data source	Google Scholar	More
Journal Content	Development of PjBL-integrated e-modules	More
Methods	Include validation results and results	No validation test

Article searches were conducted using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines to ensure transparency and accountability in the literature selection process (Liberati et al, 2009; Page et al, 2021). The process includes four main stages: identification, screening, eligibility, and inclusion, which are visualized as a PRISMA flow chart in Figure 1. Next, the selected articles were descriptively analyzed to identify the frequency, thematic tendencies, and characteristics of each study, including education level, subject, e-module platform, and integrated PjBL elements.

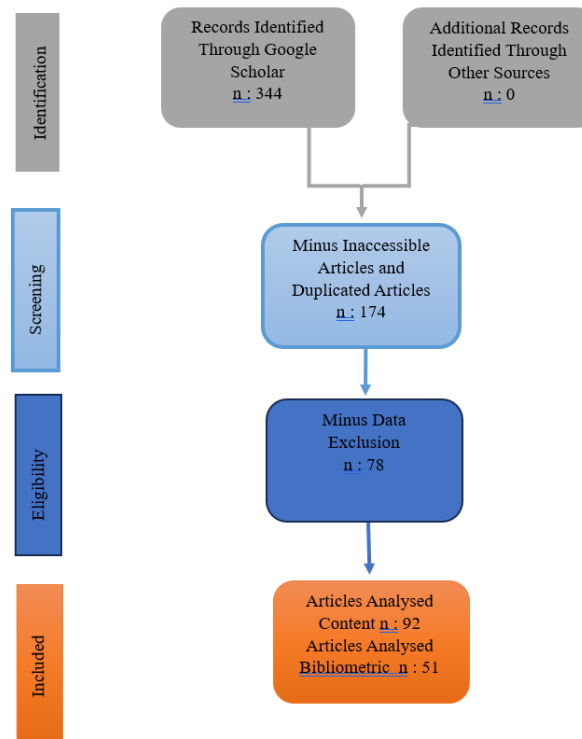


Figure 1 Stages of the PRISMA Model

RESULT AND DISCUSSION

Results should be clear and concise. Searching article data using the Publish and Perish application obtained 92 articles relevant to developing e-modules integrated with project-based learning. The articles are stored in Microsoft Excel and manually selected according to their characteristics: title and abstract. The list of relevant articles can be seen in Figure 2.

