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RESEARCH TRENDS IN THE IMPLEMENTATION OF PROBLEM-BASED LEARNING WITH AUDIO-VISUAL MEDIA IN PRIMARY SCIENCE EDUCATION: A SYSTEMATIC LITERATURE REVIEW (2020–2026)

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Abstract
Science education in primary schools requires active, contextual, and meaningful learning to develop students' conceptual understanding and critical thinking skills. Although Problem-Based Learning (PBL) supported by audio-visual media has been widely implemented, existing empirical evidence remains fragmented and has not been comprehensively synthesized. Therefore, this study aims to analyze research trends, implementation characteristics, and research gaps concerning the use of PBL supported by audio-visual media in primary science education during the period 2020–2026. A Systematic Literature Review (SLR) was conducted following the PRISMA 2020 guidelines. Relevant studies were retrieved from Google Scholar and Scopus using predefined search keywords. The articles were screened through identification, screening, eligibility, and inclusion stages based on predetermined inclusion and exclusion criteria, resulting in 22 empirical studies for analysis. Data were synthesized using content analysis and narrative synthesis to identify research trends, implementation patterns, and emerging research gaps. The findings indicate a substantial increase in publications, particularly in 2024. Most studies employed experimental and quasi-experimental designs and primarily focused on learning outcomes and critical thinking. Overall, integrating PBL with audio-visual media consistently enhanced students' learning outcomes, critical thinking, motivation, and engagement. However, studies investigating implementation processes, teacher readiness, and long-term sustainability remain limited, indicating important directions for future research. This review provides a comprehensive synthesis of current evidence, highlights key research gaps, and offers theoretical and practical implications for researchers and educators in developing more effective and context-sensitive primary science education.
Keywords: *audio-visual media; critical thinking; primary science education; problem-based learning; systematic literature review.*

Abstrak
Pembelajaran IPA di sekolah dasar memerlukan proses belajar yang aktif, kontekstual, dan bermakna untuk mengembangkan pemahaman konsep serta kemampuan berpikir kritis murid. Meskipun Problem-Based Learning (PBL) berbantuan media audio visual telah banyak diterapkan, bukti empiris yang tersedia masih tersebar dan belum disintesis secara komprehensif. Oleh karena itu, penelitian ini bertujuan menganalisis tren penelitian, karakteristik implementasi, dan kesenjangan penelitian mengenai penerapan PBL berbantuan media audio visual dalam pembelajaran IPA sekolah dasar pada periode 2020–2026. Penelitian ini menggunakan metode *Systematic Literature Review (SLR)* dengan mengacu pada pedoman PRISMA 2020. Artikel diperoleh melalui Google Scholar dan Scopus menggunakan kata kunci yang telah ditentukan, kemudian diseleksi melalui tahap identifikasi, penyaringan, kelayakan, dan inklusi berdasarkan kriteria yang telah ditetapkan sehingga diperoleh 22 artikel empiris sebagai sumber utama analisis. Data dianalisis menggunakan content analysis dan sintesis naratif untuk mengidentifikasi tren penelitian, pola implementasi, serta kesenjangan penelitian. Hasil penelitian menunjukkan adanya peningkatan publikasi yang signifikan, terutama pada tahun 2024. Sebagian besar penelitian menggunakan desain eksperimen dan quasi eksperimen serta berfokus pada hasil belajar dan kemampuan berpikir kritis. Secara umum, integrasi PBL dengan media audio visual terbukti meningkatkan hasil belajar, kemampuan berpikir kritis, motivasi, dan keterlibatan murid. Namun demikian, penelitian mengenai proses implementasi, kesiapan guru, serta keberlanjutan penerapan dalam jangka panjang masih relatif terbatas.Kajian ini memberikan sintesis komprehensif mengenai bukti empiris terkini, mengidentifikasi kesenjangan penelitian, serta menawarkan implikasi teoretis dan praktis bagi peneliti dan pendidik dalam mengembangkan pembelajaran IPA sekolah dasar yang lebih efektif dan kontekstual.

Kata Kunci: media audio visual; berpikir kritis; pembelajaran IPA; *problem-based learning*; sekolah dasar; s*ystematic literature review*

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Introduction

Science education in primary schools plays a crucial role in developing students' scientific literacy, reasoning, and scientific thinking skills from an early age. It should not be limited to the acquisition of facts and concepts but should also encourage students to observe, question, analyze, and draw conclusions about phenomena related to their daily lives (OECD, 2018; UNESCO, 2017) . In this context, effective science learning requires instructional approaches that actively engage students in constructing knowledge through meaningful learning experiences rather than passive information acquisition. Active and student-centred learning has been shown to significantly improve conceptual understanding and student engagement (Freeman et al., 2014; Prince, 2004). Furthermore, the demands of 21st-century learning emphasize the importance of higher-order thinking skills, problem-solving abilities, collaboration, and adaptability, making contextual and interactive learning approaches increasingly essential in primary science education (OECD, 2018).

