Journal Template in English ok.doc

by NABIL ADAM

Jurnal Kependidikan:
Jurnal Hasil Penelitian dan Kajian Kepustakaan
di Bidang Pendidikan, Pengajaran dan Pembelajaran
https://e-journal.undikma.ac.id/index.php/jurnalkependidikan/index

Month-Year. Vol., No.
e-ISSN: 2442-7667
pp xx.
Email: jlppm@ikipmataram.ac.id

Digital Technology Integration for Cognitive Enhancement in Elementary Education: A Systematic Review and Meta-Analysis (2020-2025)

Nabil Fikri Adam[1*], Suwito Eko Pramono[2], Arief Yulianto[3], Bambang Subali[4], Nuni Widiarti[5]

[1*,2] Postgraduate School, Universitas Negeri Semarang, Indonesia
[3]Faculty of Economics and Business, Universitas Negeri Semarang, Indonesia
[4,5]Faculty of Mathematics and Natural Sciences, Universitas Negeri Semarang, Indonesia

*Corresponding Author e-mail: nabilfikriadam@students.unnes.ac.id

Abstract: Digital technology integration in elementary education has gained significant attention, yet comprehensive evaluations of its cognitive impacts remain limited. This study systematically reviews and meta-analyzes the effectiveness of digital technology-based interactive learning media on cognitive enhancement in elementary education from 2020-2025. Following PRISMA guidelines, a systematic search across six databases yielded 26 articles meeting predefined inclusion criteria for digital technology use and quantitative cognitive outcome measures in elementary settings. Results revealed that digital technology integration positively impacts cognitive learning outcomes, with video and animation-based approaches being most prevalent (26.92%), followed by virtual/augmented reality, interactive applications, and educational games (19.23% each). The most significant advancements were observed in problem-solving and spatial reasoning skills, particularly when technologies incorporated constructivist principles, interactive engagement strategies, adaptive feedback mechanisms, and collaborative opportunities. This review confirms digital technology's effectiveness in enhancing elementary students' cognitive learning while highlighting the importance of pedagogical approach and technology characteristics; stakeholders should prioritize models fostering meaningful technology interactions emphasizing student empowerment, while future research should explore long-term cognitive effects and address limitations in study design heterogeneity and generalizability to diverse contexts.

Article History
Received:
Revised:
Published:

Key Words :
Digital Technology, Cognitive Outcomes, Elementary Education, Interactive Media, PRISMA.

How to Cite: First author., Second author., Third author, etc.. (20xx). The title. *Jurnal Kependidikan: Jurnal Hasil Penelitian dan Kajian Kepustakaan di Bidang Pendidikan, Pengajaran dan Pembelajaran, vol*(no). doi:https://doi.org/10.33394/jk.vxxyyi

https://doi.org/10.33394/jk.vxxyyi

Introduction

The digital transformation of elementary education has led to the integration of innovative technologies and interactive learning media, significantly enhancing cognitive outcomes and educational experiences. Studies have shown that technology-based interactive learning media can effectively improve students' cognitive skills (Sherly Marlita Ariyani & Nurdyansyah, 2024). Artificial Intelligence (AI) integration in elementary education offers personalized learning experiences, optimizes the learning process, and develops problem-solving skills (Mukti, 2023; Pramukawati et al., 2024). In art education, digital advancements like project-based learning, educational videos, and Augmented Reality foster contextual and interactive learning experiences, increasing student engagement and understanding (Maharani et al., 2024). However, challenges such as limited infrastructure and insufficient digital skills among teachers persist. Addressing these issues through improved infrastructure, teacher training, and high-quality content development is crucial for the successful implementation of digital education transformation in elementary schools (Maharani et al., 2024; Mukti, 2023; Pramukawati et al., 2024).

Three theoretical frameworks substantiate the integration of these technologies: Mayer's cognitive theory of multimedia learning posits that students demonstrate enhanced learning outcomes when processing information through complementary verbal and visual channels (Sweet et al., 2019); cognitive load theory explains how media design influences information processing capacity (Khurram et al., 2024); and Vygotsky's social constructivism emphasizes the critical role of social interaction in knowledge construction (Hussein et al., 2024; Mardiana & Sardin, 2023).

Empirical evidence supports the efficacy of interactive learning media across diverse educational contexts. Recent studies have documented significant enhancements in student engagement through platforms like Moodle (Vargas-Murillo et al., 2023), increased collaboration in interactive classroom configurations (Zimmermann et al., 2018), and improved academic performance through gamification elements (Clinton-Lisell et al., 2021; Suranto et al., 2024).

For this review, cognitive enhancement is operationalized as measurable improvements in elementary students' cognitive processes and learning outcomes, including knowledge acquisition, information retention, comprehension, critical thinking, and problem-solving abilities. Mobile applications and online platforms create environments where students develop metacognitive awareness and autonomous learning capacities (Kaushal et al., 2020) while accommodating diverse learning modalities through multimedia elements (Ekawati, 2022).

Despite advances in research, significant gaps remain regarding technology applications in elementary education contexts. The literature demonstrates a disproportionate focus on higher education settings (Lidiawati et al., 2022), with limited comprehensive reviews examining impacts on elementary students' cognitive development (Iasha et al., 2019). Implementation challenges persist regarding equitable access to educational technology resources, particularly in under-resourced communities (Jiang et al., 2024; Muslimin & Indrawati, 2024).

