

## INTEGRATING PjBL AND LOCAL WISDOM IN E-MODULES TO FOSTER STUDENTS' CREATIVE THINKING: A LITERATURE REVIEW

**Hanisyah Vita Roudlotul Aliyah <sup>\*1)</sup>, Widowati Budijastuti <sup>2)</sup>, Lisa Lisdiana <sup>3)</sup>**  
<sup>1,2,3)</sup>Master Program of Biology Education, Faculty of Mathematics and Natural Sciences, University  
of Surabaya, East Java, Indonesia.  
*\*Corresponding author*  
e-mail: [hanisyahvita28@gmail.com](mailto:hanisyahvita28@gmail.com) <sup>\*1)</sup>

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### ABSTRACT

Creative thinking is an important twenty-first-century competency for generating ideas and developing innovative responses to environmental problems. This literature review addresses three questions: (1) how does Project-Based Learning (PjBL) support creative thinking in biology education? (2) how do e-modules and local wisdom support contextual biology learning? and (3) what potential does coffee-ground waste offer as an environmental learning context? A structured search adapted from PRISMA was conducted through Google Scholar and the Garuda national journal database for publications from 2019 to 2026. Eleven primary studies meeting the inclusion criteria were thematically synthesized into four areas: PjBL and creative thinking, e-modules, local wisdom, and coffee-ground waste. Findings from these studies indicate that PjBL supports authentic problem investigation, idea generation, project design, product development, and reflection. E-modules facilitate structured and independent learning, while local wisdom strengthens contextual learning. Coffee-ground waste provides an authentic context for environmental and creative activities. Synthesizing these findings suggests that PjBL, e-modules, local wisdom, and coffee-ground waste associated with the cethe tradition could be integrated as a direction for future instructional design. This synthesis is limited to 11 primary studies and does not include meta-analysis; therefore, the findings represent thematic evidence rather than pooled effect estimates.

**Keywords:** creative thinking; e-module; environmental pollution; local wisdom; PjBL; biology education

### INTRODUCTION

Twenty-first-century education requires learning experiences that prepare students to respond to complex academic, social, and environmental problems. Creative thinking is an important competency because it involves generating diverse ideas, considering alternatives, producing original responses, and developing ideas into meaningful outcomes. In biology education, this competency is particularly relevant because biological concepts are closely connected with real environmental phenomena that require investigation and problem solving.

*Project-Based Learning* (PjBL) provides a learning environment that can accommodate these demands, equipping

students with skills considered essential for success in the twenty-first century (Bell, 2010). PjBL engages students in authentic problems, investigation, project planning, product development, and reflection. These learning mechanisms are theoretically relevant to the four dimensions of creative thinking. Fluency is stimulated when students are encouraged to generate multiple ideas or possible solutions to an authentic problem. Flexibility develops when students examine problems from different perspectives and consider alternative strategies during project planning and implementation. Originality is fostered when students are encouraged to propose unique ideas and develop

distinctive solutions or products. Elaboration is developed when students refine, detail, modify, and communicate their ideas throughout the project process. Thus, the stages of investigation, idea generation, planning, creation, revision, and reflection in PjBL provide opportunities for students to practice the four dimensions of creative thinking.

Literature studies have consistently reported the contribution of PjBL to creativity and higher-order thinking. Putri and Zulyusri (2022), through a meta-analysis involving 30 studies, reported a positive influence of PjBL on students' creative thinking in biology learning. Azzahra et al. (2023), through a literature review of 20 articles, likewise concluded that PjBL positively influences creative thinking skills in biology education. Fitri et al. (2024) further synthesized research on PjBL and creativity and concluded that project activities provide opportunities for students to explore, create, interpret, and develop products. Zulyusri et al. (2023) also reported the potential of PjBL to improve creativity and critical thinking in science education. Recent evidence published in EDUPROXIMA also supports the relationship between PjBL and creative thinking. Hayati et al. (2026) found that PjBL assisted by a student worksheet was effective in fostering creative thinking skills in science learning.

