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Gamification, multimodal, and local wisdom-based learning: trends and effectiveness in developing elementary students' critical thinking and ecoliteracy

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ABSTRACT

The development of 21st-century education requires learning approaches that promote students' higher-order thinking skills and environmental awareness from an early age. Gamification, multimodal learning, and local wisdom-based learning offer opportunities to create engaging, contextual, and meaningful learning experiences in elementary education. This study aims to examine publication trends and research characteristics, explore how these approaches are integrated into elementary school learning, and synthesize their reported effectiveness in developing students' critical thinking and ecoliteracy. A Systematic Literature Review (SLR) was employed, complemented by bibliometric analysis using VOSviewer to identify keyword relationships, thematic clusters, and research development patterns. The findings reveal three major thematic orientations: local wisdom and sociocultural contexts, the development and validation of instructional materials, and the evaluation of learning effectiveness. The thematic mapping also highlights the relevance of higher-order thinking skills, creativity, student engagement, and digital technology in recent educational research. Regarding instructional integration, gamification functions as an activity-design mechanism through challenges, missions, and feedback; multimodal approaches provide varied representations through text, images, audio, video, and interactive media; while local wisdom provides culturally and environmentally relevant learning contexts. Previous studies indicate promising contributions of these approaches to critical thinking and ecoliteracy-related outcomes. However, the evidence remains varied across learning contexts, instructional designs, and outcome measurements. The limited visibility of gamification and multimodal learning as dominant themes in the bibliometric maps also indicates an opportunity for further integrated research. This study highlights the need for instructional designs that systematically combine gamification, multimodal representation, and local wisdom to support elementary students' critical thinking and ecoliteracy.

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Introduction

The development of Society 5.0 and the Fourth Industrial Revolution has increased the need for education to prepare students to use technology while maintaining human values and social responsibility. This transformation requires competencies such as critical thinking, problem-solving, creativity, collaboration, and social intelligence. These competencies need to be developed from an early age through learning that connects

scientific and technological knowledge with students' social and cultural environments (Harun, 2022; Isma et al., 2022). Critical thinking is particularly important because it enables students to examine, analyze, and evaluate information before making decisions. Therefore, elementary education should provide opportunities for students to seek, process, and assess information rather than merely receive it (Susanti et al., 2019; Halim, 2022).

Meaningful learning is essential to developing these competencies. Deep learning emphasizes conceptual understanding, reflection, and active engagement (Ramadan et al., 2025), consistent with constructivist perspectives that view knowledge as something learners build through experience and social interaction (Piaget, 1973; Vygotsky, 1978). Biggs and Collis (1982), through the SOLO Taxonomy, also describe the development of understanding from surface-level responses toward more integrated and deeper learning. The need to strengthen reasoning is underscored by Indonesia's performance in TIMSS, where scores in 2003, 2007, 2011, and 2015 remained below the international scale average of 500 (Pusat Asesmen Pendidikan, 2022). In response, educational policy has emphasized holistic graduate development through eight dimensions, including critical reasoning, creativity, collaboration, independence, and communication, supported by mindful, meaningful, and joyful learning (Kementerian Pendidikan Kebudayaan Riset dan Teknologi, 2023).

Local wisdom provides a context for connecting school learning with students lived experiences and environmental conditions. In elementary science and social studies (IPAS), topics such as regional characteristics and natural resources can help students explore their surroundings and understand local knowledge and practices. Such contextual learning may also foster ecoliteracy, which involves ecological awareness, knowledge, and responsible action. Masfufah et al. (2025) explain that incorporating the local wisdom of Kampung Bungur into IPAS can stimulate ecoliteracy, while Dwipranoto et al. (2023); Yunita et al. (2025) report improvements in students' ecological understanding and behavior through learning based on local potential. A systematic review by Muyassaroh et al. (2024) similarly indicates that local wisdom in elementary science learning can strengthen scientific literacy, environmental awareness, and ecoliteracy.

The characteristics of Generation Alpha also call for learning experiences that are visual, interactive, adaptive, and supported by immediate feedback. Students in this generation have grown up with digital devices and may respond positively to videos, animations, educational games, interactive modules, and other digital media (Rohmah et al., 2026; Adillah et al., 2023). Learning motivation and engagement are important in this context because they influence students' participation and persistence; engaging and meaningful learning media can support these factors (Destanto et al., 2026; Perdana & Valentina, 2022; Zainal, 2022). However, technology should be integrated in ways that preserve humanistic values and connect learning to local contexts.