However, science learning in primary schools continues to face several instructional challenges. In many classrooms, teaching remains predominantly teacher-centred, characterised by one-way content delivery and the limited use of meaningful learning media (Rauf et al., 2022; Rambe et al., 2024). Consequently, students often play a passive role in the learning process, limiting their opportunities to construct knowledge, develop higher-order thinking skills, and actively engage in scientific inquiry. Such conditions may also reduce students' engagement and participation in classroom learning, both of which are widely recognized as important predictors of meaningful learning and successful technology-enhanced instruction (Fredricks et al., 2004; Bond et al., 2021; Michael, 2006). Moreover, the limited variation in instructional strategies and learning media contributes to superficial conceptual understanding and restricts students' ability to relate scientific concepts to real-life phenomena. These challenges highlight the need for instructional approaches that actively involve students in meaningful learning experiences and promote inquiry, problem-solving, and contextual understanding.

One instructional approach that addresses these challenges is Problem-Based Learning (PBL). According to Savery (2006) and Hmelo-Silver (2004)**,** PBL is an instructional model that uses authentic problems as the starting point for learning, encouraging students to identify problems, seek relevant information, engage in collaborative discussions, and develop appropriate solutions. These characteristics make PBL particularly relevant to primary science education, where learning is closely connected to real-world phenomena and scientific inquiry.

A growing body of empirical evidence has demonstrated the effectiveness of PBL in improving students' critical thinking skills and learning outcomes (Hmelo-Silver, 2004; Sukowati & Harjono, 2023; Aprina et al., 2024). In addition, previous review studies have reported positive effects of PBL on student engagement, motivation, and learning activities (Jamaludin et al., 2023). However, most existing studies have primarily evaluated the effectiveness of PBL in specific classroom settings and focused on individual learning outcomes. Consequently, limited attention has been given to synthesizing broader implementation

patterns, methodological trends, and research characteristics of PBL in primary science education. This indicates the need for a more comprehensive review to consolidate existing evidence and identify emerging research directions.

The effectiveness of PBL can be further enhanced through the use of appropriate learning media, particularly audio-visual media. According to Mayer (2009), Cognitive Theory of Multimedia Learning, students learn more effectively when information is presented through a combination of verbal and visual representations. Given that science learning often involves abstract concepts and dynamic processes that are difficult to observe directly, audio-visual media are highly relevant in supporting conceptual understanding in primary education.

Previous empirical studies have consistently reported that audio-visual media improve students' motivation, engagement, and learning outcomes (Fiorella & Mayer, 2018; Aeniyah & Meilana, 2021; Azizah & Fatimah, 2022; Erlitaviana & Tyas, 2025). Likewise, previous review studies indicate that instructional videos, animations, and other multimedia resources facilitate students' understanding of abstract scientific concepts (Almazmar et al., 2026). However, most existing studies primarily examine the effectiveness of audio-visual media as independent instructional tools. Comparatively little attention has been devoted to understanding how these media function as an integral component within the Problem-Based Learning process, particularly in primary science education. Consequently, evidence regarding the pedagogical role of audio-visual media in supporting each stage of PBL implementation remains fragmented and requires a more comprehensive synthesis.

The integration of PBL with audio-visual media is increasingly important, as both complement each other in creating active, contextual, and meaningful learning experiences. Audio-visual media can function not only as instructional tools but also as problem triggers, contextual enhancers, and visualization supports within the PBL process (Ningtias et al., 2024). Several empirical studies have demonstrated that this integration improves learning outcomes, critical thinking skills, and student engagement in primary science education (Nonisa P et al., 2025; Jauhari et al., 2024). Despite these encouraging findings, existing studies differ considerably in terms of research focus, instructional contexts, types of audio-visual media employed, outcome variables, and methodological approaches. Moreover, most studies examine the effectiveness of this integration within individual classroom settings rather than providing a comprehensive understanding of broader research trends and implementation characteristics. Consequently, the current body of evidence remains fragmented, making it difficult to identify consistent patterns, methodological developments, and emerging research opportunities. These limitations highlight the need for a systematic literature review that synthesizes existing evidence and maps the current state of research in a more comprehensive manner.

Despite the growing number of studies, the existing body of research remains fragmented in several important respects. Previous studies have investigated diverse aspects of PBL supported by audio-visual media, including learning outcomes, critical thinking, motivation, conceptual understanding, and media development (Jamaludin et al., 2023; Aprina et al., 2024). However, these studies differ substantially in their research focus, methodological approaches, implementation contexts, and outcome measures, making it difficult to develop a comprehensive understanding of how this instructional approach has evolved in primary science education.

Furthermore, existing review studies have generally examined either Problem-Based Learning or audio-visual media separately, while reviews specifically synthesizing their integration in primary science education remain limited. More importantly, no previous review

has comprehensively mapped publication trends, implementation characteristics, methodological patterns, and emerging research gaps related to the integration of PBL and audio-visual media during the period 2020–2026. This gap provides the rationale and novelty for the present study.