The relevance of PjBL becomes stronger when it is implemented in environmental pollution learning. Environmental pollution involves problems that can be observed in students' surroundings, including waste accumulation, inappropriate waste disposal, and the environmental consequences of human activities. Sukmawijaya et al. (2019) investigated

STEM-PjBL in environmental pollution learning and reported higher N-gain in the experimental class than in the control class, with the STEM-PjBL model influencing students' creative thinking. Thus, environmental pollution can provide an authentic problem context in which students investigate environmental conditions, generate alternative solutions, and develop project-based responses.

However, PjBL requires learning resources that can guide students throughout the project process. E-modules are digital learning resources that can combine learning materials, multimedia, activities, instructions, assessment, and reflection in an integrated format. Sureni et al. (2023) developed an e-module using Flip PDF Professional on environmental pollution and examined its validity as a digital learning resource.

E-modules can support independent learning through structured materials and activities and can be designed to accommodate project-based learning. Darmastuti et al. (2025) developed an e-module based on PjBL on virus material to improve students' creative thinking. The study used the ADDIE development model and included expert validation, readability testing, student responses, and N-gain analysis. This finding demonstrates that the digital module format can be integrated with project-based learning rather than functioning merely as an electronic version of a textbook. Nevertheless, existing evidence provides limited explanation of how an e-module can deliberately facilitate specific creative-thinking processes through the stages of PjBL.

Another important component is local wisdom. Biology learning becomes more contextual when scientific concepts are connected with phenomena and

practices that students recognize within their communities. Local wisdom can provide a meaningful entry point for introducing biological and environmental problems because it connects scientific knowledge with students' sociocultural experiences. Restianingrum and Isnawati (2023), for example, developed an e-LKPD based on local wisdom in conventional biotechnology to train students' creative thinking skills.

Similar findings were reported by Rosidi et al. (2023), who developed an e-module on biodiversity based on problem-based learning and local wisdom. The e-module was designed to improve critical thinking, problem-solving skills, and environmental attitudes. Sahil et al. (2023) also developed a Grade X biology e-module based on local potential and local wisdom using Canva Design and reported that the product was feasible as a biology learning resource. More recent evidence from Marlina et al. (2025) indicates that ecosystem e-modules integrated with local wisdom can achieve high validity and practicality while supporting sociocultural awareness and critical thinking. These studies indicate that local wisdom can function not merely as additional cultural information but as a contextual element that connects scientific concepts with authentic situations.

Coffee-ground waste associated with the cethe tradition in Tulungagung, East Java, offers a distinctive local context. Biologically, coffee grounds are organic material containing carbon and other compounds that can be decomposed and converted into useful products. Ecologically, their accumulation and improper disposal contribute to waste-management problems, whereas reuse supports waste reduction and resource

recovery. Socially, cethe is a distinctive practice familiar within the local community, and educationally, it connects students' everyday experiences with organic waste, environmental pollution, decomposition, and sustainable utilization. The cethe context therefore offers more than a cultural theme: it provides an authentic local situation through which students can identify environmental problems, generate ideas, consider alternatives, and develop useful products.

Existing research demonstrates that coffee-ground waste has potential for reuse. Rifa'i et al. (2025) used it as an educational painting medium, while Rochmah et al. (2021) and Sumadewi et al. (2020) reported its conversion into organic fertilizer and other value-added products. These studies indicate that coffee grounds can be transformed into useful materials rather than treated solely as waste.

Nevertheless, the existing literature reveals a gap at the construct level. Previous studies show that PjBL can support creative thinking, e-modules can facilitate structured independent learning, and local wisdom can strengthen contextual biology education, but provide limited evidence on how specific PjBL mechanisms facilitate the four creative-thinking dimensions — fluency, flexibility, originality, and elaboration — when embedded in an e-module within an authentic local-wisdom context. The role of coffee-ground waste in triggering these processes within environmental pollution learning has also not been sufficiently synthesized. Therefore, the gap is not merely the absence of a study combining several components, but the limited understanding of the relationship between PjBL mechanisms, creative-thinking

dimensions, digital scaffolding, and local-wisdom affordances.