Cites	Authors	Title	Year	Source	Publish
6	D Delimanugari	Development of Project Based Learning E-Modules with Local Wisdom Content in Grade IV Science Lessons (IPAS)	2024	International Journal of E-Journal	
1	D Maharani	Pengembangan E-Modul Ansambel Musik Berbasis Project Based Learning di Kelas IV Sekolah Dasar	2024	Jurnal PGSD: Jurnal Ilmiah	e-journal
2	DAA Makuasa, S Rahmawati...	Development of a Chemistry Learning E-module Based on Project-based Learning with a STEM Approach to Improve Stuc	2024	Journal of Education ...	Journal
1	E Sriwahyuni, D Eliza	Project-Based Learning E-Modules Improve Science Literacy Skills and Character on Minangkabau Cultural Themes	2024	JPI (Jurnal Pendidikan In-ejournal	
0	EB Santosa	Problem Based Learning-Oriented E-Module to Innovate Learning Activities in High School	2024	... of Education Research	e-journal
1	EK Sidiq, J Wantoro	E-Learning berbasis Moodle Mata Pelajaran Informatika dengan Pendekatan Project Based Learning	2024	Edumatic: Jurnal Pendidikan e-journal	
0	FABashir, S Sarwanto, BA Prayitno	Kelayakan Modul IPA Berbasis Project Based Learning Terintegrasi Literasi Sains	2024	SEMNASFIP	Jurnal
2	Fitriani, S Hidayat, MU Genisa, J Sa	Analisis Kebutuhan Pengembangan e-Modul Ajar Berbasis PjBL Terintegrasi Etnoekologi untuk Meningkatkan Keterampi	2024	Jurnal Pendidikan dan ...	Jurnal
0	I Pramuniati, J Sitompul	French E-Module for Production Ecrite Débutante Learning Based on Project Based Learning Using Kodular	2024	Jurnal Penelitian dan ...	e-journal
0	IPCY Pratama, AAG Agung...	E-Modul Berbasis Project Based Learning IPAS Kelas V	2024	Journal of Education ...	e-journal
3	JDR Sari, A Ambiyar, R Mukhaiyar...	Project-Based Module Development in the Electrical Circuit Course	2024	Jurnal Penelitian ...	Journal
1	L Firdausia, AF Nisa, HM Zulfati...	Penerapan E-Modul Ecoprint Flipbook Berbasis Project Based Learning Untuk Meningkatkan Motivasi Dan Kreativitas Sis	2024	Pendas: Jurnal Ilmiah ...	Journal
3	MA Gunawan, A Fitri, N Murodah	Development of an E-Module For Educational Evaluation Course With a Problem Based Learning Framework	2024	Edukasia Islamika	e-journal
3	MDA Sukma, TN Diyana	Analisis Kelayakan Modul Model Project Based Learning Berbasis Kearifan Lokal Dalam Upaya Meningkatkan Pemaham	2024	MAGNETON: Jurnal Inow	Journal
2	MLV Tampubolon, H Sipahutar	Development of project-based modules to improve learning outcomes critical thinking and problem-solving skills	2024	JPBI (Jurnal Pendidikan ...)	e-journal
2	MM Pratiwi, W Nelмира	Innovation in Vocational Learning: Project Based Learning E-Module on the Textile Dyeing Course	2024	Journal of Education Tecl	e-journal
1	MRN Huda, MS Sari, D Listyorini	Development of E-Module Project-Based Learning (PjBL) Plant Diversity Based on the Local Potential of East Sumba Regu	2024	BIOEDUKASI	
0	N Angkatsan, WS Tonra...	Pengembangan E-book Kalkulus Integral Berbasis Project Based Learning (PjBL) Berbantuan Aplikasi Flip Pdf Corporate	2024	Indiktika: Jurnal ...	Jurnal
0	N Nurlaelah, D Deriwanto, H Hartini...	Integrasi Project Based Learning dalam Modul PAI: Meningkatkan Keterlibatan Siswa di SMK	2024	... of Gurutta Education	pasca-u
3	NC Hany, D Syafriani	Development of A Chemistry E-Module Based on Project Based Learning Using the Flipbook Application to Improve Lear	2024	Jurnal Teknologi Pendi	e-journal
22	NP Pertiwi, S Saputro, S Yamtinah, A	Enhancing Critical Thinking Skills through STEM Problem-Based Contextual Learning: An Integrated E-Module Education	2024	... of Baltic Science Educa	ERIC
4	P Resmanti, A Faridah, Y Yusmerita...	Development of the E-module with Project-Based Learning for the Flat Pattern Design Course	2024	Journal of Innovation In	Jleer.org

Figure 2 List of Relevant Articles

The 92 relevant articles were sorted back into 51 articles used as analysis data. Table 1 presents the findings extracted from the 51 articles included in the analysis. It summarizes platforms, subjects, and learning outcomes associated with PjBL-integrated e-module development.