Unlike previous studies that primarily examined the effectiveness of Problem-Based Learning (PBL) or audio-visual media as separate instructional approaches, this review provides a comprehensive synthesis of their integrated implementation in primary science education. Beyond mapping publication trends, this review identifies methodological patterns, implementation characteristics, theoretical implications, and existing research gaps while highlighting future research directions. Therefore, the contribution of this study extends beyond summarizing previous findings by offering an evidence-based synthesis that provides a more comprehensive understanding of how the integration of PBL and audio-visual media supports meaningful science learning and informs future research, instructional practice, and curriculum development in primary education.

Therefore, this study employs a Systematic Literature Review (SLR) based on the PRISMA 2020 guidelines to systematically synthesize empirical evidence concerning the implementation of Problem-Based Learning supported by audio-visual media in primary science education. Unlike previous studies and review articles that have primarily examined Problem-Based Learning or audio-visual media independently, this review integrates both perspectives by comprehensively mapping publication trends, implementation characteristics, methodological patterns, and emerging research gaps during the period 2020–2026. Accordingly, this study aims to provide a comprehensive synthesis of current evidence while offering theoretical and practical insights for researchers, educators, and policymakers. The findings are expected to support future research, inform instructional practice, and contribute to the development of more effective, contextual, and evidence-based science learning in primary schools.

The present review is grounded in two complementary theoretical perspectives that explain the pedagogical relationship between Problem-Based Learning (PBL) and audio-visual media in primary science education. First, PBL is rooted in constructivist learning theory, which views learning as an active process in which students construct knowledge through meaningful experiences, inquiry, collaboration, and problem solving (Savery, 2006). Within this perspective, authentic problems encourage learners to connect prior knowledge with new experiences, thereby fostering higher-order thinking, critical thinking, and meaningful conceptual understanding. These theoretical principles explain why PBL has consistently been associated with improved learning outcomes, critical thinking, and student engagement in science education (Hmelo-Silver, 2004; Bond et al., 2021).

Second, the role of audio-visual media is explained through Mayer's Cognitive Theory of Multimedia Learning (Mayer, 2009), which posits that students learn more effectively when verbal and visual information are meaningfully integrated. In primary science education, audio-visual media facilitate the visualization of abstract concepts and scientific phenomena that are difficult to observe directly, thereby supporting conceptual understanding and reducing cognitive overload. When integrated within the PBL process, audio-visual media function not only as instructional resources but also as contextual stimuli that enhance students' motivation, engagement, and critical thinking during problem-solving activities. Accordingly, this review adopts these complementary theoretical perspectives to interpret the relationships among Problem-Based Learning, audio-visual media, learning outcomes, critical thinking, motivation, and student engagement throughout the reviewed studies.

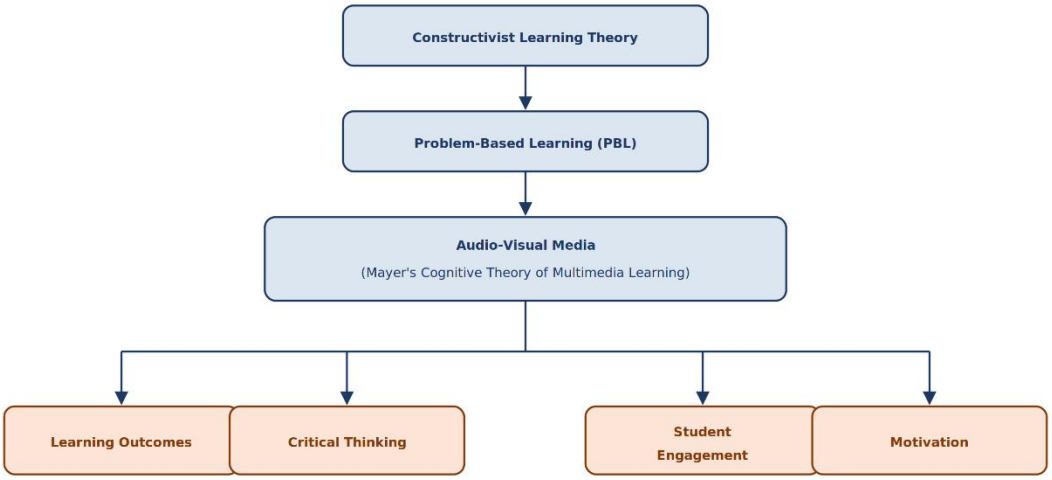

Figure 1. Conceptual Framework of the Systematic Literature Review

Research Methods

This study employed a Systematic Literature Review (SLR) to analyse research trends concerning the implementation of Problem-Based Learning (PBL) supported by audio-visual media in primary science education between 2020 and 2026. The review was designed to synthesise empirical evidence, identify methodological patterns, examine implementation characteristics, and reveal emerging research gaps. Unlike a Scoping Review, which primarily maps the breadth of available evidence, an SLR enables a more rigorous synthesis and critical interpretation of empirical findings. Accordingly, the review followed the PRISMA 2020 guidelines to ensure a transparent and systematic selection process (Snyder, 2019; Page et al., 2021).