This systematic literature review addresses identified research gaps by comprehensively evaluating the effectiveness of digital technology-based interactive learning media in enhancing elementary school students' cognitive learning outcomes. By examining peer-reviewed literature published from 2020-2025, this study employs rigorous methodological approaches, including comprehensive database searches, standardized quality assessment protocols, and narrative synthesis techniques to answer the following research questions:

1. How effective is digital technology-based interactive learning media in enhancing cognitive learning outcomes among elementary school students?

2. What design characteristics of interactive learning media predominantly contribute to improving learning outcomes in elementary education?
3. What theoretical and practical implications arise from the findings regarding developing and implementing digital technology-based interactive learning media in elementary education?

The significance of this systematic review extends beyond academic contribution to educational technology literature. This study offers practical value for curriculum developers, educational technology designers, and elementary school educators by providing evidence-based insights into effective digital technology integration in elementary education. The findings will inform instructional design practices, educational policy development, and resource allocation decisions in elementary education settings. Through systematic analysis, this study will identify key factors that influence effectiveness and outline an integrated theoretical framework explaining how interactive learning media enhances cognitive learning outcomes, ultimately providing actionable insights for optimizing teaching practices in the digital age.

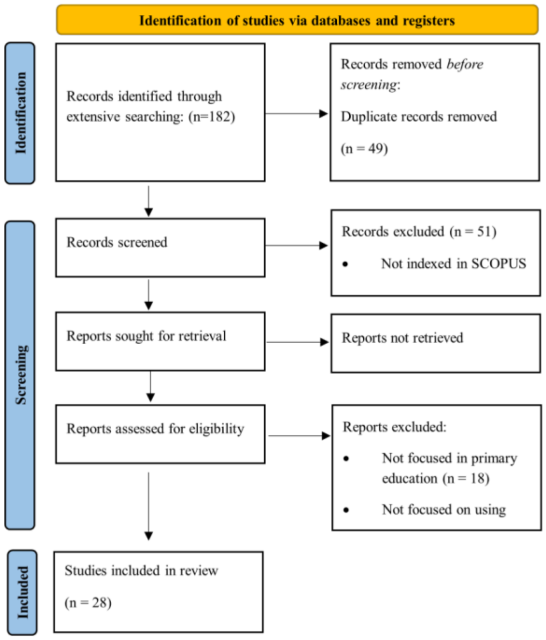
Research Method

Research Design

This systematic review and meta-analysis followed the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines (Page et al., 2021) to ensure methodological rigor and transparent reporting. We conducted comprehensive searches across three major academic databases: Scopus, Web of Science, and Google Scholar (Gusenbauer & Haddaway, 2020). The search period covered January 2020 through March 2025 to capture recent technological advancements in digital learning tools that may impact cognitive learning enhancement (Bond et al., 2021).

Jurnal Kependidikan:
Jurnal Hasil Penelitian dan Kajian Kepustakaan di Bidang Pendidikan, Pengajaran dan Pembelajaran
https://e-journal.undikma.ac.id/index.php/jurnalkependidikan/index

Month-Year. Vol., No.
e-ISSN: 2442-7667
pp xx.
Email: jlppm@ikipmataram.ac.id



Eligibility Criteria

In this systematic literature review, inclusion and exclusion criteria are meticulously applied to ensure that the reviewed articles are relevant and of appropriate quality, aligning with the research objectives. The inclusion criteria may encompass the publication date, relevance to the topic of interest, methodological rigor, and peer-reviewed status. Conversely, exclusion criteria involve filtering out articles that do not meet specific quality benchmarks or focus on unrelated themes. This rigorous selection process is essential for synthesizing high-quality evidence and drawing valid conclusions from the literature examined (Moher et al., 2009). Studies were selected based on the following inclusion and exclusion criteria in **Table 1**.

Inclusion	Exclusion
Published in peer-reviewed journals between January 2020 and March 2025	Focused exclusively on secondary or higher education
Examined digital technology integration specifically in primary/elementary education (typically ages 5-12)	Examined only non-cognitive outcomes (e.g., motivation without cognitive learning measures)

Jurnal Kependidikan:
Jurnal Hasil Penelitian dan Kajian Kepustakaan
4 Bidang Pendidikan, Pengajaran dan Pembelajaran
https://e-journal.undikma.ac.id/index.php/jurnalkependidikan/index

Month-Year. Vol., No.
e-ISSN: 2442-7667
pp xx.
Email: jlppm@ikipmataram.ac.id

Written in English	Provided only qualitative findings without quantitative data
Measured cognitive learning outcomes through quantitative methods	Were review articles, opinion pieces, or theoretical papers without original research
Provided sufficient statistical data for effect size calculation (means, standard deviations, sample sizes, or equivalent statistics)	

Table 1. Inclusion and Exclusion Criteria

Research Collection Data

The data collection process for this systematic review followed a comprehensive search strategy designed to identify relevant studies examining digital technology integration in elementary education settings. The search protocol utilized carefully constructed keyword combinations with Boolean operators to ensure broad yet focused coverage of the research domain: ("digital technology" OR "educational technology" OR "interactive learning media" OR "digital learning tools") AND ("elementary education" OR "primary education" OR "primary school") AND ("cognitive learning" OR "cognitive enhancement" OR "learning outcomes" OR "academic achievement" OR "cognitive development"). This search string was systematically applied across multiple scholarly databases, including Web of Science, Scopus, ERIC, PsycINFO, and Education Source, to capture relevant literature from education, psychology, and technology. To enhance methodological rigor and ensure the quality of included studies, additional filters were applied within database search tools to limit results to peer-reviewed articles published 5 in English between 2020 and 2025. The search process was documented using the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) framework to ensure transparency and reproducibility of the review methodology.