Table 2. Results of PjBL Integrated E-Module Development

Author and Year	Research Results
Nurussalamah & Fatmaryanti, (2025)	The development of the PjBL E-Module on the Canva platform has been proven valid, practical, and effective in improving student collaboration and scientific literacy in Physics subjects.
Sagala & Widyastuti, (2021)	The PjBL e-module using the flipbook platform is very valid and very practical for merdeka belajar-based learning, l
Febriyanti et al (2023)	E-Modules are very practical and effective in improving understanding of the Islamic-based digestive system,
Triwoelandari et al (2023)	E-modules can integrate valid and effective. There was a significant increase in students' collaboration skills in science subjects.
Aprilia et al (2024)	The e-module is considered valid and practical because it utilizes the Flipbook platform, enhancing students' collaboration and communication skills in Mathematics.
Riyanto, D. M. R., & Kawuryan (2025)	The PjBL IPAS e-module developed through the Canva platform is feasible, practical, and effective in improving students' collaboration skills.
Rahayu, I., & Sukardi, (2020)	PjBL e-modules on computer network material for vocational students are proven to be valid and practical. The use of Android applications effectively improves learning outcomes, with posttest scores reaching 91.67%.
Delimanugari (2024)	Using a self-made interactive digital platform, the PjBL Maple IPAS E-module is considered interesting, helps to learn independence, and fosters an appreciation for local wisdom.
Rusmansyah et al (2023)	The PjBL e-module, utilizing an Android application platform, is considered valid, practical, and effective in improving students' conceptual understanding.
Gunawan et al (2024)	PjBL e-modules using the multi-access canvas platform effectively improve students' experience, independence, critical thinking, and learning outcomes on learning evaluation material.
Sepriana (2025)	Sigil format PjBL e-module (epub) is feasible, facilitates learning, attracts interest in education, and effectively increases the understanding of vocational basics of vocational high school students.

Author and Year	Research Results
Alya, A., & Purwaningsih, (2025)	PjBL e-modules on an interactive web platform are considered valid and effective in training concept understanding and science process skills.
Selano et al (2024)	PjBL e-module using a website platform is very effective in improving the computational thinking skills of high school students.
Rizal (2024)	The Moodle platform for PjBL e-module development effectively improves critical thinking skills in simulation and communication subjects.
Farida & Indah (2024)	PJBL on e-modules effectively improves mathematical communication; the rest is influenced by other factors (self-efficacy, mathematical reasoning),
Hany & Syafriani (2024)	PjBL-integrated e-modules in chemistry lessons produce a positive correlation between collaboration skills and learning outcomes.
Hasibuan et al (2020)	The PjBL e-module flipbook is valid and effective in improving student learning competence and motivation in biochemistry courses.
Resmanti et al (2024)	Interactive flipbook as a PjBL e-module platform improves students' psychomotor skills regarding introductory pattern courses.
Mustika (2022)	PjBL e-module is proven to train creative thinking and effectively learn and build space.
Syahri & Ekaputra, (2024)	PjBL e-modules effectively increase student understanding and participation.
Huda et al (2024)	Biology PjBL e-modules have a significant effect on improving students' critical thinking skills.
Rahman et al (2025)	Google Site as a PjBL e-module platform has been proven effective in improving students' understanding of physics history and engagement in learning.
Nainggolan et al (2023)	Creating an interactive website as a PjBL e-module platform improves organic chemistry learning outcomes.
Tishana et al (2024)	The PjBL e-module media developed for electrical material is valid in terms of material and media, and practical to use.
Firdausia et al (2024)	E-modules effectively increase motivation, cognitive learning outcomes, and student creativity in IPAS learning, providing variations in classroom learning activities.
Syarofatin et al (2022)	The PjBL biology module, based on an Android application, is highly valid and effective in enhancing critical thinking and digital literacy.
Amalia et al (2023)	Development of valid, effective, and practical PjBL e-modules for elementary students
Haryanto et al (2023)	The development of Android-based PjBL e-modules for Chemistry subjects is valid, and teachers and high school students have responded positively.
Ulfa et al (2023)	The use of the Google Collaboration platform to develop Pjbl-integrated e-modules yielded valid, practical, moderately effective, and highly positive student responses.
Pratama et al (2024)	Canva, as a math PjBL e-module platform, is valid, practical, and effective.
Makuasa & Rahmawati (2024)	The FlipHTML5 platform, as a PJBL E-module platform, effectively improves problem-solving skills.
Wulansari et al (2023)	Canva collaboration as a PjBL e-module platform effectively improves junior high school students' math problem-solving
Ananda & Herwanto (2025)	Very feasible, increases learning independence and material understanding
Imamuddin & Prasetya (2024)	PjBL e-modules make learning more interactive and improve concept understanding and student participation.
Rani & Alfiandra (2025)	PjBL e-modules effectively provide interactive learning, supporting creativity and independent learning.
Imansari et al (2022)	According to experts and experimental results, the PjBL E-Module increases student learning motivation with high validity.
Siregar (2024)	The PjBL e-module was rated highly valid and effective, increasing student creativity.
Fransiska et al (2025)	The PjBL e-module enhances the value of cooperation and creativity in kindergarten children through a local wisdom-based approach, demonstrating high validity and effectiveness.
Yanti et al (2025)	Through interactive and multimedia features, PJBL-based digital modules enhance student engagement, deepen their understanding of concepts, and foster critical thinking skills.
Maharani & Desyandri (2024)	The PjBL e-module is valid, practical, and effective in increasing students' interest in learning in grade IV SD.

