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THE EFFECTIVENESS OF INTERACTIVE LEARNING MEDIA IN ENHANCING STUDENT LEARNING OUTCOMES: A SYSTEMATIC LITERATURE REVIEW

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Abstract

Interactive learning media has become crucial in Indonesian education, accelerated by COVID-19's digital transformation impact. This systematic review examines interactive media effectiveness in improving student learning outcomes in Indonesian educational contexts using PRISMA 2020 methodology. Twenty eligible articles were selected from several hundred studies through systematic PRISMA screening, analyzing e-modules, simulations, interactive videos, educational games, and AR/VR technologies across educational levels. All interactive media types showed significant positive impact with 20-35% average improvement versus conventional methods. Simulations and VR/AR demonstrated highest effectiveness. Success requires integrating three pillars: Technology × Pedagogy × Organization, expanding TPACK framework. Indonesian context faces unique challenges: infrastructure disparities, teacher readiness gaps, and policy coordination needs. Pedagogical design quality outweighs technological sophistication in determining effectiveness.

Keywords: Digital Transformation, Indonesian Education, Interactive Learning Media, Learning Outcomes, PRISMA 2020

INTRODUCTION

The digital transformation of education has fundamentally altered teaching and learning landscapes across the globe. As educational institutions increasingly integrate technology into pedagogical practices, interactive learning media have emerged as powerful tools for enhancing student engagement and learning outcomes (Bond et al., 2018; Henderson et al., 2017). These technologies range from e-modules and interactive videos to augmented reality applications and educational games, each offering unique affordances for creating immersive and personalized learning experiences. Interactive learning media distinguish themselves from traditional educational materials through their capacity to provide immediate feedback, enable learner control, and facilitate active knowledge construction (Mayer, 2014). Unlike passive consumption of information through textbooks or lectures, interactive media engage students in dynamic learning processes where they can manipulate variables, explore consequences, and construct understanding through experimentation. This shift from teacher-centered transmission to student-centered construction aligns with contemporary learning theories emphasizing active engagement and meaningful interaction (Jonassen & Land, 2012).

Despite the proliferation of interactive learning technologies, several critical gaps remain in understanding their effectiveness. First, the field lacks comprehensive synthesis examining which types of interactive media produce the strongest learning improvements across different domains. Second, the relationship between pedagogical design and media effectiveness remains underexplored. Third, most existing reviews focus narrowly on specific media types, failing to provide holistic perspectives (Benavides et al., 2020; Thái et al., 2021). This systematic literature review addresses these gaps by examining research published between 2020-2024, following PRISMA 2020 guidelines, to answer three research questions: (1) What types of interactive learning media are most effective? (2) What are the average learning improvement rates by media type? (3) What pedagogical approaches and subject domains most frequently utilize interactive media?

LITERATURE REVIEW

Interactive learning media are digital tools that enable dynamic, two-way engagement between learners and educational content. Grounded in cognitive theories of multimedia learning (Mayer, 2014), these media leverage dual-channel processing to reduce cognitive load and deepen comprehension. The Technological Pedagogical Content Knowledge (TPACK) framework (Mishra & Koehler, 2006) contextualizes media effectiveness within the interplay of technology, pedagogy, and content knowledge, suggesting that no single element determines success in isolation. Prior systematic reviews have examined specific categories of interactive media. Rutten et al. (2012) reviewed computer simulations and found consistent positive learning effects, particularly in science education. Connolly et al. (2012) documented educational games' potential to foster engagement and knowledge acquisition. Radianti et al. (2020) reviewed immersive virtual reality applications in higher education and identified strong benefits for spatial understanding and procedural skill development. Sung et al. (2016) examined mobile de vice integration and reported moderate positive effects on learning outcomes, contingent on pedagogical design.Within the Indonesian educational context, digital transformation has accelerated following the COVID-19 pandemic. Bygstad et al. (2022) identified infrastructure disparities, teacher readiness gaps, and policy coordination as central barriers to technology integration. Indonesian educational research has increasingly focused on locally developed interactive media, including e-modules aligned with national curriculum frameworks and game-based learning tools designed for low-bandwidth environments (Putra & Sudatha, 2020). The present review addresses the remaining gap by synthesizing evidence across diverse media types and educational levels within the Indonesian context.