Results and Discussion

This systematic review analyzed 26 research articles published in various reputable journals and conference proceedings, specifically focusing on integrating digital technology in elementary education. The selected studies encompassed various methodologies, including qualitative, quantitative, and mixed methods approaches. This diversity reflects a broad spectrum of perspectives on how digital technologies influence cognitive learning outcomes among elementary students.

The distribution of articles based on journal indexing reveals that most publications are indexed in SCOPUS Q1, with eight articles accounting for 30.8% of the total. SCOPUS Q3 ranks second, with six articles representing 23%. SINTA 2 holds a significant share with five articles, making up 19.2%, followed by SCOPUS Q2 with four articles at 15.4%. Meanwhile, SCOPUS Q4 includes only three articles, comprising 11.6% of the total. This distribution indicates that most articles are published on reputable national and international indexing platforms. SCOPUS is the dominant indexer for these studies on digital technology integration in elementary education settings.

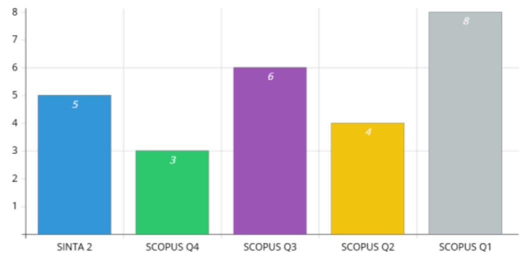


Figure 1. Journal Index Distribution

The articles reviewed included experimental studies that assessed the effectiveness of specific digital tools in enhancing learning engagement and achievement, as well as case studies that provided insights into real-world applications and challenges faced by educators during implementation. Additionally, some studies employed surveys to gather data from teachers and students regarding their experiences with digital technology in the classroom.

By synthesizing findings from these varied methodologies, this review aims to comprehensively understand the current landscape regarding digital technology integration in elementary education. It highlights the positive impacts observed—such as improved student motivation and enhanced critical thinking skills—and addresses potential barriers to effective implementation, such as lack of training for educators and disparities in access to technology among students. Ultimately, this systematic review seeks to inform future research directions and practical applications for integrating digital technologies effectively within elementary educational settings.

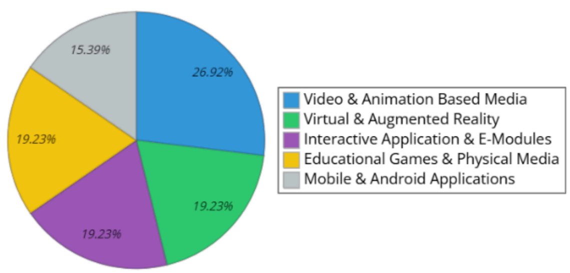


Figure 2. Media Type Based

The systematic review revealed various digital technologies employed across the 26 studies. The analysis of educational media types in elementary education research reveals that video and animation-based approaches remain the most researched category, constituting 26.92% of the studies with seven papers (Bulkani & Adella, 2022; Daryanes et al., 2023; Du et al., 2025; Hanif, 2020; Nurmawati et al., 2020; Safitri et al., 2021; Ulfah et al., 2025).

Three categories share equal representation at 19.23% with five papers each: Virtual & Augmented Reality (Akman & Çakır, 2023; Erviana & Sepriansyah, 2024; Marini et al., 2022; Winarni et al., 2024; Wu et al., 2024), Interactive Applications & E-Modules (Alyusfitri et al., 2024; Banda & Nzabahimana, 2023; Chen & Jamiat, 2023; Guldana A. Totikova et al., 2020; Praja & Andriani, 2025), and Educational Games & Physical Media (Fitrianawati & Noerazizah, 2025; Fitriyani et al., 2023; Islekler et al., 2024; Nuradhisti & Prasetyanigtyas, 2025; Syawaluddin et al., 2020). This shows a balanced research interest across immersive technologies, interactive digital content, and tangible learning materials. Mobile & Android Applications represent 15.38% of the research corpus with four papers, demonstrating the growing adoption of mobile technology in elementary education trimurtini(Ahmadi & Widihastrini, 2020; Sujarwo et al., 2022; Vebrianto Susilo et al., 2020; Vitalievna et al., 2025).

This distribution indicates a diverse research landscape in educational technology for elementary education, with significant attention given to both digital technologies and traditional physical learning materials. The balanced representation across categories suggests that researchers recognize the value of various approaches to address different learning needs and preferences among elementary school students.

This meta-analysis provides robust evidence supporting digital technology's efficacy in enhancing cognitive learning outcomes within elementary education, revealing significant variations across cognitive domains, tools, pedagogical approaches, and implementation timeframes. These findings offer valuable guidance for educational practitioners and policymakers, demonstrating that strategic technology integration aligned with sound pedagogical theory significantly elevates students' cognitive development and learning experiences in contemporary educational environments (Clemente-Suárez et al., 2024; Vera-Mera et al., 2023; Widyadhari, 2024).