Author and Year	Research Results
Bashir et al (2024)	The PjBL module is both feasible and effective in enhancing critical thinking skills and promoting student independence.
Sidiq & Wantoro (2024)	The project-based e-module system enhances learning flexibility and virtual student collaboration, making the material more engaging and interactive.
Hakim & Sunarjan (2016)	The PjBL e-module increases students' interest in learning history. Based on linear regression, it has high validity and a positive effect on learning interest.
Rooseno & Adhi (2024)	The applied PjBL e-module improves the dimensions of the Pancasila Learner Profile.
Mutia et al (2025)	Flipbook e-module PjBL geography subject significantly improves creative thinking skills.
Maksum & Purwanto (2022)	An interactive website for PjBL e-modules improves students' cognitive, affective, and psychomotor abilities.
Puri & Diyana (2024)	PjBL e-modules are valid and effective and can improve science process skills.
Astuti et al (2023)	PjBL e-modules effectively improve soft skills, articulate storylines, and manage college events.
Rusmanto & Rukun (2020)	E-PjBL modules are valid, efficient, and effective in improving student learning outcomes.
Simamora et al (2019)	Students highly rate interactive website-based PjBL E-Modules.
Dewi & Lestari (2020)	PjBL e-modules significantly improve science learning outcomes of high school students.

Keyword

Data analysis uses the Vosviewer application, producing visual data on keywords often used in research. This research uses co-occurrence and keyword analysis. Visual data can be seen in Figure 3.

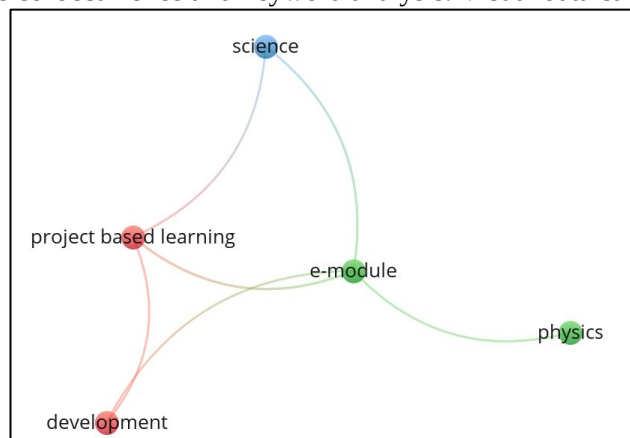
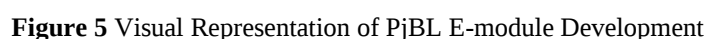


Figure 3 Most Frequently Used Keywords In The Research

The code "f:34" means that the keyword "e-module" appeared 34 times across the titles and abstracts of the 51 articles included in the analysis (see Table 1). Likewise, "project-based learning" occurred in 30 articles, and "development" in six articles. The frequency was calculated using VOSviewer keyword co-occurrence analysis. The keyword occurrence data shown in Figure 3 were extracted from the same set of 51 articles listed in Table 1. Therefore, the themes observed visually (e.g., e-module, project-based learning, science) align with the qualitative summaries presented in the table. The selected articles were analyzed in the abstract section to determine the common words used in the research abstracts. This analysis used binary calculation, with a minimum threshold of word occurrence of 5, resulting in 22 selected words. The results of the visual representation of the distribution of common words in the research abstract can be seen in Figure 4.