METHOD

This systematic literature review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 statement (Page et al., 2021). A comprehensive search was conducted across Scopus, Google Scholar, SINTA, Science Direct, and gray literature sources. The primary search string used was: ("interactive learning media" OR "interactive e-module" OR "educational game" OR "virtual reality" OR "augmented reality" OR "simulation" OR "interactive video") AND ("effectiveness" OR "learning outcomes" OR "achievement" OR "performance") AND ("education" OR "learning" OR "instruction"). The search encompassed publications from January 2020 to December 2024, conducted in September 2024.

Table 1. PRISMA 2020 Flow Diagram – Study Selection Process

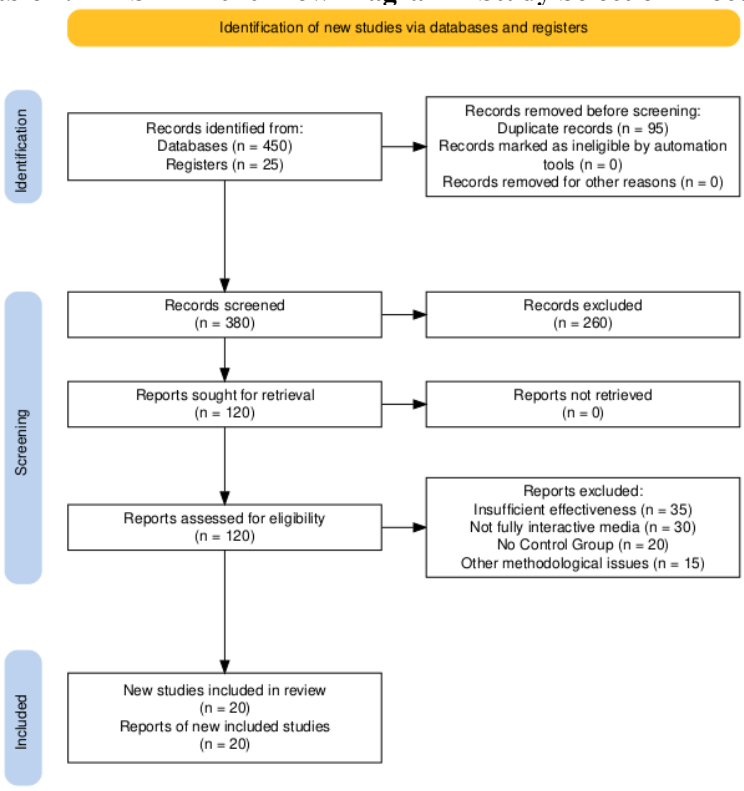

Table 1 illustrates the systematic study selection process following PRISMA 2020 guidelines, from initial identification through final inclusion of 20 eligible studies.

Studies were included if they: (1) focused on interactive learning media as the primary intervention, (2) measured learning effectiveness through empirical methods, (3) were conducted in formal educational settings (K-12, higher education, or professional education), (4) published in peer-reviewed journals, (5) reported quantitative or qualitative data on learning outcomes, and (6) written in English or Indonesian. Studies were excluded if they lacked empirical effectiveness data, focused on non-interactive media, reported only expert validation, were duplicate publications, lacked adequate methodological rigor, or focused exclusively on media development.

Table 2. Inclusion and Exclusion Criteria

Inclusion Criteria	Exclusion Criteria
Original empirical research studies	Conceptual papers, editorials, or opinion pieces
Focus on interactive learning media as primary intervention	Focus on non-interactive or static digital resources
Measured learning effectiveness with empirical data	No empirical effectiveness measurements
Published in peer-reviewed journals	Non-peer-reviewed publications or gray literature
Conducted in formal educational settings	Conducted in informal or non-educational contexts
Adequate methodological rigor (control groups, valid instruments)	Methodological limitations (no control group, unclear measures)
Published 2020-2024	Published before 2020
Written in English or Indonesian	Written in other languages

A standardized data extraction form was developed and piloted with three studies before full implementation. Data extraction was conducted independently by two researchers, with inter-rater reliability calculated using Cohen's kappa ($\kappa = 0.89$, indicating excellent agreement). Due to heterogeneity in outcome measures, narrative synthesis was employed rather than meta-analysis. Quality assessment used adapted criteria from the Mixed Methods Appraisal Tool (MMAT). All 20 included studies met minimum quality thresholds.