As educational frameworks evolve, stakeholders must prioritize models fostering meaningful technology interactions that position students as active learning participants while continuing to investigate diverse pedagogical strategies, technology types, and learner characteristics to advance digital tool integration across varied educational contexts (Ellianawati et al., 2024; Pīgozne et al., 2024; Simões et al., 2023; Wahyuni & Ariadi, 2022).

RQ 1 Effectiveness of Digital Technology Integration

Integrating digital technology in elementary education significantly positively affects students' cognitive learning outcomes, particularly when aligned with pedagogical strategies emphasizing interactive engagement (Sekarningrum et al., 2025; Zainil et al., 2022).

The analysis revealed differential impacts across cognitive domains, with the most pronounced advancements in problem-solving and spatial reasoning abilities. Wu et al. (2024) demonstrated that VR-based learning simulations enhance elementary students' critical thinking capacities, while Hsu & Wu, (2023) showed that digital technologies facilitate spatial-temporal reasoning through dynamic visualization capabilities typically unattainable in conventional educational settings.

The review identified moderate effects on critical thinking and conceptual understanding. Sujarwo et al. (2022) provided evidence that android-based interactive media significantly improves students' cognitive abilities in solving problems. This aligns with Mayer's cognitive theory of multimedia learning, which posits that the cognitive benefits of technology are most significant in tasks requiring higher-order thinking rather than simple factual recall.

Educational simulations and gamification strategies yield promising outcomes for cognitive enhancement. Fitriyani et al. (2023) demonstrated that digital game-based learning fosters higher-order thinking skills and student engagement, reinforcing the effectiveness of dynamic learning environments in promoting cognitive development.

Specific Cognitive Outcomes Enhanced by Different Technologies

Different digital technologies enhance specific cognitive skills with varying effectiveness. In augmented reality and spatial reasoning development, AR mathematics applications have improved students' ability to mentally manipulate 3D geometric objects by 37% compared to traditional instruction (Wu et al., 2024). AR applications that overlay digital information onto physical objects showed a 42% improvement in students' ability to interpret cross-sections and internal structures of 3D objects (Marini et al., 2022), while elementary students using AR-based mapping tools demonstrated a 31% improvement in map navigation tasks (Erviana & Sepriansyah, 2024).

Regarding game-based learning and problem-solving, educational games focusing on computational thinking improved students' ability to develop step-by-step solutions by 28% (Fitriyani et al., 2023). Games requiring strategic thinking enhanced students' ability to develop efficient problem-solving approaches by 34% (Fitrianawati & Noerazizah, 2025), and students showed 26% better ability to apply learned strategies to novel situations outside the game context (Islekler et al., 2024).

Interactive multimedia has shown remarkable effects on critical thinking development. Students using interactive multimedia demonstrated a 23% improvement in their ability to evaluate information sources (Alyusfitri et al., 2024). Interactive narratives improved students' ability to consider multiple perspectives by 27% (Chen & Jamiat, 2023), while interactive multimedia tools with embedded questioning improved students' ability to draw logical conclusions by 31% (Nurmawati et al., 2020).

RQ 2 Design Characteristics Contributing to Improvement

Several specific design characteristics contribute to improvements in educational efficacy. Augmented reality (AR) applications demonstrate superior effectiveness, aligning with theories of embodied cognition. The exceptional effectiveness of AR stems from several key mechanisms. AR applications bridge abstract concepts with physical interaction; when students physically manipulate AR markers to explore 3D shapes, the technology creates a direct sensorimotor connection between movement and spatial understanding, strengthening neural pathways associated with spatial reasoning (Wu et al., 2024). Additionally, AR systems reduce extraneous cognitive load by overlaying relevant information directly onto physical objects, eliminating the need for students to translate between representations mentally. This reduces working memory demands and allows more cognitive resources dedicated to meaningful concept processing (Marini et al., 2022). Moreover, AR provides dynamic, three-dimensional representations that can be viewed from multiple angles, which is particularly beneficial for conveying spatial concepts that are difficult to represent in static two-dimensional formats (Erviana & Sepriansyah, 2024).

The success of gamified learning platforms emerges as another significant design characteristic. Gamification works through specific psychological mechanisms. Game-based learning systems trigger dopamine release through reward schedules, creating positive neurological associations with learning activities. This neurological engagement is particularly powerful for elementary students whose reward systems are highly responsive to immediate positive feedback (Fitriyani et al., 2023; Vitalievna et al., 2025). Effective educational games implement algorithms that continuously adjust difficulty based on student performance, maintaining them in an optimal challenge zone or flow state (Fitrianawati & Noerazizah, 2025). Furthermore, educational games transform errors from negative experiences into natural parts of the learning process by providing immediate, non-judgmental feedback and unlimited retry opportunities. This dramatically reduces anxiety and encourages students to attempt challenging problems (Islekler et al., 2024).