This visualization highlights not only the thematic focus but also the evolution of research interest in the field of science education over the past five years. Visual representation data regarding the development flow of PjBL integrated e-modules was analyzed on the VOS viewer application, with co-occurrence and keyword analysis types using the complete calculation method. The minimum threshold of word occurrence is 1, resulting in 125 words; the map of novelty distribution results in 25 clusters, with 289 links and 309 link strengths. Visual data of the novelty distribution of the PjBL integrated e-module development is shown in Figure 5.



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occurring terms are “project-based learning,” “e-module,” and “pjbl,” indicating an intense research focus on pedagogical integration. Notably, several emerging keywords such as “Book Creator,” “creativity,” and “STEAM” appear in more peripheral but connected positions, suggesting new and growing interest areas within the field.

These emerging terms reflect a shift towards the inclusion of innovative tools and multidisciplinary approaches in e-module design. For instance, “Book Creator” represents a practical platform for creating interactive learning materials, aligning with current trends in digital literacy. The inclusion of “creativity” and “STEAM” (Science, Technology, Engineering, Arts, and Mathematics) signals an increased emphasis on developing modules that go beyond content delivery to cultivate innovation, problem-solving, and design thinking skills.

This is consistent with broader educational frameworks. Saavedra & Opfer (2012) argue that fostering higher-order thinking skills and adaptability is essential in preparing students for complex real-world challenges. Similarly, Mishra, P., & Koehler, (2006) present the TPACK (Technological Pedagogical Content Knowledge) framework as a foundation for integrating technology effectively into pedagogy.

Publication Trend (by year)

Therefore, the visualization not only maps the current state of research but also underscores promising directions, particularly the convergence of interactive digital tools, PjBL methodology, and 21st-century competencies. These intersections present a valuable opportunity for future research to explore more innovative, learner-centered, and competency-based e-module designs. As shown in Figure 6, the number of PjBL e-module publications increased significantly between 2016 and 2025.

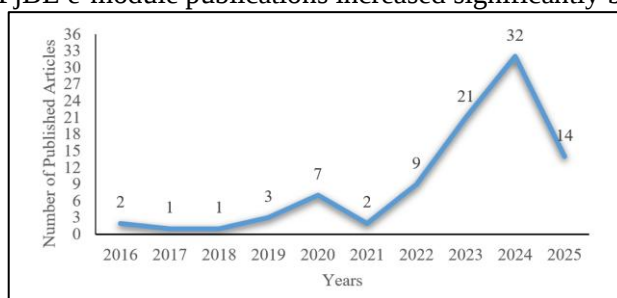


Figure 6 Distribution of Article Publications 2016-2025

The trend of developing e-modules integrated with project-based learning (PjBL) has increased rapidly from 2020 to 2025. The increase over the last five years is attributed to changes in learning patterns resulting from the 2019 pandemic, which led to a shift from face-to-face to online learning. Online learning has a significant impact on facilitating distance learning. Using e-modules in online learning is an adaptive, contextual solution and increases student participation (Wulandari et al., 2023). Project-based learning is a learning model that can be applied to online learning. PjBL helps students to hone creativity in completing projects and improve patterns of learning activities at home (Nisah et al., 2021; Susetyarini et al., 2019). Integrating e-modules into the PjBL model provides flexibility in learning time and place and strengthens students' independent learning skills (Febriyanti et al., 2023; Pratama et al., 2024). In this context, e-modules are not only a learning aid but also a vehicle for presenting learning projects systematically and interestingly.

Methodology Used

Furthermore, the distribution of research methodologies employed in the development of PjBL-based e-modules is presented below. Figure 7 shows data on the distribution of the research methods used in the articles on the development of e-modules integrated with project-based learning.