The availability and development of local wisdom-based learning resources remain important challenges. Vioreza et al. (2022) highlight the limited variety of relevant materials, while Masitoh et al. (2025); Yonanda et al. (2022) identify constraints in references and teachers' innovation when developing illustrated materials based on Indramayu local wisdom. Arifah et al. (2024) also point to the educational potential of connecting local traditions, such as the sedekah bumi ceremony, with ecological values, while noting barriers related to learning modules and teachers' understanding of regional traditions. These findings suggest that effective integration requires contextual resources, appropriate teacher competencies, and meaningful learning designs.

Gamification is one approach that may create engaging learning experiences by incorporating game elements such as points, badges, levels, challenges, and feedback into non-game learning contexts. Previous studies report positive contributions to elementary students' motivation, engagement, and learning outcomes (Pujianingsih, 2024; Valentinna et al., 2024). Digital media can further support interactive and creative learning activities (Safitri & Putra, 2022; Khoirunnisa & Habibah, 2020; Komara, 2018). Nevertheless, gamification should serve more than entertainment or motivation; it should be designed to support higher-order thinking, including critical thinking, and environmental competencies such as ecoliteracy. Its implementation also faces challenges, including limited teacher understanding and training, inadequate infrastructure, resistance to innovation, and insufficient evaluation of effectiveness (Rosly & Khalid, 2017; Yuliatin & Rosmilawati, 2025).

A multimodal approach offers another way to enrich learning by combining modes of communication and representation, including text, images, movement, music, speech, and sound (Abidin, 2022). In classroom practice, visual, audio, textual, and interactive elements can provide different ways for students to access and construct meaning. Combined with gamification, multimodality may make learning more engaging; combined with local wisdom, it may present cultural and environmental knowledge through images, audio narratives, interactive tasks, and contextual resources. However, the ways in which gamification, multimodal approaches, and local wisdom are integrated and their contributions to critical thinking and ecoliteracy require further examination.

Research has addressed gamification, digital learning media, local wisdom, and ecoliteracy from different perspectives. A bibliometric analysis by Nurkamilah et al. (2024) indicates growing research attention to gamification and digital technology in elementary education. Nevertheless, the extent to which gamification, multimodality, and local wisdom have been integrated, and the evidence concerning their effectiveness in developing critical thinking and ecoliteracy, have not yet been comprehensively synthesized. This gap warrants a systematic literature review (SLR) that maps publication trends, examines integration patterns, synthesizes reported outcomes, and identifies implementation challenges and directions for future research. In this review, motivation and engagement are treated as supporting outcomes, while critical thinking and ecoliteracy remain the primary competencies for examining reported effectiveness. Accordingly, this review addresses the following research questions:

RQ 1: What are the publication trends and characteristics of research on gamification-based, multimodal, and local wisdom-integrated learning in elementary education?

RQ 2: How are gamification, multimodal approaches, and local wisdom integrated into elementary school learning?

RQ 3: What is the reported effectiveness of these learning approaches in developing elementary school students' critical thinking and ecoliteracy skills, and what challenges and research gaps have been identified?

By answering these questions, this review aims to synthesize current research and provide theoretical and practical insights for designing elementary learning experiences that integrate technological innovation, cultural values, and environmental sustainability.

Method

Research Design

This study employs a Systematic Literature Review (SLR) to identify, evaluate, and synthesize previous research on gamification-based, multimodal, and local wisdom-integrated learning in elementary education, particularly in relation to the development of students' critical thinking and ecoliteracy skills. The SLR approach was selected to provide a systematic understanding of publication trends, learning approaches, reported educational outcomes, and research gaps within the investigated field. The review focuses on three main dimensions: (1) the integration of gamification, multimodal approaches, and local wisdom in elementary school learning; (2) the reported effectiveness of these approaches in developing students' critical thinking and ecoliteracy; and (3) the challenges and research opportunities identified in previous studies. In addition to the systematic review, bibliometric analysis was employed as a supporting technique to map publication patterns and relationships among research keywords. This combination enables the study to provide both a qualitative synthesis of research findings and a visual representation of the thematic development of the field.

Data Sources and Data Collection

The data consisted of scientific publications relevant to gamification-based learning, multimodal learning, local wisdom-integrated education, critical thinking, and ecoliteracy in elementary education. The publications included journal articles, conference proceedings, and review articles. Bibliographic data were retrieved using Harzing's Publish or Perish application connected to the Crossref database. The retrieved metadata included publication titles, authors, publication years, journal or source names, abstracts when available, and DOI information. Full-text publications were subsequently examined when accessible to determine their relevance and extract information required for the systematic review. The data collection process involved identifying relevant publications, retrieving bibliographic records, screening titles and abstracts, assessing full-text eligibility, and selecting studies that met the predetermined inclusion criteria.