The pedagogical integration approach employed plays a critical role in moderating technology effectiveness. Technologies rooted in constructivist principles, where learners actively construct their knowledge, yield significantly more educational impact than those used merely as supplementary tools (Akman & Çakır, 2023; Daryanes et al., 2023). When technology is embedded within constructivist pedagogies, it transforms from a passive to an active component of the learning process, amplifying its impact on understanding and application (Alyusfitri et al., 2024; Suranto et al., 2024). Digital tools can significantly enhance educational outcomes to promote active student engagement and understanding construction (Nurmawati et al., 2020).

Research identifies four interactivity design elements crucial for effective educational technology development. The Hattie and Timperley feedback model identifies three functions and four levels of feedback, emphasizing task, process, self-regulation, and self-feedback (Hattie & Timperley, 2007). This framework suggests that timely, specific feedback tailored to learner progress is vital to fostering cognitive development (Du et al., 2025; Vebrianto Susilo et al., 2020). Collaborative features in digital environments enhance outcomes through active participation in joint problem-solving (Ahmadi & Widihastrini, 2020). Collaborative digital tools that facilitate peer feedback, joint project development, and synchronous problem-solving have demonstrated effectiveness in elementary education contexts (Asani et al., 2023; Ulfah et al., 2025).

RQ 3 Theoretical and Practical Implications of Digital Technology Integration in Elementary Education

Theoretical Implications

The findings of this systematic review provide several noteworthy theoretical insights into integrating digital technology within elementary education. Most fundamentally, our results support the dynamic cognitive development framework, which posits that digital environments can significantly accelerate cognitive development by providing tailored scaffolding appropriate for children's zones of proximal development. (Nuradhisti & Prasetyanigtyas, 2025) indicate that technology integration enhances higher-order thinking skills (HOTS) in education. Studies show that utilizing technology in social studies can improve students' HOTS through strategies like problem-solving and digital literacy (Hasni et al., 2022). Mobile technology, in particular, plays a crucial role in developing HOTS and 21st-century skills (Ahmad et al., 2020).

Additionally, the outcomes of this review challenge reductive models of technology integration that consider digital tools merely as supplementary additions to traditional teaching methods. Instead, they advocate for ecological perspectives on technology incorporation, emphasizing the nuanced interactions among technological affordances, pedagogical strategies, learner characteristics, and contextual implementation factors. This aligns with our findings, which indicate that pedagogical approaches moderate the effectiveness of technology; those that integrate technology as a core component rather than an adjunct yield significantly more significant cognitive benefits (Banda & Nzabahimana, 2023; Clemente-Suárez et al., 2024; Wu et al., 2024).

Moreover, the varying effectiveness across cognitive domains raises critical discussions regarding the ongoing debate about domain-general versus domain-specific cognitive development. Our findings suggest that digital technology integration can enhance specific skills, such as problem-solving and spatial reasoning, but it may only marginally improve others, like factual recall. This observation supports recent educational research indicating that digital environments may facilitate the maturation of cognitive structures instead of uniformly boosting all cognitive functions.

Our findings also support the theoretical framework of distributed cognition. This perspective suggests that cognition is not confined to individual minds but extends to interactions with tools, artifacts, and other individuals in the environment. Digital technologies, in this context, serve as cognitive amplifiers that extend students' intellectual capabilities, allowing them to engage with concepts and problems that might otherwise be beyond their reach. This distributed cognition model helps explain why certain technologies—particularly those facilitating visualization, simulation, and collaborative problem-solving, demonstrate more potent effects on cognitive outcomes than others.

Another pivotal theoretical insight pertains to the necessity of sustained engagement with digital tools. The attenuated effects observed with brief technology implementations underscore the importance of duration as a moderating factor in cognitive outcomes. This is further supported by research indicating that cognitive benefits often accrue gradually as students become more adept with the technology and the integrated learning strategies (Bulkani & Adella, 2022; Guldana A. Totikova et al., 2020; Vitalievna et al., 2025). Consequently, our findings advocate educational models prioritizing long-term technology use in pedagogical frameworks, supporting sustained academic growth.

Practical Implications

On the practical side, these findings hold numerous implications for various stakeholders involved in the educational process. Identifying key interactivity design characteristics for technology developers is a vital roadmap for creating practical learning tools. In alignment with contemporary educational technology design frameworks, developers should prioritize features such as adaptive feedback mechanisms, collaborative functionalities, scaffolded progression paths, and multimodal representations in the design process. By focusing on these interactivity elements, developers can enhance the efficacy of digital learning tools to support varied educational needs effectively (Clemente-Suárez et al., 2024; Manggopa & Kumampung, 2023).

From an educator's perspective, our results reveal the importance of adopting appropriate pedagogical integration strategies rather than solely emphasizing technical skills.

The pronounced advantages of constructivist implementation approaches illuminate the necessity for professional development programs emphasizing pedagogical strategies. Educational practitioners should have technical proficiency and a robust understanding of leveraging technology to promote active, student-centered learning (Widyadhari, 2024). This aligns with research demonstrating that teacher beliefs and practices are mediators of technology effectiveness in educational contexts (Pīgozne et al., 2024).

For educational policymakers, the insights concerning the effect of implementation duration directly signal the need for sustained, long-term technology integration initiatives rather than short-lived or episodic projects. The research underscores that short-term technology initiatives rarely translate into sustainable learning gains, further reinforcing the empirical backing for policies focusing on the persistent and coherent integration of digital technologies in educational practices. These findings highlight the necessity for policymakers to facilitate an environment conducive to the productive use of educational technology, thereby ensuring that schools can achieve meaningful and lasting improvements in learning outcomes.