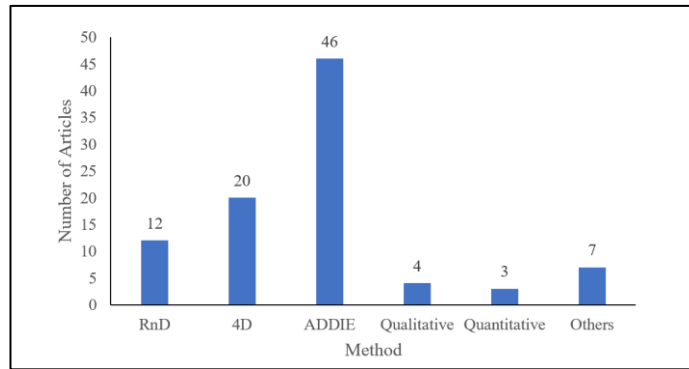


Figure 7 Distribution of Article Research Methods

Figure 7 presents information to identify the most used methods in developing project-based learning integrated e-modules. From Figure 7, the ADDIE method is the most dominant method used in the research. Other methods in project-based learning integrated e-module development research are the quasi-experimental method (f:5), mixed-method method (f:1), and community service method (f:1). The dominance of the R&D research method approach in the development of PjBL-integrated e-modules shows that researchers try to design learning products that meet the needs of students and teachers empirically (Borg, W. R., & Gall, 1983; Haryati, 2012). R&D stages, including needs analysis, design, expert validation, and limited trials, enable the final product in e-modules to be more assured in terms of quality and relevance. Additionally, this approach facilitates incremental improvements throughout the module development process, which is crucial in the context of rapidly evolving educational technology. The development of PjBL-integrated e-modules is applied to various levels of education, from the initial (PAUD-TK) to employee training.

Educational Level

After identifying the research methods, it is also important to examine at which educational levels PjBL e-modules are most frequently developed. Figure 8 shows data on the distribution of levels.

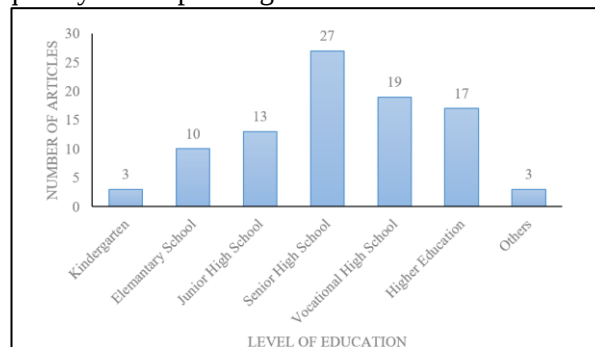


Figure 8 Distribution of Education Levels for Research Articles

The high school level dominates as a research subject for developing PjBL-integrated e-modules, followed by vocational schools and universities. The other levels in Figure 8 are groupings of teacher training (f:1) and HEI employee training (f:2). Most e-module development is applied at the secondary education level (junior high, senior high, and vocational schools), followed by higher education. This aligns with the characteristics of students at these levels, who are beginning to think abstractly, take responsibility, and collaborate in project-based groups (Habsy, 2017; Jati, G. W., & Yoenanto, 2013). It also supports the Merdeka Belajar Curriculum, which emphasizes project-based thematic learning (Amanullah et al., 2023; Kemendikbud, 2022; Nursalam et al., 2023). The use of e-modules promotes digital literacy and aligns with students' growing technological competence (Chairunisa et al., 2022; Halim et al, 2023; Kurniawan, C., & Kuswandi, 2021).

Subject Distribution

In addition to educational level, PjBL-integrated e-module development also specifies the subjects used as the basis for the module content. Data on the distribution of subjects can be seen in Figure 9.