Search Strategy and Data Selection Criteria

The literature search was conducted using combinations of keywords related to the main concepts of this study. The search terms included *gamification*, *game-based learning*, *multimodal learning*, *multimodal approach*, *local wisdom*, *local culture*, *elementary education*, *primary school*, *critical thinking*, and *ecoliteracy*. The keywords were combined using Boolean operators, particularly AND and OR, to identify publications addressing the relationships among the learning approaches, educational context, and targeted learning outcomes. The search strategy was designed to capture studies examining these concepts individually as well as studies integrating two or more of them.

The selection of studies was guided by the following inclusion criteria: 1) Publications discussing gamification, multimodal learning, or local wisdom as part of an educational approach or learning intervention; 2) Studies conducted in elementary or primary school education, or studies providing directly relevant evidence for elementary education; 3) Publications addressing critical thinking, ecoliteracy, environmental literacy, or

closely related learning outcomes; 4) Empirical studies, research and development studies, and relevant literature reviews; and 5) Publications available within the predetermined publication period and containing sufficient bibliographic information for identification.

The exclusion criteria consisted of publications that were unrelated to the research focus, studies conducted exclusively in educational levels outside elementary education without relevant implications for primary school learning, duplicate records, and publications with insufficient information to establish their relevance. The screening process was conducted in stages, beginning with the identification of records, followed by title and abstract screening, full-text eligibility assessment, and final inclusion. The study selection process was organized using the Vosviewer and Harzing's publish or perish framework to improve transparency and reproducibility.

Data Extraction and Synthesis

Relevant information from the selected studies was organized into a data extraction matrix. The extracted information included authors, publication year, research context, educational level, research design, learning approach, instructional media, local wisdom elements, measured learning outcomes, and principal findings. The extracted data were analyzed through thematic synthesis. The analysis focused on identifying patterns in how gamification, multimodal approaches, and local wisdom were incorporated into elementary school learning. Particular attention was given to the reported contributions of these approaches to students' critical thinking and ecoliteracy skills. The findings were subsequently categorized according to the research questions. Publication characteristics and thematic patterns were used to describe the development of the research field, while the reported learning approaches, outcomes, challenges, and research gaps were synthesized to address the effectiveness and implementation of the investigated approaches.

Bibliometric Analysis Techniques

To complement the systematic literature review, bibliometric analysis was conducted using VOSviewer software. The bibliometric analysis was used to visualize the relationships among keywords and identify thematic patterns within the selected publication metadata. Three types of visualization were employed: 1) Network visualization was used to identify relationships among keywords and group related research topics into clusters based on their co-occurrence; 2) Overlay visualization was used to examine the temporal development of research themes based on the average publication year associated with keyword occurrences; and 3) Density visualization was used to identify areas of high keyword concentration and determine the themes receiving relatively greater attention in the analyzed publications. These visualizations provided complementary evidence regarding the thematic structure, temporal patterns, and concentration of research topics related to gamification, multimodal learning, local wisdom, critical thinking, and ecoliteracy.

Results and Discussions

RQ 1: What are the publication trends and characteristics of research on gamification-based, multimodal, and local wisdom-integrated learning in elementary education?

Publication Trends and Research Characteristics (Network Visualizatio)

The VOSviewer co-occurrence network visualization reveals three major thematic clusters in elementary school learning research: the integration of local wisdom and sociocultural values (red cluster), the evaluation of learning effectiveness (green cluster), and the development and validation of instructional materials (blue cluster). These findings are illustrated in the following figure.