The data sources consisted of core articles and supporting articles. Core articles were defined as primary empirical studies that directly investigated the implementation of Problem-Based Learning (PBL), audio-visual media, or their integration in primary science education and served as the principal source of evidence for the review. Supporting articles, including systematic reviews, meta-analyses, conceptual papers, and seminal theoretical works, were incorporated to strengthen the theoretical foundation and interpretation of the findings. This distinction ensured that the synthesis was primarily based on empirical evidence while being supported by well-established theoretical perspectives.

The literature search was conducted using Google Scholar and Scopus, as these databases provide comprehensive coverage of educational research and peer-reviewed publications related to science education, instructional models, and educational technology. Google Scholar was selected to maximize the retrieval of relevant educational studies, while Scopus was used to ensure the inclusion of internationally indexed, high-quality publications. The search covered publications from 2020 to 2026 to capture recent developments in digital learning technologies and student-centred instructional practices within primary science education.

The search strategy employed predefined keywords combined using Boolean operators (AND, OR) to improve the precision and comprehensiveness of the search process. The principal search string was: ("Problem-Based Learning" or PBL) and ("audio-visual media" or multimedia or instructional video) and ("primary science education" or elementary science or elementary school science). Additional keywords, including "critical thinking" and "student engagement", were incorporated where appropriate to broaden the retrieval of relevant

empirical studies.

Inclusion and exclusion criteria were established prior to the literature search to ensure the relevance, methodological consistency, and transparency of the article selection process. These criteria were designed to minimize selection bias by including only empirical studies that directly addressed the implementation of Problem-Based Learning (PBL), audio-visual media, or their integration in primary science education. Studies that did not meet these criteria were excluded from further analysis. The detailed inclusion and exclusion criteria are presented in Table 1.

Table 1. Inclusion and Exclusion Criteria

Aspect	Inclusion Criteria	Exclusion Criteria
Year of publication	2020-2026	Outside the 2020-2026 range
Topic	Discussing PBL, audio-visual media, or the integration of both in elementary school science learning	Not relevant to the focus of the study
Core article types	Primary/empirical research articles	Conceptual, opinion, editorial, or non-empirical articles
Access the article	Full text available	Full text not available
Article Contents	Contains research methods, instruments, and results that can be analyzed	Data is incomplete or cannot be analyzed
Subject/Context	Elementary School Students/Elementary Science Learning	Contexts outside of elementary school or non-science

The study selection process followed the PRISMA 2020 framework, which comprises four sequential stages: identification, screening, eligibility, and inclusion (Page et al., 2021). During the identification stage, a total of 400 records were retrieved from Google Scholar and Scopus. After duplicate removal, 340 unique records remained for the screening stage. Titles and abstracts were systematically reviewed according to the predefined inclusion and exclusion criteria to ensure their relevance to the objectives of this review. As a result, 220 records were excluded because they did not meet the scope of the study. The complete study selection process is illustrated in Figure 2.