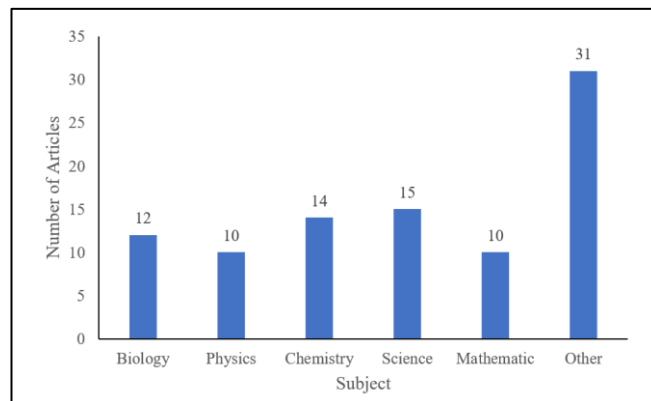


Figure 9 Distribution of subjects

PjBL-integrated e-modules, which the university conducted, entail various forms of development. These cover a wide range of subjects. Main fields include science (some things related to chemistry, biology, and physics), where the activities often require projects--experiments and problem solving in everyday life (Widiyatmoko & Pamelasari, 2012). In addition, the development progress was facilitated to continue for other courses, including management (*f3*), social studies (*f3*), design and music (*f5*), engineering and vocational education (*f10*), and technology and informatics (*f11*). Vocational and technical courses can lead to creativity, interest, and new learning (Oksa & Soenarto, 2020). In the field of information and communication technology (ICT), it is essential to develop PjBL e-modules more effectively to deliver information to students while still engaging them with the content. PjBL e-modules also help integrate theoretical knowledge with practical applications to enhance students' informal learning at home (Ansya, 2023; Azhar et al., 2024). Additionally, it is a feasible way to convey scientific attitudes and skills, such as curiosity, discipline, and responsibility.

Platform

Diverse platforms can also provide convenient access for entering classes and adapting to new environments, as illustrated by Figure 10.

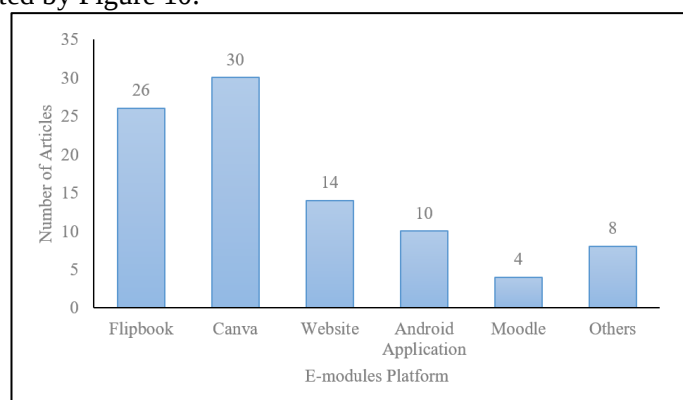


Figure 10 Distribution of E-Module Platforms

The dominant platform used in PjBL-integrated e-module development research is Canva, followed by Flipbook. Some studies used self-made websites (*f10*) or existing ones, such as Google Sites (*f1*), Kodular (*f2*), Book Creator (*f1*). Other non-web-based platforms that can be used for e-module development are Sigil (*f2*), PPT + iSpring Suite (*f1*), Adobe Flash (*f2*), Articulate Storyline (*f3*). The use of digital platforms, such as Google Sites, Moodle, Canva, Flipbook, and Articulate Storyline, in PjBL e-modules supports personalized and interactive learning (Anggreni, F., & Sari,

2022). These platforms enable the integration of videos, simulations, quizzes, and digital worksheets within a single module, which students can access independently (Lastri, 2023). Such features enhance the effectiveness of distance and hybrid learning, aligning with post-pandemic education needs.

Research Instrument

The development of PjBL-integrated e-modules also involves the use of research instruments to assess their validity and effectiveness in enhancing the learning experience. Data on the use of research instruments to develop PjBL-integrated e-modules can be seen in Figure 11.