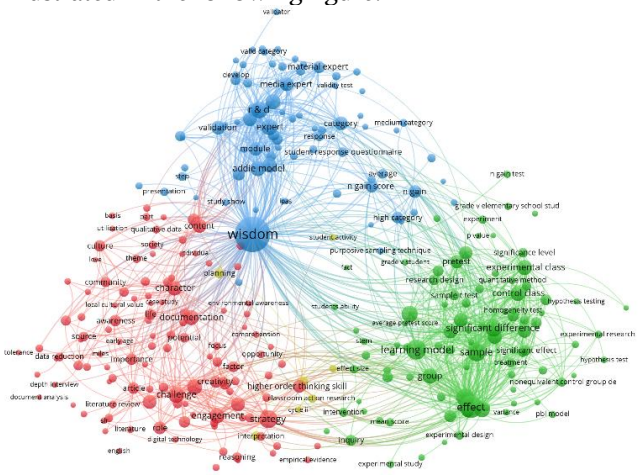


Figure 1. Network Visualization

The red cluster is dominated by the keywords wisdom, culture, community, character, and environmental awareness. This cluster indicates a research tendency to position local wisdom as a learning context and a source of character development. This tendency is supported by Sinthya and Ramadan (2021), who examined Malay local wisdom values in elementary school learning, and Siska et al. (2021), who investigated character development based on local wisdom through social studies learning. Agusta et al. (2022) also developed instructional materials based on South Kalimantan local wisdom to improve students' higher-order thinking skills and Gawi Manuntung character. These studies demonstrate that local wisdom is not merely used as supplementary learning content but can serve as a foundation for connecting classroom learning with culture and community life.

The green cluster is characterized by the dominant keywords effect, learning model, pretest, posttest, experimental class, and control class. This pattern indicates a research tendency toward evaluating the effectiveness of learning models or instructional media through quantitative and experimental approaches. This is consistent with Bai (2023), who examined the implementation of gamification methods to enhance elementary school students' learning interest in history lessons. Safitri and Sumardi (2024) also investigated the use of a Game-Based Learning model supported by the Baamboozle application in relation to second-grade elementary school students' critical thinking skills and Civic Education learning outcomes. These studies suggest that the use of games in learning is increasingly directed not only toward enhancing student engagement but also toward improving learning outcomes and cognitive competencies.

The blue cluster is characterized by the keywords ADDIE model, module, development, validation, expert, and student response questionnaire. This cluster indicates a strong research orientation toward the development and validation of instructional media and learning materials. For example, Maisaroh et al. (2019) developed an integrative learning model incorporating local wisdom through multimedia animation for elementary school students. Meanwhile, Budiyanto and Laila (2024) developed a local wisdom-based pop-up book for fifth-grade students. These studies demonstrate efforts to present local knowledge through more engaging instructional media that are appropriate to the learning characteristics of elementary school students.

Overall, the three clusters indicate that elementary school learning research has developed along three major directions: strengthening cultural contexts and character, evaluating learning effectiveness, and developing instructional media and materials. The central position of the keyword wisdom in the network indicates its interconnectedness with various other research themes. However, the keywords gamification and multimodal do not appear as dominant nodes in the visualization. This suggests that integrating gamification and multimodality with local wisdom remains an area that requires further investigation, particularly in supporting elementary school students' critical thinking and ecoliteracy skills.

Publication Trends Based on Overlay Visualization

Unlike network visualization, which illustrates relationships among keywords, VOSviewer overlay visualization illustrates the development of research themes based on the average publication year associated with keyword occurrences. The color gradient in the map represents the period from 2023.5 to 2025.5, with blue-purple indicating relatively earlier themes, green representing the intermediate period, and yellow indicating relatively more recent themes. Furthermore, the research trends related to the focus of this study can be identified through the following figure.

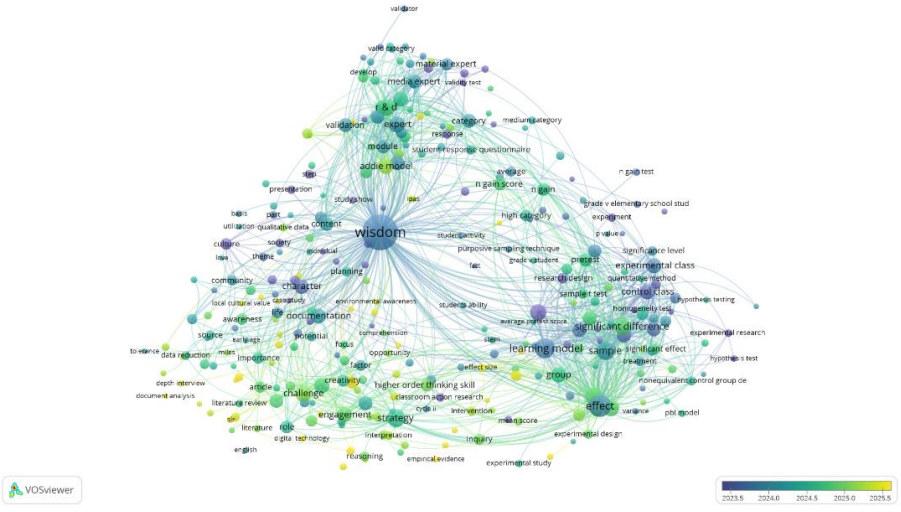


Figure 2. Overlay Visualization of Keyword Co-occurrence Based on Average Publication Year

Based on the visualization, the keyword wisdom appears in areas ranging from blue to bluish-green. This indicates that local wisdom has been an established research theme since the earlier period of the analyzed publication range and has remained connected to various other research topics. Meanwhile, keywords such as learning model, effect, significant difference, and experimental class are located in areas with varying shades of bluish-green to green. This pattern indicates the continued research interest in the development of learning models and the evaluation of their effectiveness.