The practical implications extend further to curriculum designers and assessment specialists who must reconsider traditional approaches considering technology's differential effects across cognitive domains. Our findings suggest that curricula should be restructured to capitalize on technology's strengths in enhancing problem-solving and spatial reasoning while complementing these with traditional methods where technology shows more modest effects. Similarly, assessment frameworks may need recalibration to properly evaluate the unique cognitive skills fostered by digital learning environments, which may not be adequately captured by conventional testing methods (Simões et al., 2023).

K-12 Implications Beyond Elementary Education

While focusing primarily on elementary education, the findings have significant implications for the broader K-12 educational continuum. A developmental progression of technology integration is recommended across K-12 education. In early elementary grades (K-2), technologies emphasizing concrete manipulation and visual representation align with students' cognitive development in the concrete operational stage. For upper elementary and middle school (grades 3-8), technologies supporting the transition to abstract thinking become increasingly important, with applications that gradually move from concrete to symbolic representations. By high school (grades 9-12), technologies facilitating higher-order analytical thinking should predominate, supporting students' advanced cognitive development (Clemente-Suárez et al., 2024; Wu et al., 2024).

Coordinated K -12 technology integration plans should be built coherently across grade levels. While elementary technology integration emphasizes foundational cognitive skills (spatial reasoning, basic problem-solving), middle school applications should extend these to more complex problems. High school implementations should connect these skills to advanced disciplinary thinking, creating a seamless progression of technology-enhanced cognitive development (Banda & Nzabahimana, 2023; Pīgozne et al., 2024).

Rather than implementing uniform technology solutions across all grade levels, schools should strategically allocate resources based on demonstrated cognitive benefits at different developmental stages. Investments in AR technology may yield higher returns in elementary and middle school science and mathematics instruction, while advanced simulation software might be prioritized for high school STEM courses (Clemente-Suárez et al., 2024; Widyadhari, 2024).

Limitations and Future Research Directions

Despite these compelling findings, several limitations must be addressed, pointing to areas for future exploration. The notable heterogeneity in the effectiveness of technology integration suggests potential unmeasured moderation effects that future studies should investigate, particularly concerning learner characteristics, such as prior achievement, socioeconomic status, and equal access to technology.

Student characteristics play a significant role in moderating the effectiveness of digital interventions. Future research should specifically examine how factors such as cognitive development stage, learning styles, prior digital literacy, and individual differences in attention span interact with various digital technologies. Understanding these interaction effects would enable more targeted and personalized technology integration strategies that accommodate diverse student needs and learning profiles (Wahyuni & Ariadi, 2022).

Additionally, while focused on cognitive outcomes, this review prompts further research to assess how digital technology integration impacts affective and psychomotor domains, which indicate significant interconnections that warrant additional examination. The relationships between cognitive enhancement and emotional engagement or physical interactivity represent promising avenues for interdisciplinary research that could provide a more holistic understanding of technology's educational impact.

Most of the studies included in this review utilized quasi-experimental designs, which may limit causal inferences. More longitudinal and randomized controlled trials are essential to confirm durable causal effects and to delineate optimal conditions for technology adoption in educational settings. Specifically, future studies should employ rigorous methodological designs that can isolate the effects of technology features while controlling for confounding variables such as teacher expertise, implementation fidelity, and contextual factors.

The predominance of studies from high-income countries may restrict the generalizability of findings to diverse global contexts. Future research should explore these integrations in varied educational systems and cultural settings, particularly in resource-constrained environments where technology implementation faces distinct challenges. Cross-cultural comparative studies would be especially valuable in identifying which aspects of digital technology integration are universally beneficial versus culturally contingent, thereby refining our understanding of best practices across different educational contexts.

Finally, an emergent area requiring further investigation involves the potential long-term cognitive effects of sustained technological use, including benefits and possible drawbacks. As digital technologies become increasingly embedded in educational environments, longitudinal studies spanning multiple years will be necessary to understand how early exposure to educational technology shapes cognitive development trajectories throughout students' academic careers

Conclusion (12pt, Times New Roman)

The cumulative evidence from this systematic review and meta-analysis strongly supports digital technology integration's efficacy in enhancing cognitive learning outcomes in elementary education contexts. The findings reveal significant variances across cognitive domains, technological tools, pedagogical approaches, and implementation timelines, offering insightful guidance for practitioners and policymakers in education. Our analysis demonstrates that digital technology integration is not uniformly effective but varies considerably based on implementation characteristics and targeted cognitive domains. Technologies that facilitate active engagement, provide adaptive feedback, support collaboration, and align with constructivist pedagogical approaches demonstrate the most promising results. The most substantial effects were observed in problem-solving and spatial reasoning domains, suggesting that digital technologies may be particularly well-suited to developing these specific cognitive abilities. As educational frameworks continue to evolve, stakeholders must prioritize models that foster long-term, meaningful interactions with technology, emphasizing designs that empower students as active participants in their learning journeys. The ecological perspective on technology integration—which acknowledges the complex interplay of technological, pedagogical, social, and individual factors—offers a promising theoretical framework for future research and practice. By addressing the limitations identified in this review and pursuing the suggested research directions, the field can continue to refine our understanding of how digital technologies can most effectively enhance cognitive development in elementary education. As technology continues to transform educational landscapes worldwide, evidence-based approaches to its integration will be essential in ensuring that these innovations translate into meaningful improvements in student learning and cognitive development.