Therefore, this literature review aims to synthesize empirical evidence

concerning PjBL, e-modules, local wisdom, environmental pollution, and creative thinking in biology education, examining how PjBL mechanisms relate to the dimensions of creative thinking, how e-

## METHOD

This study employed a descriptive literature review approach to identify, compare, and synthesize previous findings concerning Project-Based Learning (PjBL), creative thinking, e-modules, local wisdom, environmental pollution, and coffee-ground waste in biology and science education (Snyder, 2019).

The literature search was conducted through Google Scholar and Garuda, with national scientific journals prioritized because the review focuses on Indonesian educational contexts, particularly local wisdom, environmental issues, and coffee-ground waste associated with the cethe tradition in Tulungagung. Google Scholar was selected for its broad coverage of scholarly publications, while Garuda provides access to nationally published Indonesian scientific literature, particularly in education and biology education. These sources were considered appropriate for capturing literature relevant to the biological, educational, environmental, and sociocultural context of the review.

The search covered publications from 2019 to 2026 using combinations of keywords related to PjBL, creative thinking, e-modules, local wisdom, environmental pollution, and coffee-ground waste. The search and selection process followed structured identification,

modules and local wisdom support contextual and independent learning, and how coffee-ground waste can function as an authentic environmental learning context. The findings are intended to guide future instructional design integrating PjBL, e-modules, and local wisdom associated with coffee-ground waste and the cethe context in Tulungagung.

screening, eligibility, and inclusion procedures adapted from the PRISMA 2020 guideline (Page et al., 2021). No systematic review protocol was registered and no meta-analysis was conducted. Studies meeting the predefined inclusion and exclusion criteria were thematically synthesized according to the main themes of the review.

## Search Strategy

The literature search was conducted using Google Scholar and Garuda and was followed by verification through journal publisher websites when necessary. The search was limited to publications from 2019 to 2026, except for a small number of foundational theoretical references used to support the conceptual framework. Table 1 presents the search strings used for each thematic cluster.

**Table 1. Search Strings Used in the Literature Search**

| The matic Cluster          | Search String (Boole an)                                                                |
|----------------------------|-----------------------------------------------------------------------------------------|
| PjBL and creative thinking | ("Project-Based Learning" OR "PjBL") AND ("creative thinking" OR "berpikir kreatif")    |
| E-module                   | ("e-module" OR "electronic module" OR "e-modul") AND ("biology" OR "science education") |

| The matic Cluster       | Search String (Boolean)                                                                    |
|-------------------------|--------------------------------------------------------------------------------------------|
| Local wisdom            | ("local wisdom" OR "kearifan lokal") AND ("biology education" OR "e-module")               |
| Environmental pollution | ("environmental pollution" OR "pencemaran lingkungan") AND ("PjBL" OR "creative thinking") |
| Coffee-ground waste     | ("coffee-ground waste" OR "limbah ampas kopi" OR "cethe")                                  |

### Selection Procedure

Article selection followed the identification, screening, eligibility, and inclusion logic of the PRISMA guideline (Page et al., 2021). The search was conducted through Google Scholar and the Garuda national journal portal from June to July 2026. Across all keyword combinations, the search engines returned approximately 37,364 raw hits. Of these, 883 records from Google Scholar and 131 records from Garuda were retrieved as candidate records, yielding 1,014 records identified for the review.

After 662 duplicate records were removed, 352 unique records remained and were screened by title and abstract. A total of 302 records were excluded at this stage because they were not relevant to the review themes. The remaining 50 records were assessed in full text against the inclusion and exclusion criteria presented in Table 2, and 39 records were excluded for not meeting these criteria. This process yielded 11 selected studies that were retained for the thematic synthesis.