Several keywords displayed in yellowish-green to yellow, including higher order thinking skill, creativity, reasoning, literature review, and digital technology, indicate relatively newer themes within the observation period. The emergence of these themes reflects an increasing research focus on the development of higher-order thinking skills, reasoning abilities, and the use of technology in learning.

Overall, the overlay visualization indicates a shift in research attention from themes related to local wisdom and instructional material development toward studies that place greater emphasis on higher-order thinking skills, creativity, reasoning, and the use of technology. These findings suggest that research on elementary education is increasingly concerned not only with learning contexts and instructional media but also with the competencies developed through the learning process.

In relation to the present study, these developments indicate an opportunity to integrate gamification, multimodal approaches, and local wisdom into a unified learning design. Such integration has the potential to connect cultural contexts with technology-based learning experiences while directing student activities toward the development of critical thinking and ecoliteracy skills.

Research Theme Density and Concentration (Density Visualization)
The VOSviewer density visualization illustrates the frequency and interconnectedness of keyword occurrences in the analyzed publications. Yellow areas represent relatively high keyword concentrations, whereas green to blue areas indicate lower levels of density.

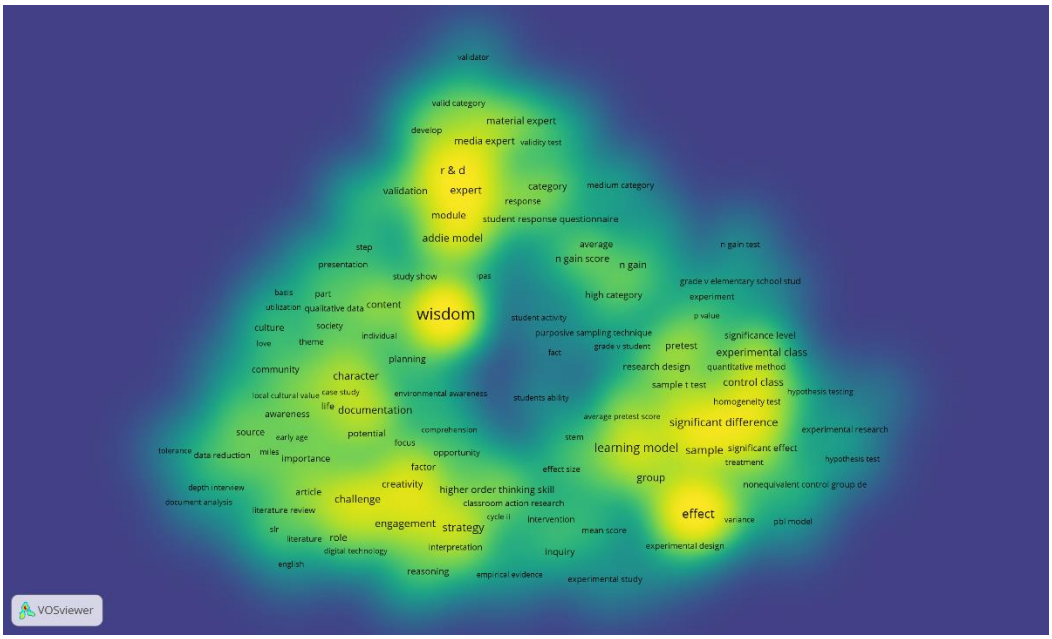


Figure 3. Density Visualization

Based on the map, three main areas of concentration can be identified. First, the keyword wisdom exhibits the most prominent density in the middle-left section of the map. This indicates that local wisdom is one of the themes most frequently connected to other research topics. This finding is consistent with Rostika and Herlambang (2026), who positioned local wisdom as an epistemological foundation for the development of ecopedagogy and ecological awareness. Furthermore, Natalina et al. (2023) demonstrated that multiliteracy learning can improve elementary school students' ecological knowledge, attitudes, and behavior.

Second, the area on the right shows a concentration of the keywords effect, learning model, significant difference, and experimental class. This pattern indicates considerable research attention toward testing learning models and measuring the effectiveness of instructional interventions. This tendency is also related to the study by Natalina et al. (2023), which employed an experimental design with a control group and involved 79 fifth-

grade students. The findings indicated improvements in students' ecological knowledge, attitudes, and behavior following the implementation of the multiliteracy learning model.