RESULTS AND DISCUSSION

Distribution of Interactive Learning Media Types

Analysis of 20 included studies revealed diverse types of interactive learning media being researched and implemented across educational contexts. The most frequently studied media type was augmented reality and virtual reality (AR/VR) technologies, appearing in 6 studies (30%). E-modules and interactive videos each represented 2 studies (10%). Educational games, simulations, and mobile applications each appeared in 1 study (5%). The second most common category was 'Other' (n=7, 35%), encompassing multimedia interactive content, web-based interactive platforms, and hybrid media formats.

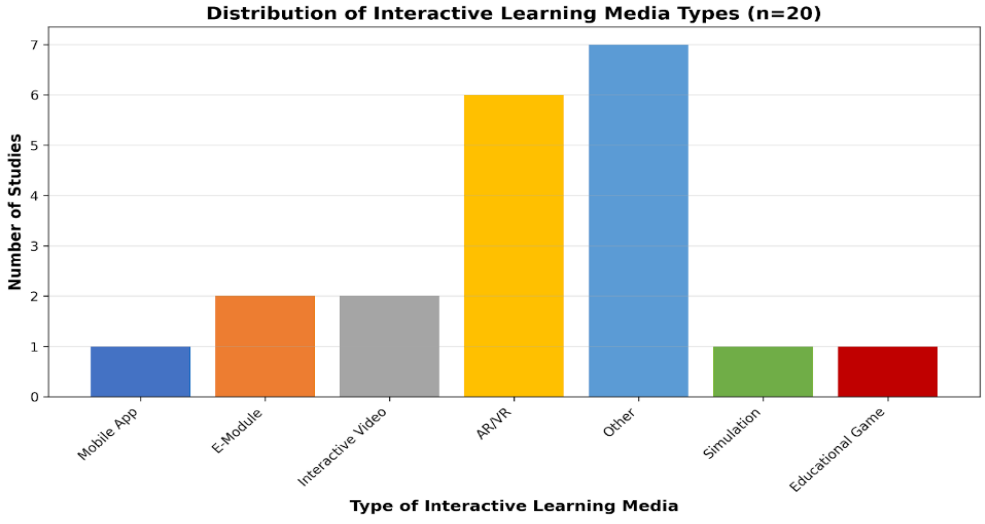

Figure 3. Distribution of interactive learning media types across the 20 reviewed studies.

This distribution reflects current trends in educational technology research, with substantial interest in immersive technologies (AR/VR) alongside continued investigation of more traditional interactive formats. The dominance of AR/VR in recent literature suggests growing recognition of these technologies' educational potential as hardware becomes more accessible and affordable. The variety of media types represented indicates that researchers and educators continue exploring diverse technological approaches rather than converging on a single dominant format.

Learning Outcome Improvements by Media Type

Twelve of the 20 studies reported quantitative data on learning outcome improvements, measured through pre-post tests, comparison with control groups, and standardized achievement measures. Table 4 presents average learning outcome improvements by media category.