The 11 selected studies addressed four major components of the review: PjBL and creative thinking, e-modules as digital learning resources, local wisdom in biology education, and coffee-ground waste as an environmental learning context. The

selected studies represented different types of evidence, including meta-analysis, literature review, empirical study, development study, feasibility study, and contextual or community application study. Therefore, the studies were not treated as statistically equivalent sources but were interpreted according to their respective contributions to the review themes.

Before thematic synthesis, data were systematically extracted from each of the 11 selected studies using a structured extraction framework. The extracted information included (1) author and publication year, (2) research objectives, (3) research design and methodology, (4) participant characteristics and learning context, (5) learning model or instructional approach, (6) learning materials and digital learning resources, (7) integration of local wisdom or local potential, (8) environmental or coffee-ground waste context, (9) creative-thinking dimensions addressed, and (10) main findings and their relevance to the review questions. Particular attention was given to findings related to the four dimensions of creative thinking, namely fluency, flexibility, originality, and elaboration, as well as evidence concerning PjBL, e-modules, local wisdom, and environmental contexts in biology or science education. The extracted information was recorded, compared across studies, and grouped according to the review themes as the basis for the subsequent thematic synthesis. The complete selection process is summarized in Figure 1.

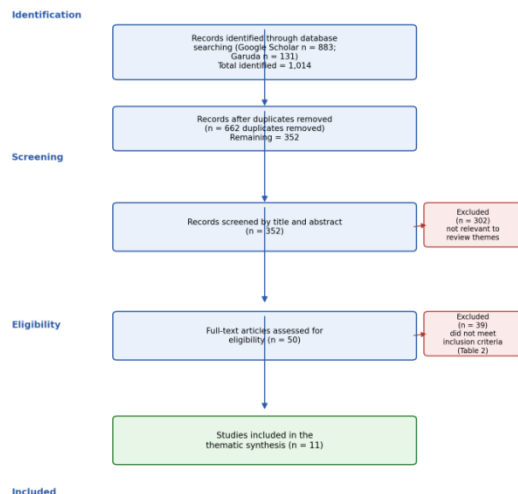


*Figure 1. PRISMA-Adapted Flow Diagram of the Study Selection Process*

**Table 2. Inclusion and Exclusion Criteria**

| Publication type | Inclusion                                                                                                                   | Exclusion                                                                                                          |
|------------------|-----------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------|
| Topic relevance  | Scientific journal articles or directly relevant scholarly publications with identifiable objectives, methods, and findings | Theses, books, non-peer-reviewed sources, or publications whose focus and findings could not be clearly identified |
| Duplication      | Addresse's biology or science education, environmental learning, or at least one principal theme of the review              | Publications unrelated to the research themes                                                                      |
| Contribution     | Publications that contribute directly to the thematic synthesis                                                             | Duplicate publications; publications with no direct contribution to the synthesis                                  |

Because the studies differed in research designs, participant populations, instruments, contexts, and outcomes, they were compared at the level of underlying

educational concepts and relationships rather than assumed to be statistically comparable. This involved identifying concepts relevant to the review questions, grouping similar findings into descriptive categories, and organizing these into broader themes, with particular attention to recurring relationships among PjBL activities, creative-thinking dimensions, digital learning resources, local wisdom, and environmental learning contexts..

Supporting references were used to strengthen theoretical and contextual explanations but were not counted among the 11 selected studies.

The findings were synthesized thematically into four themes: (1) PjBL and creative thinking; (2) e-modules as digital learning resources; (3) local wisdom in biology education; and (4) coffee-ground waste as an environmental learning context. The final synthesis was then used to identify the construct-level research gap and implications for future e-module instructional design.

## RESULTS AND DISCUSSION

### 1. Project-Based Learning and Students' Creative Thinking

The first theme concerns the relationship between PjBL and students' creative thinking. The literature indicates that project-based learning provides opportunities for students to develop creative ideas through authentic problem solving, project planning, product development, and reflection. Putri and Zulyusri (2022), through a meta-analysis of 30 studies, reported a positive influence of PjBL on students' creative thinking in biology learning. Azzahra et al. (2023), through a literature review of 20 articles, similarly reported a positive influence of PjBL on creative thinking in biology

education. Ni'mah and Usman (2026) further reported that PjBL can enhance students' creative thinking skills in biology learning. More specifically, Sukmawijaya et al. (2019) found that STEM-PjBL in environmental pollution learning improved students' creative thinking, with the experimental group obtaining a higher N-gain than the control group.