Third, the upper area shows a concentration of the terms R&D, ADDIE model, module, expert, and validation, reflecting research interest in the development and validation of instructional materials. This is relevant to the study by Gantina et al. (2024) on the usability of a Problem-Based Learning-based teaching module for poetry riddle activities in elementary schools. The findings showed that the feedback aspect received the highest score at 73%, whereas user activity accounted for 13%, indicating that certain aspects still require further development. In addition, the lower area displays the keywords higher order thinking skill, creativity, engagement, strategy, and digital technology. This indicates the connection between research on the development of higher-order thinking skills, student engagement, and the use of technology in learning. This research direction is consistent with the study by Herlambang, Putra, and Karimah (2026), which mapped trends in futuristic pedagogy, ecopedagogy, and deep learning in 21st-century education.

Overall, the density visualization reinforces the finding that the analyzed research is concentrated around local wisdom, instructional material development, and the evaluation of learning model effectiveness. The studies also demonstrate the relevance of pedagogical development that connects ecological and cultural dimensions with learning transformation. However, the keywords gamification and multimodal do not appear as major density centers. This condition indicates an opportunity for further research to integrate these two approaches with local wisdom within a unified learning design aimed at developing elementary school students' critical thinking and ecoliteracy skills.

RQ 2: How are gamification, multimodal approaches, and local wisdom integrated into elementary school learning?

Based on a review of the publications included in the reference document, the integration of gamification, multimodal approaches, and local wisdom in elementary school learning demonstrates a development pattern oriented toward the use of digital technology, interactive media, and local cultural and environmental contexts. These three approaches have complementary characteristics. Gamification introduces game elements to enhance student engagement, multimodal approaches provide various forms of information representation, while local wisdom offers learning contexts that are closely connected to students' social and cultural lives. Nevertheless, these three approaches are not always implemented simultaneously within a single learning design. Some studies integrate gamification with local wisdom, others develop multimodal media based on local culture, while other studies combine local wisdom with problem-based or project-based learning models. Therefore, the integration of these three approaches is more appropriately understood as an interconnected development pattern rather than a single learning model that has been implemented uniformly.

Integration of Gamification and Local Wisdom

Gamification in elementary school learning is generally implemented through the use of game elements, such as challenges, points, levels, rewards, interactive quizzes, and feedback. These elements are used to create more participatory learning activities and provide engaging learning experiences for students. When combined with local wisdom, game content is not merely oriented toward achieving scores but also incorporates knowledge, traditions, folklore, and cultural values originating from students' local environments. One study that directly demonstrates this integration pattern is Patras et al. (2025), which combined Culturally Responsive Teaching, local wisdom, and gamification in Pancasila Education to develop students' multicultural competencies. Kadoi et al. (2026) also demonstrated the implementation of culturally embedded gamification by integrating the local wisdom of the Behoa Valley into elementary school science learning. Both studies indicate that gamification can be developed by incorporating cultural identities and social contexts into learning activities.

A similar integration pattern can also be found in the study by Nitiasih et al. (2022), which utilized stories based on local wisdom through gamification to support students' reading comprehension skills in online learning. In addition, Aswar et al. (2026) developed a local wisdom-based snakes and ladders game as a learning medium for folklore in elementary schools. Pamungkas and Wakhudin (2026) integrated the Wordwall platform with Banyumas local wisdom to support the development of elementary school students' critical thinking skills. Based on these patterns, the integration of gamification and local wisdom can take several forms, including: (1) using folklore and regional traditions as game content; (2) utilizing digital games to present learning materials related to local culture; (3) incorporating challenges and quizzes based on environmental or social issues in students' surroundings; and (4) providing rewards upon completion of tasks related to local knowledge.

This pattern indicates that local wisdom can function both as a content source and as a contextual foundation for gamified activities. Students do not merely complete game challenges but also interact with knowledge and values originating from their own environments. Therefore, incorporating cultural elements into gamification

has the potential to make learning more contextual while strengthening the connection between learning experiences and everyday life.

Integration of Multimodal Approaches in Local Wisdom-Based Learning

Multimodal approaches are implemented through the use of various modes of communication and representation, such as text, images, illustrations, audio, video, animation, and interactive activities. The use of these different modes allows information to be conveyed through more than one form of representation, thereby providing students with various ways to understand learning materials.