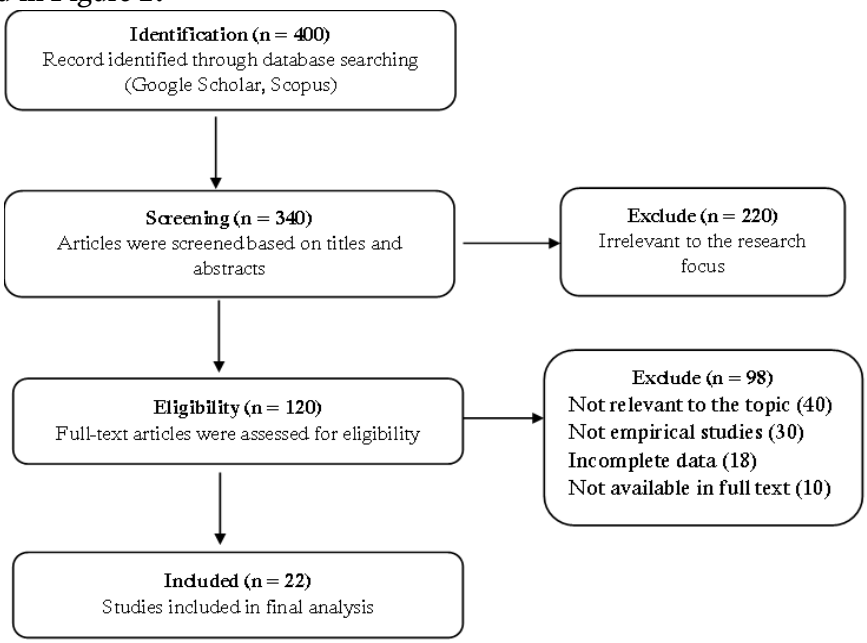

Figure 2. PRISMA 2020 Flow Diagram of Article Selection

The remaining 120 articles underwent full-text eligibility assessment to determine their relevance and methodological suitability for inclusion in the review. Each article was examined in relation to the predefined inclusion criteria as well as the quality assessment procedure described in the following stage. Following this process, 98 articles were excluded because they did not fully satisfy the eligibility requirements or did not provide sufficient empirical evidence to support the objectives of this review. Consequently, 22 empirical studies met all selection criteria and were retained as the core studies for the final synthesis.

To ensure the methodological quality of the selected studies, a quality assessment was conducted after the eligibility stage and before data extraction. Each full-text article was evaluated using a predefined quality assessment checklist adapted to the objectives of this review. The assessment focused on five criteria: (1) clarity of the research objectives, (2) appropriateness of the research methodology, (3) adequacy of participant and context descriptions, (4) completeness of data collection instruments and procedures, and (5) clarity and relevance of the reported findings.

Each criterion was assessed using a dichotomous scale (Yes = 1; No = 0). Articles that met at least four of the five criteria were considered to have sufficient methodological quality and were included in the final synthesis. This assessment ensured that only studies providing reliable and relevant empirical evidence contributed to the findings of the review. All 22 studies included in the final synthesis satisfied the minimum quality threshold and were therefore retained for further analysis.

Data extraction was conducted after the final selection and quality assessment of the included studies. A structured data extraction form was developed to ensure consistency throughout the review process. For each selected article, the following information was recorded: (1) author(s) and year of publication, (2) research objectives, (3) research design, (4) participants and educational context, (5) type of audio-visual media employed, (6) implementation characteristics of Problem-Based Learning, (7) research instruments, and (8) key findings related to learning outcomes, critical thinking, motivation, and student engagement. The extracted information served as the basis for identifying research trends and synthesizing evidence across the selected studies.

Data analysis was conducted using a combination of content analysis and narrative synthesis. Content analysis was employed to categorize and summarize the characteristics of the selected studies, including publication trends, research objectives, methodological approaches, implementation characteristics of Problem-Based Learning, types of audio-visual media, and reported educational outcomes. These categories were identified through an iterative coding process in which similar findings were grouped into broader thematic patterns.

Narrative synthesis was subsequently applied to integrate and interpret the findings across studies. Rather than statistically combining results, this approach enabled the comparison of similarities and differences among studies, identification of recurring themes, and exploration of methodological variations. The synthesis focused on explaining how the integration of Problem-Based Learning and audio-visual media has been implemented across different educational contexts and how this implementation has influenced learning outcomes, critical thinking, motivation, and student engagement. Together, content analysis and narrative synthesis enabled not only the identification of publication trends and methodological patterns but also a critical interpretation of the relationships, consistencies, and research gaps emerging across the reviewed studies.

Results and Discussion

Following the PRISMA 2020 selection process, 22 empirical studies that satisfied the predefined inclusion criteria were included in the final synthesis, while additional supporting references were used to strengthen the interpretation of the findings. Collectively, these studies demonstrate a substantial increase in research examining the integration of Problem-Based Learning (PBL) and audio-visual media in primary science education between 2020 and 2026. Beyond the increasing number of publications, the evidence indicates a gradual transition from investigating the independent effectiveness of PBL or audio-visual media toward examining their integrated implementation as complementary instructional strategies. This trend reflects a growing recognition that meaningful science learning requires not only active learning models but also appropriate digital learning media capable of promoting inquiry, visualization, and student engagement.

The reviewed studies also reveal considerable diversity in research objectives, methodological approaches, and educational outcomes. While some studies explicitly investigated the integration of PBL and audio-visual media, others focused separately on learning outcomes, critical thinking, motivation, student engagement, or media development. Taken together, these studies illustrate the multidimensional nature of current research while simultaneously revealing fragmentation across instructional contexts and outcome variables. Consequently, the evidence should be interpreted not as isolated findings but as complementary perspectives that collectively describe the current state of research on PBL supported by audio-visual media in primary science education. A summary of the reviewed studies is presented in Table 2.