The relationship between PjBL and creative thinking can be explained through the characteristics of project-based learning. Students are not restricted to reproducing a single answer; instead, they are encouraged to identify problems, formulate questions, consider alternatives, make decisions, develop products, and revise their work. These activities correspond with the dimensions of creative thinking, particularly fluency, flexibility, originality, and elaboration (Munandar, 2012). However, the evidence identified in the literature should be distinguished by type. Evidence of effectiveness refers to empirical findings showing that PjBL improves students' creative-thinking skills, such as higher creative-thinking scores or N-gain after implementation. Evidence of feasibility indicates that a PjBL-based resource or design can be implemented appropriately by teachers or students. Evidence of validity refers to expert judgments that a resource, module, or instrument meets established content, media, or instructional criteria. Evidence of contextual potential, in contrast, indicates that a context such as local wisdom, environmental problems, or coffee-ground waste offers meaningful opportunities for contextual learning without directly demonstrating effectiveness in improving creative thinking. These four levels of empirical support should not be interpreted interchangeably.

## **2. E-Modules as Digital Learning Resources for Project-Based Biology Learning**

The second theme concerns the role of e-modules as digital learning resources for biology learning. E-modules can organize learning materials, multimedia, project instructions, activities, and assessment within an integrated digital environment, incorporating interactive elements and contextual materials that may support students throughout project-based learning activities.

Sureini et al. (2023) developed an e-module using Flip PDF Professional for environmental pollution learning among Grade VII students. The study focused on the development and validity of the e-module as a digital learning resource. Its focus on environmental pollution makes the study particularly relevant to the present review because it demonstrates how digital learning resources can be designed around an environmental context.

Darmastuti et al. (2025) provide further evidence concerning the integration of PjBL and e-modules. Their study developed a PjBL-based e-module on virus material to support students' creative thinking. The development process followed the ADDIE model and involved expert validation, readability testing, student responses, and N-gain analysis. These findings indicate that an e-module can function not only as a repository of learning materials but also as a structured resource for guiding students through project-based learning activities and supporting the development of creative thinking.

Yovita et al. (2025) also reported the development of an IPA e-module based on Project-Based Learning. The study illustrates the potential of digital modules to

organize project-oriented learning activities in a structured manner. This finding complements the evidence from other studies by demonstrating that PjBL principles can be incorporated into the organization and presentation of digital learning resources.

Across these studies, two patterns can be identified. First, e-modules can integrate learning materials, multimedia, activities, and assessment into a structured digital learning resource. Second, e-modules can be organized around an instructional model such as PjBL rather than merely converting printed materials into digital form. The integration of digital features with project-based activities may therefore provide opportunities for students to engage with problems, plan activities, develop products, monitor their progress, and reflect on their learning.

From this synthesis, an e-module designed to support PjBL should integrate more than digital content: contextual stimuli, relevant multimedia, project instructions, planning activities, monitoring guidance, product assessment, and reflection, positioning it as a structured learning environment throughout the PjBL process. However, evidence of e-module validity, feasibility, or implementation does not by itself establish its effectiveness in improving students' creative thinking.

### **3. Local Wisdom as a Contextual Resource in Biology Education**

The third theme concerns local wisdom as a contextual resource in biology education. Local wisdom can contextualize biology learning by connecting scientific concepts with students' cultural and environmental experiences.