In the context of local wisdom, multimodal approaches can be used to represent traditions, folklore, environmental knowledge, and community cultural practices through visual and audiovisual media. For example, Amelia et al. (2021) examined the use of audiovisual media based on local wisdom as a learning medium for elementary school students. Meanwhile, Fitriasti and Wuryandani (2025) developed a local wisdom-based illustrated storybook to strengthen the values of mutual cooperation and students' critical thinking skills.

The development of digital media also represents one form of multimodal integration. Emilia et al. (2026) developed an Ethno-STEAM E-Book that integrates Bungurasih local wisdom into digital learning to support elementary school students' critical thinking skills. Suharta et al. (2025) developed a local wisdom-based digital comic for teaching the water cycle, while Utami et al. (2026) developed a local wisdom-based pop-up book to improve students' critical thinking skills and cultural appreciation. These forms of media demonstrate how local knowledge can be presented through a combination of narratives, illustrations, text, and visual representations.

Furthermore, the use of interactive digital modules was identified in the study by Syahfitri and Muntahanah (2024), which examined the effectiveness of interactive digital modules based on local wisdom in relation to students' critical thinking dispositions. Perawati et al. (2025; 2026) also developed local wisdom-based e-storybooks incorporating ecoliteracy into elementary school reading comprehension instruction. Thus, multimodal media function not only as a means of delivering learning materials but also as a platform for connecting cultural knowledge with conceptual understanding and environmental issues.

Based on these findings, multimodal approaches in local wisdom-based learning can be classified into three main forms. First, visual multimodality, through illustrated storybooks, digital comics, illustrations, and pop-up books. Second, audiovisual multimodality, through videos, audio narratives, and visual representations featuring local culture or environments. Third, interactive digital multimodality, through e-books, digital modules, applications, and interactive media that enable students to participate directly in learning activities.

Multimodal integration is particularly relevant because local knowledge is often contextual in nature and transmitted through stories, traditions, social practices, and environmental observations. Presenting such knowledge through various modes enables it to be developed into more structured and accessible learning materials that are appropriate to the characteristics of elementary school students.

Integration of Gamification, Multimodal Approaches, and Local Wisdom as Contextual Learning

These three approaches offer opportunities to be integrated into a complementary learning design. Gamification can serve as a mechanism for learning activities, multimodal approaches can function as forms of information representation, and local wisdom can serve as a source of content and learning context. In practice, teachers can develop game-based activities incorporating local cultural and environmental issues, present learning materials through images, videos, digital stories, or audio, and then provide challenges that require students to analyze and solve problems based on the information they have obtained.

For example, a science and social studies (IPAS) lesson on natural resources could use local stories or environmental issues as its learning context. The materials could be presented through videos, illustrations, and digital narratives introducing environmental conditions and community practices in managing natural resources. Gamification elements could then be incorporated through missions, quizzes, group challenges, and points awarded based on students' abilities to identify problems, analyze information, and propose solutions. This integration pattern is consistent with the study by Yunita et al. (2025), which combined a local wisdom-based Problem-Based Learning model with the ELIKOSIS medium to develop ecoliteracy and science learning outcomes among elementary school students. Pangsuma et al. (2024) also developed an Education for Sustainable Development module based on Bugis local wisdom, targeting the development of critical thinking skills and environmental literacy. Both studies demonstrate the relationship between local contexts, problem-based learning, and the development of sustainability-related competencies. Thus, the integration of these three approaches can be conceptualized through the following framework.



Figure 4. Integration Framework

The framework represents a conceptual synthesis of research patterns identified in the documents, rather than an integration model that has been empirically tested as a unified approach. This distinction is important because the available publications indicate that the integration of gamification and local wisdom has begun to be developed, as has the use of multimodal media based on local wisdom. However, evidence regarding the simultaneous implementation of all three approaches within a single elementary school learning design still needs to be strengthened.

RQ 3. What is the reported effectiveness of these learning approaches in developing elementary school students' critical thinking and ecoliteracy skills, and what challenges and research gaps have been identified?
The effectiveness of gamification-based, multimodal, and local wisdom-based learning needs to be examined in relation to the competencies targeted by the studies. In this review, critical thinking and ecoliteracy are positioned as the two main competencies. Meanwhile, motivation, engagement, learning outcomes, and cultural appreciation are considered supporting outcomes that may enhance learning experiences but do not automatically indicate improvements in critical thinking or ecoliteracy.

Effectiveness in Developing Critical Thinking Skills
Based on the identified publications, local wisdom-based learning tends to be directed toward developing critical thinking skills through problem-solving activities, environmental exploration, information analysis, and decision-making. Local wisdom provides authentic contexts that can be used as analytical materials, enabling students not only to learn concepts abstractly but also to connect them with problems encountered in everyday life.