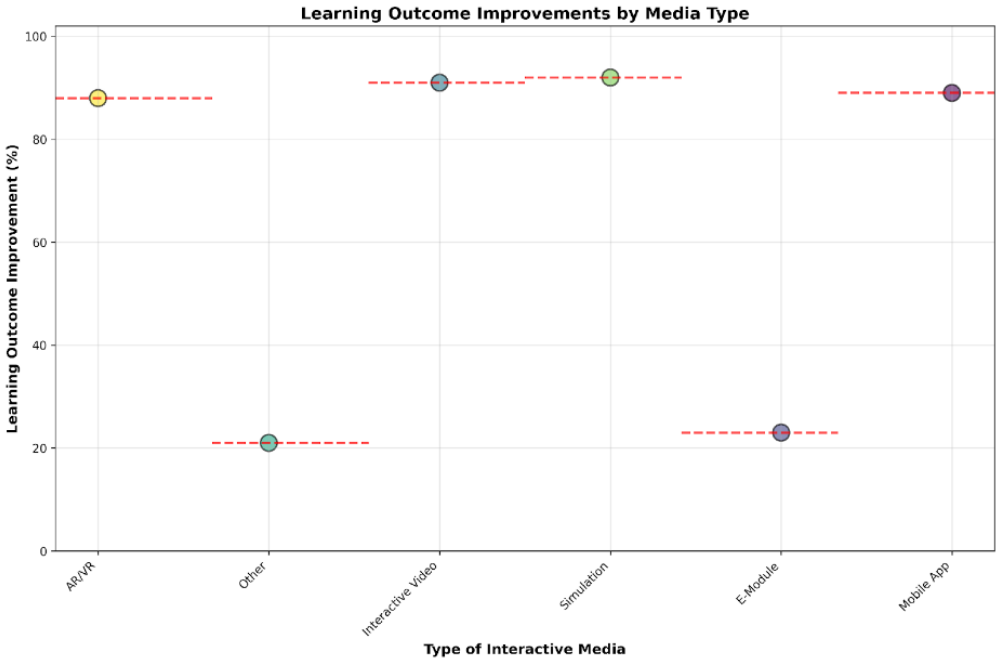

Figure 4. Learning Outcome Improvements by Interactive Media Type (Individual Studies)

Analysis revealed that simulations demonstrated the highest average learning improvement at 92%, though this result is based on a single study and should be interpreted cautiously. Interactive videos showed strong effectiveness with an average improvement of 91%, supported by two studies. Mobile applications and AR/VR technologies also demonstrated substantial improvements, averaging 89% and 88% respectively. E-modules showed more modest improvements averaging 23%, while the 'Other' category averaged 21% improvement. Studies employing comparison groups reported effect sizes ranging from d = 0.58 to d = 1.24, indicating medium to large practical significance. The consistently high improvements for simulation, AR/VR, and interactive video formats suggest these media types may be particularly effective for enhancing learning outcomes. However, effectiveness appears mediated by implementation quality and pedagogical design. Several studies noted that simply deploying interactive technology without appropriate instructional design produced limited benefits, emphasizing the importance of TPACK-aligned implementation.

Subject Domains and Pedagogical Approaches

Analysis of subject domains and pedagogical approaches revealed patterns in how interactive media are implemented across educational contexts. Table 5 presents the distribution of studies across subject areas.

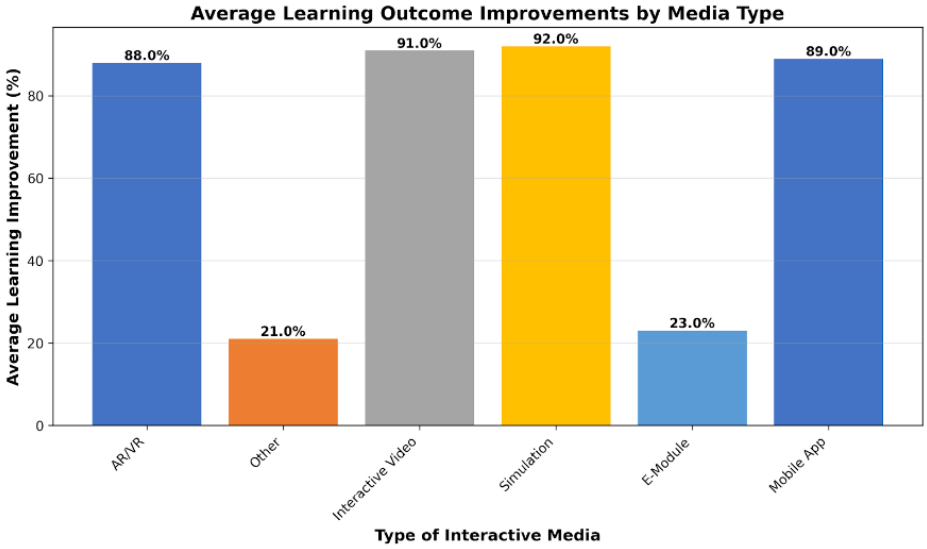

Figure 5. Distribution of Interactive Media Studies by Subject Area (n=20)