Restianingrum and Isnawati (2023) developed an e-LKPD based on local wisdom in conventional biotechnology to

train students' creative thinking skills. This finding indicates that local wisdom can be integrated into digital learning activities designed to support creative-thinking development. Rosidi et al. (2023) developed an e-module integrating Project-Based Learning (PjBL) and local wisdom in biodiversity learning. The study examined learning outcomes including critical thinking, problem-solving skills, and environmental attitudes, indicating that local wisdom can be embedded within a PjBL-based digital learning environment.

Across the reviewed literature, a consistent pattern is that local wisdom can provide contextual meaning and authentic situations for biology and science learning. However, the evidence differs in terms of the outcomes examined. Some studies focus on creative thinking, whereas others emphasize critical thinking, problem solving, environmental attitudes, or the validity and practicality of learning resources. Thus, the existing evidence supports the contextual and instructional potential of local wisdom but provides more limited evidence on its direct effectiveness in developing fluency, flexibility, originality, and elaboration — indicating the need to connect local wisdom with explicit PjBL activities that deliberately provide opportunities to practice these dimensions.

Fandi and Widowati (2026) developed a science e-module integrating the Ikan Larangan local wisdom tradition into ecology and biodiversity learning. Their study illustrates how local cultural practices can be incorporated into digital science learning to establish connections between scientific concepts and students' sociocultural experiences. Marlina et al. (2025) further reported the feasibility of ecosystem e-modules integrated with local

wisdom, including evidence of validity and practicality. Rohmania et al. (2026) similarly reported high validity of a science module based on SETS-SDGs for environmental pollution learning, supporting the feasibility of contextual learning resources for environmental topics.

The findings suggest that local wisdom can serve three functions in biology learning: as a contextual stimulus introducing scientific concepts through familiar situations, as a source of authentic problems and project ideas meaningful to students, and as a bridge connecting scientific knowledge with students' sociocultural environment.

Within this literature synthesis, the cethe tradition can serve as a local context for introducing coffee-ground waste. Importantly, the cultural context should not be presented as scientific evidence of environmental pollution. Rather, it can function as an entry point through which students encounter a familiar cultural practice and subsequently investigate the associated environmental issue through scientific inquiry and PjBL activities.

#### **4. Coffee-Ground Waste as an Environmental Learning Context**

The fourth theme concerns coffee-ground waste as a potential environmental learning context — an organic waste material that can be observed, discussed, and utilized as a contextual object, connecting waste-related environmental issues with activities involving reuse, product development, and problem solving.

Rifa'i et al. (2025) demonstrated that coffee-ground waste could be reused as an educational painting medium for school children. The activity combined environmental education, waste reuse, and creativity. Rochmah et al. (2021) reported

another form of utilization by processing coffee-ground waste into liquid organic fertilizer through a community empowerment program. Similarly, Sumadewi et al. (2020) reported a community empowerment activity in Catur Village, Bangli, in which coffee-ground waste from local coffee farming was processed into economically useful products. Together, these findings indicate that coffee-ground waste has utilization potential across different community and regional contexts.

However, these studies demonstrate waste-utilization and community-based potential rather than the effectiveness of coffee-ground waste as a biology learning context. Thus, they provide contextual support for incorporating coffee-ground waste as an authentic environmental issue in PjBL activities, rather than direct evidence of improved creative thinking.

Based on the synthesis of the reviewed studies, the relationship among the major components can be conceptualized as a contextual project-based learning pathway: local wisdom functions as the contextual entry point connecting students' sociocultural experiences with the environmental issue of coffee-ground waste; coffee-ground waste is positioned as an authentic environmental problem investigated through biology learning; the e-module functions as digital scaffolding, providing structured materials, multimedia stimuli, instructions, activities, reflection, and assessment; and PjBL functions as the learning mechanism through which students identify problems, generate and compare ideas, plan projects, develop products, evaluate results, and revise solutions — practicing fluency, flexibility, originality, and elaboration, and thereby supporting creative thinking.

The synthesized relationship can therefore be represented as follows:

local wisdom (cethe context) → coffee-ground waste → authentic environmental problem → e-module scaffolding → PjBL learning process → project/product solution → creative thinking

This relationship is not intended to indicate a simple linear causal sequence. Rather, local wisdom provides contextual meaning, coffee-ground waste the authentic problem, the e-module digital learning support, and PjBL the instructional mechanism for developing project-based solutions and practicing creative thinking.