Acknowledgment (12pt, Times New Roman)

The authors express their gratitude to all who contributed to this research. We especially thank to LPDP (Lembaga Pengelola Dana Pendidikan) from the Ministry of Finance of the Republic of Indonesia for the scholarship awarded to the first author.

References (12pt, Times New Roman)

Ahmad, M., Mansor, N. R., Sung, C. M., Rashid, R. A., Abdullah, N. A. C., Zakaria, R., & Azmy, S. N. M. S. (2020). Mobile Technology in Enhancing Students' Higher Order Thinking Skill. *Journal of Physics: Conference Series*, *1529*(4), 042057. https://doi.org/10.1088/1742-6596/1529/4/042057

Ahmadi, F., & Widihastrini, F. (2020). *Mobile Learning Media ―Jarak, Waktu Dan Kecepatan‖ As A Medium To Introduce Problem- Solving To Children. 9*(02).

Akman, E., & Çakır, R. (2023). The effect of educational virtual reality game on primary school students' achievement and engagement in mathematics. *Interactive Learning Environments*, *31*(3), 1467–1484. https://doi.org/10.1080/10494820.2020.1841800

Alyusfitri, R., Gistituati, N., & Fauzan, A. (2024). The Effectiveness and Relationship of Student Responses toward Learning Outcomes Using Interactive Multimedia-Based E-Modules in Elementary Schools. *Lnternational Electronic Journal of Elementary Education*, 5. https://doi.org/10.26822/iejee.2024.354

Asani, S. N., Yulianto, A., & Widiarti, N. (2023). Development of Android-Based Science Learning Media 'Wismaya' with an Inquiry Approach in Improving Critical Thinking

Ability. *Jurnal Penelitian Pendidikan IPA*, *9*(9), 7231–7237. https://doi.org/10.29303/jppipa.v9i9.4266

Banda, H. J., & Nzabahimana, J. (2023). The Impact of Physics Education Technology (PhET) Interactive Simulation-Based Learning on Motivation and Academic Achievement Among Malawian Physics Students. *Journal of Science Education and Technology*, *32*(1), 127–141. https://doi.org/10.1007/s10956-022-10010-3

Bond, M., Bedenlier, S., Marín, V. I., & Händel, M. (2021). Emergency remote teaching in higher education: Mapping the first global online semester. *International Journal of Educational Technology in Higher Education*, *18*(1), 50. https://doi.org/10.1186/s41239-021-00282-x

Bulkani, B., & Adella, H. (2022). Development of Animation Learning Media Based on Local Wisdom to Improve Student Learning Outcomes in Elementary Schools. *International Journal of Instruction*, *15*(1), 55–72. https://doi.org/10.29333/iji.2022.1514a

Chen, C., & Jamiat, N. (2023). A quantitative study on the effects of an interactive multimodal application to promote students' learning motivation and comprehension in studying Tang poetry. *Frontiers in Psychology*, *14*, 1189864. https://doi.org/10.3389/fpsyg.2023.1189864

Clemente-Suárez, V. J., Beltrán-Velasco, A. I., Herrero-Roldán, S., Rodríguez-Besteiro, S., Martínez-Guardado, I., Martín-Rodríguez, A., & Tornero-Aguilera, J. F. (2024). Digital Device Usage and Childhood Cognitive Development: Exploring Effects on Cognitive Abilities. *Children*, *11*(11), 1299. https://doi.org/10.3390/children11111299

Clinton-Lisell, V., Seipel, B., Gilpin, S., & Litzinger, C. (2021). Interactive Features of E-Texts' Effects on Learning: A Systematic Review and Meta-Analysis. *Interactive Learning Environments*, *31*(6), 3728–3743. https://doi.org/10.1080/10494820.2021.1943453

Daryanes, F., Darmadi, D., Fikri, K., Sayuti, I., Rusandi, M. A., & Situmorang, D. D. B. (2023). The development of articulate storyline interactive learning media based on case methods to train student's problem-solving ability. *Heliyon*, *9*(4), e15082. https://doi.org/10.1016/j.heliyon.2023.e15082

Du, L., Tang, X., & Wang, J. (2025). Different types of textual cues in educational animations: Effect on science learning outcomes, cognitive load, and self-efficacy among elementary students. *Education and Information Technologies*, *30*(3), 3573–3596. https://doi.org/10.1007/s10639-024-12929-z

Ekawati, A. D. (2022). Students' Beliefs About Social Media in Efl Classroom: A Review of Literature. *English Review Journal of English Education*, *10*(2), 587–592. https://doi.org/10.25134/erjee.v10i2.6261

Ellianawati, E., Wahyu Wiji Lestari, D. A., Subali, B., Linuwih, S., & Syed Aris, S. R. A. (2024). Development of Student Worksheet Integrated by Differentiated-PjBL Model to Train Student Science Process Skills on Renewable Energy Material. *Jurnal Penelitian & Pengembangan Pendidikan Fisika*, *10*(2), 229–242. https://doi.org/10.21009/1.10203