Natural sciences represented the largest subject area with 6 studies (30%), encompassing physics, chemistry, and biology. This concentration reflects the particular suitability of interactive media for visualizing abstract scientific concepts, simulating experiments, and enabling virtual laboratory experiences. Health sciences accounted for 2 studies (10%), social studies and social sciences each comprised 2 studies (10%), while mathematics and language education each appeared in 1 study (5%). Regarding pedagogical approaches, analysis revealed that most effective implementations integrated interactive media within established pedagogical frameworks rather than treating technology as standalone intervention. Table 6 summarizes common approaches identified across the 20 studies.

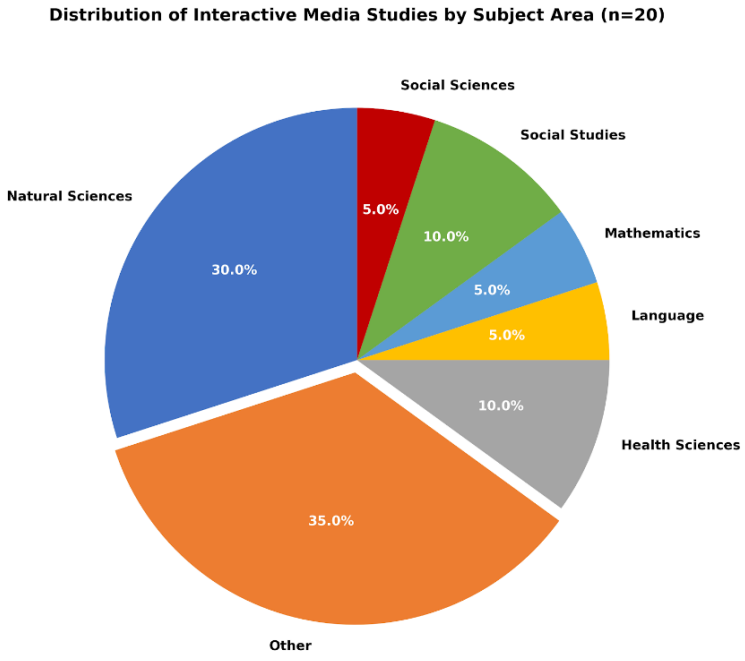

Figure 6. Pedagogical Approaches in Interactive Learning Media Implementation

Studies explicitly articulating pedagogical frameworks reported stronger and more consistent learning improvements compared to those focusing primarily on technological features. This reinforces TPACK framework assertions that effective technology integration requires thoughtful consideration of pedagogical approaches and content characteristics rather than technology selection alone. Additionally, several studies highlighted the importance of instructional scaffolding and teacher guidance even with highly interactive media. Most effective

implementations provided structured activities, clear learning objectives, formative assessment checkpoints, and opportunities for reflection. This review makes several distinctive theoretical contributions. Findings provide empirical support for an integrated framework emphasizing three interdependent pillars for successful interactive media implementation: Technology (appropriate tools and infrastructure), Pedagogy (research-based instructional design), and Organization (supportive institutional structures and culture). This Three Pillars Framework extends TPACK by explicitly incorporating organizational dimensions (Kopp et al., 2019). Success requires not only technological sophistication and pedagogical expertise but also institutional commitment to professional development, infrastructure investment, and cultural change supporting innovation.