Table 2. Analysis of Core Articles

No	Author (Year)	Focus of Study	Method	Key Findings
1	Aeniyah & Meilana (2021)	Audio visual media and science learning motivation	Experiment	Audio visual media increases students' learning motivation.
2	Azizah & Fatimah (2021)	Audio visual media and learning engagement	Descriptive	Audio visual media increases student engagement in learning.
3	Rauf et al. (2022)	PBL and critical thinking in science	Quasi-experimental	PBL is more effective in improving students' critical thinking skills.
4	Sukowati & Harjono (2023)	PBL, critical thinking, and science learning outcomes	CAR	PBL improves students' critical thinking and science learning outcomes.
5	Jauhari et al. (2024)	PBL assisted by audio-visual media and science learning outcomes	Experiment	Integration of PBL and audio-visual media improves student learning outcomes.
6	Rambe et al. (2024)	PBL and science learning outcomes	Experiment	PBL improves student learning outcomes and activities.
7	Ningtias et al. (2024)	PBL assisted by audio-visual media and critical thinking	Quasi-experimental	PBL assisted by audio-visual media improves students' critical thinking.
8	Amanda et al. (2024)	PBL assisted by audio-visual media and thinking skills	Quasi-experimental	PBL assisted by audio-visual media has a positive effect on students' thinking skills.
9	Ahmad Yani et al. (2024)	PBL and critical thinking in science	Experiment	PBL has an impact on improving students' critical thinking skills.

No	Author (Year)	Focus of Study	Method	Key Findings
10	Adhyaksa et al. (2024)	PBL and digital media on learning outcomes	Quasi-experimental	Integration of PBL and digital media improves student learning outcomes.
11	Putri et al. (2024)	PBL assisted by learning videos	Quasi-experimental	The use of video in PBL improves student learning outcomes.
12	Mustika et al. (2024)	PBL assisted by visual media in science learning	Quasi-experimental	PBL assisted by visual media increases student activity and learning outcomes.
13	Halimah et al. (2024)	PBL in science learning	CAR	PBL improves science learning outcomes through more active learning.
14	Ahmad et al. (2024)	PBL and science learning outcomes	Quasi-experimental	PBL has a positive influence on students' science learning outcomes.
15	Marliani (2024)	Science learning videos	Descriptive	Learning videos increase student attention and engagement.
16	Janah et al. (2024)	The need for audio-visual media in science learning	Descriptive	Audio visual media is needed to support more interesting science learning.
17	Sa'adah et al. (2024)	Audio visual media in science learning	R&D	The audio-visual media developed is suitable for use in science learning.
18	Juniantari & Suniasih (2024)	Development of audio-visual media for science and technology	R&D	The audio-visual media developed are valid and suitable for implementation.
19	Maharani et al. (2024)	Digital media for science learning	R&D	Digital media helps to understand science concepts more concretely.
20	Erlitaviana & Tyas (2025)	Audio visual media, motivation, and learning outcomes	Correlational	There is a positive relationship between the use of audio-visual media and student learning outcomes.
21	Yustiani et al. (2026)	The need for PBL learning models in Natural and Social Sciences	Descriptive	PBL is considered relevant to support meaningful science learning.
22	Apriliya et al. (2026)	Animated videos and science/natural science learning outcomes	Pre-experiment	Animated videos improve students' learning outcomes in science/science learning.

The synthesis presented in Table 2 demonstrates that research on PBL supported by audio-visual media extends beyond academic achievement alone. Although learning outcomes remain the dominant research focus, an increasing number of studies also investigate critical thinking, motivation, student engagement, and media development as complementary indicators of instructional effectiveness. This pattern suggests that science learning is increasingly viewed as a multidimensional process in which cognitive, affective, and behavioural outcomes are closely interconnected.

Nevertheless, the reviewed evidence also reveals a common tendency within the existing literature. Most empirical studies primarily evaluate instructional effectiveness by measuring improvements in learning outcomes or critical thinking through pre-test and post-test comparisons. Comparatively fewer studies explore how PBL and audio-visual media are

implemented in authentic classroom settings, how students interact during learning activities, or which contextual factors contribute to successful implementation. Consequently, the current body of evidence provides stronger support for determining whether these instructional approaches are effective than for explaining how and under what conditions they produce positive educational outcomes. To better understand this methodological tendency, the distribution of research approaches employed across the reviewed studies is presented in Figure 3.