This proposed relationship is derived from the convergence of findings across the reviewed studies rather than from a single empirical study testing the complete model; it should therefore be regarded as a conceptual synthesis and instructional proposition requiring empirical validation in future research.

### 5. Synthesis of Selected Studies and Research Gap

The synthesis of the eleven selected studies is presented in Table 3. The selected studies were examined based on their contribution to four major components of the review: (1) Project-Based Learning (PjBL) and students' creative thinking, (2) e-modules as digital learning resources, (3) local wisdom as a contextual resource in biology education, and (4) coffee-ground waste as an environmental learning context. The studies differed in research design and type of evidence; therefore, their findings were interpreted according to their respective contributions, including effectiveness, validity, feasibility, implementation, and contextual potential.

**Table 3. Synthesis of Selected Studies Relevant to the Literature Review**

| No. | Key Findings and Relevance to the Literature Review                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|-----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1   | <p><b>Meta-analysis.</b> A meta-analysis of 30 studies reported a positive influence of PjBL on students' creative thinking in biology learning, supporting its relevance for fostering creative thinking.</p> <p><b>Literature review.</b> A review of 20 articles indicated that PjBL has potential to foster students' creative thinking in biology education, strengthening the basis for integrating PjBL with creative-thinking-oriented activities.</p> <p><b>Empirical study.</b> STE M-PjBL applied to environmental pollution learning improved students' creative thinking, with the experimental group achieving a higher N-gain than the control group — direct empirical support for PjBL in environmental contexts.</p> <p><b>Development and validity study.</b> An e-module using Flip PDF Professional was developed for environmental pollution learning, demonstrating validity as a digital resource for organizing environmental learning content.</p> <p><b>Development and effectiveness study.</b> A PjBL-based e-module on virus material was developed using the ADDIE model; expert</p> |
| 2   | Azzahra et al. (2023)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| 3   | Sukmawijaya et al. (2019)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 4   | Sureni et al. (2023)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| 5   | Darmastuti et al. (2025)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |

| No. | Key Findings and Relevance to the Literature Review                                                                                                                                                                                                                                                   | No.                                                                                                                                                                                                                                                                                                                                                                                                                        | Key Findings and Relevance to the Literature Review                                                                                                                                                                                         |
|-----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|     | validation, readability, student responses, and N-gain results indicated it could support PjBL and students' creative thinking.                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                            | <b>Contextual application study.</b> Coffee-ground waste was utilized as an educational painting medium for school children, demonstrating its potential as a contextual resource for environmental education, waste reuse, and creativity. |
| 6   | Restianingrum & Isnawati (2023)<br><b>Development study.</b> A local-wisdom-based e-LKPD was developed for conventional biotechnology learning to train students' creative thinking, showing that local wisdom can be integrated into digital learning activities for meaningful contextual learning. | 10                                                                                                                                                                                                                                                                                                                                                                                                                         | Rifa'i et al. (2025)                                                                                                                                                                                                                        |
|     | <b>Development study.</b> An e-module integrating Project-Based Learning (PjBL) and local wisdom was developed for biodiversity learning.                                                                                                                                                             | 11                                                                                                                                                                                                                                                                                                                                                                                                                         | Rochmah et al. (2021)                                                                                                                                                                                                                       |
| 7   | Rosidi et al. (2023)<br>The study examined outcomes including critical thinking, problem solving, and environmental attitudes, demonstrating the potential of combining local wisdom with project-based digital learning.                                                                             | The synthesis in Table 3 indicates that the four major components of the review are supported by different types of evidence. PjBL is associated with creative thinking, e-modules demonstrate validity, feasibility, and potential effectiveness, local wisdom provides contextual resources for biology learning, and coffee-ground waste offers potential as an authentic environmental context and material for reuse. |                                                                                                                                                                                                                                             |
| 8   | Sahil et al. (2023)<br><b>Development and feasibility study.</b> A Grade X biology e-module based on local potential and local wisdom was developed and found feasible, supporting the use of local contexts in digital biology learning resources.                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                             |
| 9   | Marlina et al. (2025)<br><b>Development and feasibility study.</b> An ecosystem e-module integrated with local wisdom demonstrated high validity and practicality, supporting the integration of local wisdom into digital biology learning materials.                                                |                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                             |