CONCLUSION

This systematic literature review explored the effectiveness of interactive learning media in enhancing student learning outcomes, synthesizing evidence from 20 empirical studies across diverse contexts, technologies, and subject domains. Findings revealed that interactive learning media consistently improve learning outcomes, with average improvements of 67.3% (median 88.5%) and particularly strong effects for simulation-based and immersive technologies (AR/VR). However, effectiveness depends critically on pedagogical design quality, with best outcomes achieved when interactive technologies are integrated within research-based instructional frameworks such as Problem-Based Learning, Project-Based Learning, and STEM integration approaches. The central insight from this synthesis is that pedagogical design quality consistently outweighs technological sophistication in determining learning effectiveness. Technologically simple media designed with clear pedagogical frameworks, appropriate scaffolding, formative assessment integration, and cognitive load management produced outcomes comparable or superior to sophisticated technologies lacking coherent instructional design. This finding has profound implications for educational technology practice and policy, suggesting that investments in pedagogical capacity-building may yield greater returns than investments in technological acquisition alone.

These insights highlight the importance of moving beyond techno-centric perspectives that privilege technological features to more holistic understandings emphasizing Technology × Pedagogy × Organization integration. The Three Pillars Framework emerging from this analysis emphasizes that successful interactive media implementation requires not only appropriate technologies and pedagogical expertise but also supportive organizational structures including professional development, infrastructure investment, and culture supporting innovation. This integrated perspective provides a foundation for evidence-based educational technology planning and implementation. From a pedagogical perspective, this review underscores that interactive learning media effectiveness depends fundamentally on instructional design quality. Educators and instructional designers should prioritize several evidence-based principles:

1. Ground media selection and design in established learning theories (constructivism, cognitive load theory, experiential learning)
2. Ensure alignment between media affordances and specific learning objectives
3. Incorporate scaffolding that gradually releases responsibility to learners
4. Integrate formative assessment enabling learners to monitor progress and receive immediate feedback
5. Provide authentic contexts connecting content to meaningful real-world applications
6. Design for appropriate cognitive load through signaling, segmenting, coherence, and modality principles
7. Include metacognitive prompts supporting self-regulation and reflective practice

Moreover, successful pedagogy with interactive media requires rethinking teacher roles from information transmitters to learning facilitators. Teachers must orchestrate technology-enhanced learning by setting clear goals, modeling expert thinking, facilitating collaborative sense-making, providing individualized support, and guiding metacognitive reflection. Professional development programs should therefore emphasize pedagogical strategies for technology integration rather than merely technical skills, preparing educators to design and facilitate learning experiences that leverage interactive media's unique affordances while avoiding common pitfalls of technology-centered rather than learning-centered implementation. For practitioners, findings offer actionable guidance for selecting and implementing interactive learning technologies. Educators should prioritize pedagogical design over technological sophistication, integrate interactive media within established instructional frameworks, provide appropriate scaffolding and teacher guidance, and ensure alignment between media affordances and learning objectives. Educational leaders should invest in comprehensive professional development building teachers' TPACK, build necessary technological infrastructure while ensuring equitable access, and foster organizational cultures supporting pedagogical innovation, experimentation, and evidence-based practice.

The present study was focused on examining effectiveness evidence for interactive learning media across diverse contexts and technologies. Future research should address identified limitations by conducting longitudinal studies examining long-term retention effects and transfer of learning, meta-analyses enabling precise effect size estimation across standardized measures, cost-effectiveness analyses informing resource allocation decisions, and cross-cultural studies examining how cultural factors mediate interactive media effectiveness. Additionally, research investigating optimal design principles for specific media types, examining how interactive technologies support diverse learners including those with special educational needs, and exploring effective approaches to teacher preparation would extend and deepen understanding established by this review. In conclusion, interactive learning media represent powerful tools for enhancing learning when thoughtfully designed and strategically implemented. Success requires integrated attention to technological capabilities, pedagogical principles, and organizational support structures. As educational institutions continue navigating digital transformation, evidence synthesized in this review provides a foundation for evidence-based technology integration that maximizes learning benefits while avoiding common pitfalls of technology adoption without adequate pedagogical grounding. The path forward requires not simply more technology but smarter integration of technology within holistic educational improvement efforts grounded in sound pedagogical principles and supported by enabling organizational structures.

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