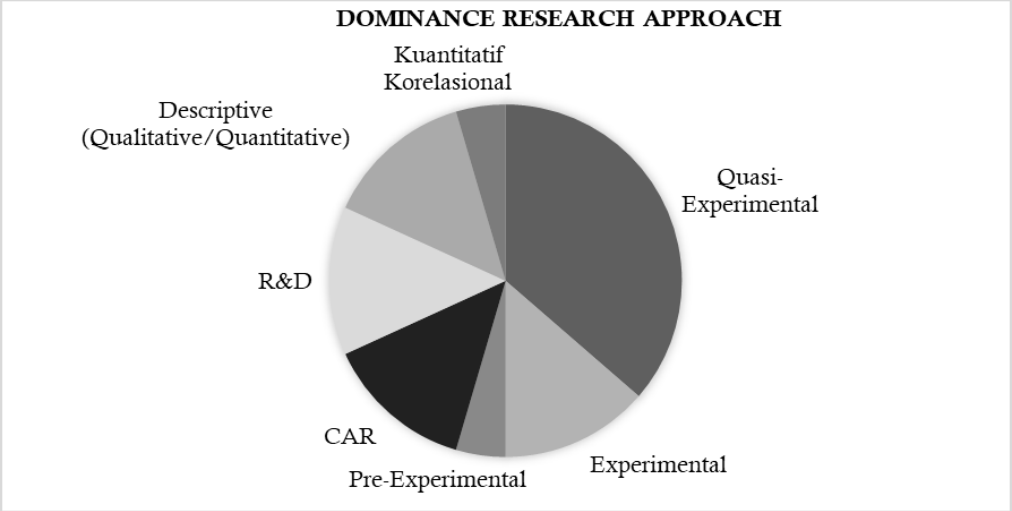

Figure 3. Distribution of Studies Based on Research Approaches

Figure 3 shows that quasi-experimental research is the most frequently employed methodological approach, followed by experimental studies, classroom action research (CAR), descriptive studies, and research and development (R&D). The predominance of quasi-experimental designs reflects a strong emphasis on evaluating instructional effectiveness within authentic classroom settings, where random assignment of participants is generally impractical. Consequently, this design has become the preferred approach for examining the educational impact of PBL supported by audio-visual media in primary science education.

Although the dominance of quasi-experimental studies provides substantial empirical evidence regarding instructional effectiveness, it also reveals an important methodological limitation. Most studies concentrate on measuring improvements in learning outcomes and critical thinking through quantitative comparisons, whereas relatively few investigate classroom implementation processes, teacher decision-making, learner experiences, or contextual factors influencing successful instruction. As a result, current evidence offers a comprehensive understanding of whether these instructional approaches are effective but provides comparatively limited insight into how and why they work across diverse educational contexts. Future research would therefore benefit from greater use of qualitative, mixed-methods, and longitudinal approaches capable of capturing implementation processes and classroom dynamics more comprehensively.

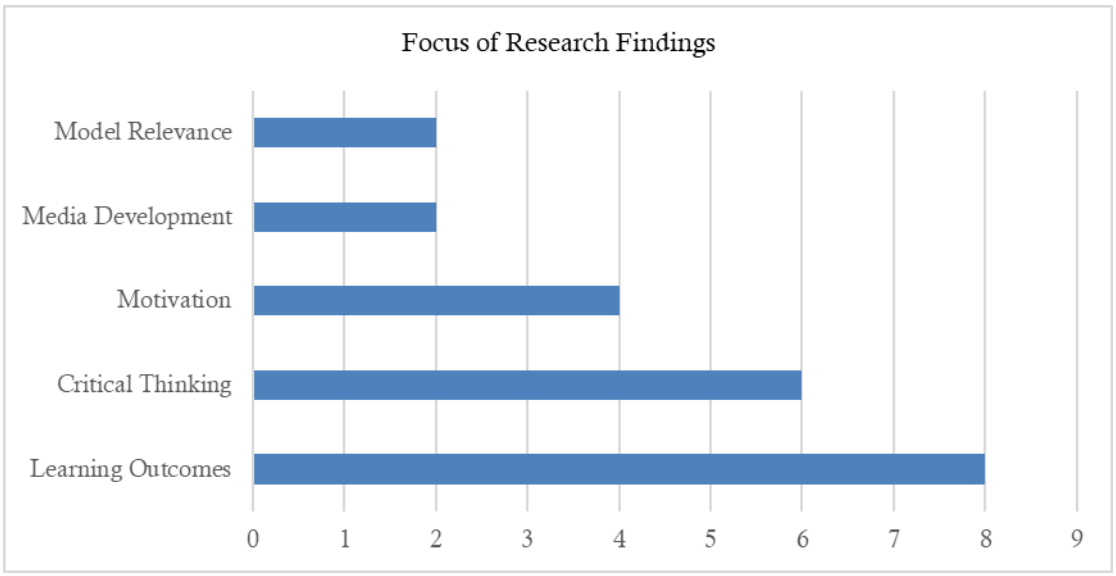

Figure 4. Distribution of Studies Based on the Focus of Research Findings

Figure 4 indicates that learning outcomes constitute the most frequently investigated research focus, followed by critical thinking, motivation, and student engagement. This distribution reflects the continuing emphasis in primary science education on evaluating instructional innovations through measurable academic performance. As educational reforms increasingly promote student-centred learning and higher-order thinking skills, researchers have naturally prioritised variables that can be assessed quantitatively, particularly learning outcomes and critical thinking.

The prominence of critical thinking is consistent with the theoretical principles of Problem-Based Learning, which encourages learners to analyse authentic problems, evaluate evidence, and collaboratively construct solutions (Savery, 2006). When supported by audio-visual media, these learning experiences become more contextual because abstract scientific concepts can be visualised more effectively, thereby facilitating deeper conceptual understanding. This interpretation also aligns with Mayer's Cognitive Theory of Multimedia Learning (Mayer, 2009), which explains that meaningful learning is enhanced when learners integrate verbal and visual information during knowledge construction.