However, several gaps remain. Few studies explicitly connect PjBL with all four dimensions of creative thinking—fluency, flexibility, originality, and elaboration—within environmental pollution learning. Studies on e-modules and local wisdom generally emphasize validity, practicality, feasibility, or broader learning outcomes rather than creative-thinking dimensions through PjBL. Meanwhile, coffee-ground waste studies

primarily address waste utilization and community activities rather than its integration into a structured biology learning process.

These gaps indicate an opportunity to integrate PjBL, e-modules, local wisdom, and coffee-ground waste within contextual environmental pollution learning. The cethe tradition can provide a

## CONCLUSION

The literature review indicates that Project-Based Learning (PjBL) has empirical support as a learning model for fostering students' creative thinking in biology education, giving students opportunities to investigate authentic problems, generate ideas, develop projects, produce solutions, and reflect on their learning. E-modules can provide structured digital learning environments, while local wisdom can strengthen contextual biology learning by connecting scientific concepts with students' sociocultural environments, and coffee-ground waste demonstrates potential for creative reuse and environmentally beneficial applications. However, these findings have primarily examined the components separately rather than within one integrated instructional framework.

The main conceptual contribution of this review is the identification of a contextual project-based learning pathway linking local wisdom, coffee-ground waste, e-module scaffolding, PjBL, and creative thinking. In this pathway, local wisdom provides sociocultural relevance, coffee-ground waste supplies an authentic environmental problem, the e-module offers structured scaffolding, and PjBL supplies the mechanism guiding students from problem investigation to reflection,

familiar local context, coffee-ground waste an authentic environmental problem, and the e-module digital scaffolding for PjBL activities. Through this integration, students can generate ideas, consider alternative solutions, develop products, and elaborate their ideas, thereby supporting creative thinking.

together fostering fluency, flexibility, originality, and elaboration.

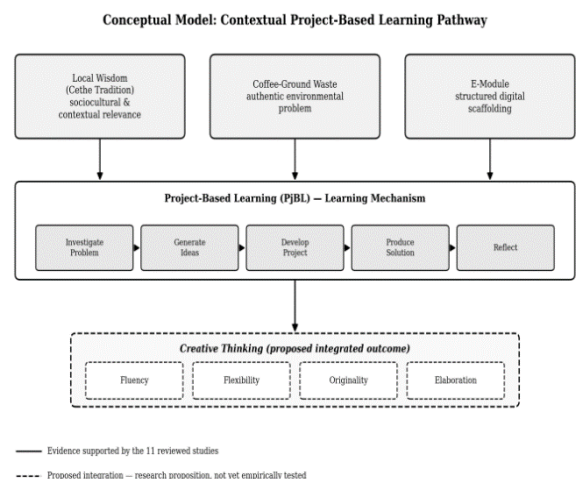


Figure 2. Conceptual model linking local wisdom, coffee-ground waste, e-module scaffolding, and PjBL to creative thinking.

Nevertheless, the integration of these components and the expected effectiveness of an e-module based on this framework constitute a research proposition rather than a finding of the present literature review. The eleven selected studies do not directly test the complete integration of PjBL, e-modules, creative thinking, environmental pollution, coffee-ground waste, and the local cethe context of Tulungagung within a single instructional intervention. Therefore, further development research is required to examine the validity, practicality, and effectiveness of an e-

module based on this framework, particularly its ability to foster the four dimensions of creative thinking—*fluency*,

*flexibility*, *originality*, and *elaboration*—in environmental pollution learning.

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