Several studies explicitly identify critical thinking skills as their intended outcomes. Pamungkas and Wakhudin (2026), for example, examined the use of Wordwall integrated with Banyumas local wisdom to improve elementary school students' critical thinking skills. Adam et al. (2025) integrated Mapag Sri local wisdom into the Problem-Based Learning model, while Kusdianto et al. (2026) incorporated Skouw local wisdom into science learning based on the deep learning approach. Uslan et al. (2025) also developed and validated a local wisdom-based Problem-Based Learning module to improve critical thinking skills in Science and Social Studies (IPAS) learning.

The development of local wisdom-based media also demonstrates a similar direction. Fitriasti and Wuryandani (2025) developed picture storybooks that integrate local wisdom, mutual cooperation (*gotong royong*), and critical thinking. Fitrianawati and Noerazizah (2025) examined local wisdom-based renewable energy learning media, while Utami et al. (2026) developed pop-up books to support students' critical thinking skills and cultural appreciation. Imaduddin et al. (2023) also developed a local wisdom-based mobile learning application using the Problem-Based Learning model to improve fifth-grade elementary school students' critical thinking skills in social studies.

In the context of gamification, Koten et al. (2023) compared Project-Based Learning with Gamification-Based Group Investigation in developing elementary school students' critical thinking skills. Meanwhile, Petrusly et al. (2024) examined the use of Kahoot in relation to critical thinking skills, with student engagement and learning motivation serving as mediating variables. These studies indicate that gamification is increasingly being directed toward the development of cognitive competencies rather than merely improving student participation.

Based on these groups of studies, the effectiveness of these approaches in developing critical thinking can be explained through several learning mechanisms. First, contextual problem-solving, in which students analyze problems originating from their local environment and culture. Second, multimodal exploration, in which students obtain information through various representations, providing them with materials to compare and evaluate. Third, gamified challenges, which encourage students to complete tasks, select strategies, and formulate answers based on the available information. Fourth, collaboration and discussion, through which students express their reasoning, respond to others' opinions, and formulate alternative solutions.

Thus, the combination of these three approaches has the potential to support critical thinking processes through activities involving problem identification, information interpretation, evidence analysis, alternative evaluation, and conclusion formulation. However, based on the available metadata, the extent of improvement in critical thinking skills and which approach produces the strongest effect cannot yet be determined.

Conclusions

This systematic literature review highlights the interconnected development of research on gamification-based, multimodal, and local wisdom-integrated learning in elementary education. The bibliometric findings reveal three major research orientations: the integration of local wisdom and sociocultural values into learning, the development and validation of instructional materials, and the evaluation of learning models through empirical approaches. These orientations demonstrate that elementary education research increasingly connects contextual learning with instructional innovation and the assessment of students' learning outcomes. The synthesis further indicates that gamification, multimodal approaches, and local wisdom have complementary roles in designing meaningful learning experiences. Gamification provides structured learning activities through challenges, missions, rewards, and feedback. Multimodal approaches enrich the representation of learning content through various modes, including text, images, audio, video, and interactive media. Meanwhile, local wisdom connects learning materials with students' cultural identities, community experiences, and environmental contexts. Their integration can create opportunities for students to analyze contextual problems, interpret information from different representations, make decisions, and develop awareness of environmental issues. Regarding learning outcomes, previous studies report promising contributions of contextual, technology-supported, and culturally responsive learning approaches to critical thinking and ecoliteracy-related competencies. Nevertheless, the available evidence does not yet establish a consistent or universal effectiveness of the simultaneous integration of all three approaches. Differences in instructional designs, educational contexts, research methods, and outcome measurements require careful consideration when interpreting the reported findings.

This review also identifies an important research gap. Although local wisdom, instructional media development, and learning effectiveness appear as prominent themes, gamification and multimodal learning are not yet dominant keyword concentrations in the bibliometric visualization. Furthermore, studies that systematically integrate all three approaches while explicitly measuring both critical thinking and ecoliteracy remain an important area for further investigation. Therefore, future research should focus on developing and empirically testing integrated instructional designs that combine gamification, multimodal representation, and local wisdom. Such research should employ validated instruments to assess critical thinking and ecoliteracy separately, involve diverse elementary school contexts, and examine not only students' immediate learning outcomes but also their ability to apply knowledge, reasoning, and environmental awareness in everyday situations. This direction may contribute to the development of more contextual, engaging, and sustainable learning practices in elementary education.

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