Despite these encouraging findings, relatively fewer studies have examined motivation, student engagement, classroom interaction, and instructional implementation processes. This imbalance suggests that existing research remains predominantly outcome-oriented, while the pedagogical mechanisms through which PBL supported by audio-visual media influences students' learning experiences remain insufficiently explored. Consequently, future investigations should place greater emphasis on understanding instructional processes and learner interactions rather than focusing solely on academic outcomes.

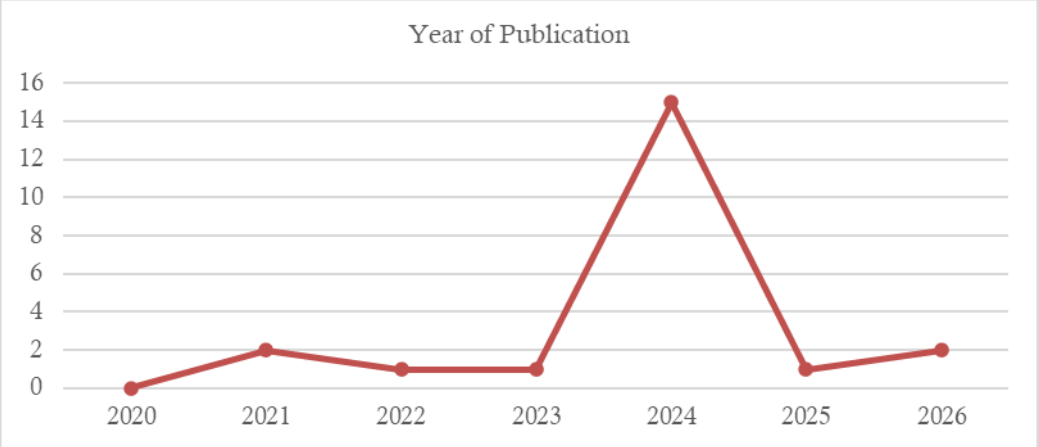

Figure 5. Distribution of Articles by Year of Publication

Figure 5 illustrates a gradual increase in research publications between 2020 and 2026, with a marked rise beginning in 2024. Rather than representing an isolated increase in publication volume, this pattern reflects broader developments in primary education that encourage technology-supported and student-centred instructional approaches. The growing number of studies indicates that integrating PBL with audio-visual media has become an increasingly important area of research within science education.

The increasing research interest after 2024 can also be interpreted within the broader context of educational digital transformation, the widespread integration of educational technology, and the implementation of more student-centred curricula, including the Merdeka Curriculum in Indonesia. These developments have encouraged teachers and researchers to explore instructional approaches capable of promoting inquiry, meaningful learning, and higher-order thinking while simultaneously integrating digital learning resources.

Another notable trend is the evolution of research topics over time. Earlier studies generally examined PBL and audio-visual media separately, whereas more recent studies increasingly investigate their combined implementation. This shift indicates that current research is moving beyond evaluating individual instructional strategies toward understanding how complementary pedagogical approaches collectively improve science learning in primary education.

Conclusion

This systematic literature review demonstrates that the integration of Problem-Based Learning (PBL) and audio-visual media has emerged as an increasingly important instructional approach in primary science education between 2020 and 2026. The reviewed studies consistently indicate positive effects on learning outcomes, critical thinking, motivation, and student engagement. More importantly, this review shows that the effectiveness of these approaches is not attributable to PBL or audio-visual media independently, but to their complementary roles in creating authentic, meaningful, and student-centred learning experiences. The findings also reveal a gradual shift in recent research from examining individual instructional strategies toward investigating integrated pedagogical approaches that better address the learning needs of contemporary primary science education.

Theoretically, this review strengthens the understanding that the integration of PBL and audio-visual media is consistent with constructivist learning principles and Mayer's Cognitive

Theory of Multimedia Learning, emphasizing that meaningful learning occurs when students actively construct knowledge through authentic problem-solving supported by appropriate visual representations. Practically, the findings provide evidence-based recommendations for teachers to integrate contextual problem-solving with carefully selected audio-visual media in science instruction. The review also offers valuable insights for curriculum developers and educational policymakers in designing student-centred learning environments that promote critical thinking, meaningful learning, and digital literacy in primary education.

Despite the consistently positive findings, the reviewed literature remains dominated by short-term quantitative studies that primarily measure instructional effectiveness. Future research should therefore place greater emphasis on classroom implementation processes, teacher readiness, learner interaction, longitudinal investigations, and mixed-methods approaches to provide a more comprehensive understanding of how PBL supported by different types of audio-visual media can be effectively implemented across diverse science topics and educational contexts. Such investigations will contribute to strengthening the evidence base for innovative science instruction and support the continuous improvement of primary science education.

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