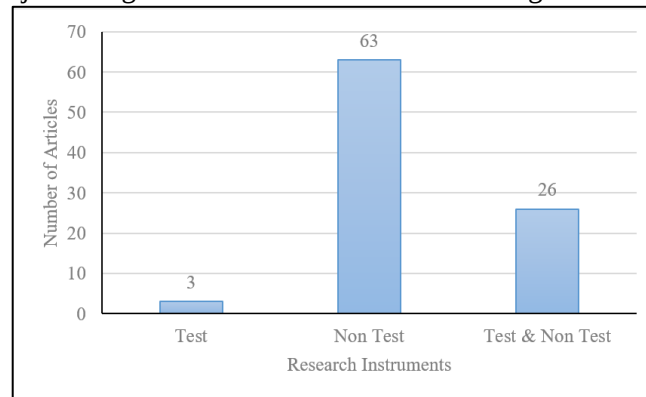


Figure 11 Use of Research Instruments

Research on e-module development predominantly uses non-test instruments, mainly to assess content validity. Test instruments such as pre-tests and post-tests are employed to evaluate the effectiveness of the e-modules on students' understanding, creativity, critical thinking, and learning outcomes. Tools such as expert validation questionnaires, observations, and cognitive tests suggest that e-module effectiveness is not only measured by cognitive gains but also by student engagement, motivation, and independence. A high-quality module should fulfill aspects of validity, practicality, and effectiveness. PjBL-integrated e-modules have been proven to enhance material comprehension, student involvement, creativity, and academic achievement (Delimanugari, 2024; Kurniawan et al., 2025; Rizal et al., 2024; Sepriana, 2025). These findings are consistent with Triwoelandari et al., (2023) and Nurussalamah & Fatmaryanti (2025), who reported the effectiveness of project-based math e-modules in enhancing collaboration and digital communication.

Mapping of Key Variables

The analysis revealed several key variables frequently addressed in PjBL-integrated e-module studies, including critical thinking, collaboration, creativity, digital literacy, independent learning, and science process skills. These variables are not only aligned with 21st-century competencies but also supported by empirical findings from the reviewed articles. For instance, PjBL e-modules were shown to enhance collaboration and communication (Aprilia et al., 2024; Nurussalamah et al., 2025) and to significantly improve critical thinking and problem-solving (Huda et al., 2024; Rizal et al., 2024). Similarly, the use of platforms such as Canva, Flipbook, and Android applications strengthened students' autonomy and digital literacy (Rusmansyah et al., 2023; Ulfa et al., 2023), indicating that these modules serve as both digital resources and pedagogical tools that foster higher-order cognitive and social skills.

In addition to these dominant themes, emerging variables point to new research directions. Bibliometric clusters identified creativity, STEAM integration, and platform-specific affordances (e.g., Book Creator) as growing areas of interest. Their presence suggests a shift from studies limited to validity and effectiveness toward more complex inquiries into innovation, interdisciplinarity, and authentic learning design. Collectively, the mapping of these variables highlights the role of PjBL e-modules as innovations that not only enhance learning outcomes but also foster broader educational goals, such as creativity, digital citizenship, and the development of 21st-century skills. Future research should expand this trajectory by examining these variables across diverse contexts and integrating immersive technologies (e.g., AR/VR) and adaptive AI-based systems.

CONCLUSION

Based on the literature review, the development of e-modules integrated with project-based learning (PjBL) shows a growing and positive trend in education. PjBL within e-modules has been proven effective in promoting active, contextual learning and fostering 21st-century skills. Most studies adopt a research and development (R&D) approach, targeting secondary education levels (SMP, SMA, SMK), especially in science subjects, and utilizing various digital platforms. These findings suggest that project-based e-modules hold strong potential to improve students' learning processes and outcomes.

Beyond academic contributions, the research also offers practical benefits. Teachers are provided with a clear model for implementing PjBL through interactive e-modules, making science learning more engaging and relevant. For curriculum developers, the findings offer valuable insights into integrating 21st-century skills and independent learning strategies within digital platforms, thereby supporting the development of adaptive, student-centered learning materials that align with current educational standards. Future development of PjBL-integrated e-modules can incorporate other approaches such as STEM, STEAM, or ethnoscience. Additionally, enhancing e-modules with technologies like augmented reality (AR), virtual reality (VR), or artificial intelligence (AI)-based personalization can further meet students' needs.

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