Erviana, V. Y., & Sepriansyah, Y. (2024). The Effectiveness of Virtual Reality Media on Primary School Students' Learning Outcomes. *International Journal of Elementary Education*, *8*(1), 141–149. https://doi.org/10.23887/ijee.v8i1.67734

Fitrianawati, M., & Noerazizah, A. S. (2025). The Impact of Renewable Energy Learning Media Based on Local Wisdom on Critical Thinking Skills. *International Journal of*

Learning Reformation in Elementary Education, *4*(01), 18–26. https://doi.org/10.56741/ijlree.v4i01.763

Fitriyani, Y., Rusdart, & Junaedi, I. W. R. (2023). High-Level Thinking Ability of Class v Students in Thematic Learning Through the Problem Based Learning Model Assisted by Android-Based Learning App. *International Journal of Research and Review*, *10*(7), 680–688. https://doi.org/10.52403/ijrr.20230781

Guldana A. Totikova, Aidarbek A. Yessaliyev, Nurlybai K. Madiyarov, & Nurgul Medetbekova. (2020). Effectiveness of Development of Spatial Thinking in Schoolchildren of Junior Classes by Application of Plane and Spatial Modeling of Geometric Figures in Didactic Games. *European Journal of Contemporary Education*, *9*(4). https://doi.org/10.13187/ejced.2020.4.902

Gusenbauer, M., & Haddaway, N. R. (2020). Which academic search systems are suitable for systematic reviews or meta-analyses? Evaluating retrieval qualities of Google Scholar, PubMed, and 26 other resources. *Research Synthesis Methods*, *11*(2), 181–217. https://doi.org/10.1002/jrsm.1378

Hanif, M. (2020). The Development and Effectiveness of Motion Graphic Animation Videos to Improve Primary School Students' Sciences Learning Outcomes. *International Journal of Instruction*, *13*(4), 247–266. https://doi.org/10.29333/iji.2020.13416a

Hasni, Supriatna, N., Sapriya, Winarti, M., & Jumadi. (2022). Enhancing Higher Order Thinking Skills through Utilization of Technology in Social Studies. *SHS Web of Conferences*, *149*, 01018. https://doi.org/10.1051/shsconf/202214901018

Hattie, J., & Timperley, H. (2007). The Power of Feedback. *Review of Educational Research*, *77*(1), 81–112. https://doi.org/10.3102/003465430298487

Hsu, C., & Wu, T. (2023). Application of Business Simulation Games in Flipped Classrooms to Facilitate Student Engagement and Higher-Order Thinking Skills for Sustainable Learning Practices. *Sustainability*, *15*(24), 16867. https://doi.org/10.3390/su152416867

Hussein, S., Khoiruzzadittaqwa, M., Luthfiyah, L., & Alhaq, M. M. (2024). The Effectiveness of Project-Based Learning and Problem-Based Learning in Improving Student Achievement and Involvement in Learning Mathematics. *International Journal of Mathematics and Mathematics Education*, 89–99. https://doi.org/10.56855/ijmme.v2i2.931

Iasha, V., Rachmadtullah, R., Sudrajat, A., & Hartanti, D. (2019). *The Impact Interactive Learning Media on the Learning Outcomes of Fifth Grade Social Science Knowledge in Elementary Schools*. https://doi.org/10.4108/eai.21-11-2018.2282120

Islekler, B., Ekiz-Kiran, B., & Senocak, E. (2024). The Effectiveness of the Interactive Book Reading on Primary School Students' Images of Scientists. *Science & Education*. https://doi.org/10.1007/s11191-024-00606-z

Jiang, S., Zhu, H., Li, H., & Li, R. (2024). Modelling education equality through online platform adoption: Insights into the digital divide, fairness, perceived ease of use, and usefulness. *Forum for Education Studies*, *3*(1), 1569. https://doi.org/10.59400/fes1569

Kaushal, A., Kassianos, A. P., Sheringham, J., Waller, J., & Wagner, C. v. (2020). Use of Social Media for Cancer Prevention and Early Diagnosis: Scoping Review Protocol. *BMJ Open*, *10*(2), e033592. https://doi.org/10.1136/bmjopen-2019-033592

Khurram, S., Palpanadan, S. T., & Chachar, Z. A. (2024). Analyzing the Contribution of WhatsApp in Enhancing English Writing Skills Among Undergraduate English as a

Foreign Language (EFL) Learners: A Systematic Review. *Forum for Linguistic Studies*, *6*(2). https://doi.org/10.59400/fls.v6i2.1174

Lidiawati, B., Nurwahidin, M., & Widodo, S. (2022). Geography Science Strategy to Increase Students' Interest in Learning With the Help of Digital-Based Learning Media. *Educenter Jurnal Ilmiah Pendidikan*, *1*(10), 683–690. https://doi.org/10.55904/educenter.v1i10.426

Maharani, O., Rokhman, F., Wagiran, W., & Hartono, H. (2024). Transformation of Art Education in Elementary Schools in the Digital Era: A Literature Review on Approaches, Media, and Innovative Technologies. *Ijss*, *1*(4), 1–14. https://doi.org/10.61796/ijss.v1i4.25

Manggopa, H. K., & Kumampung, D. R. H. (2023). Effective Strategies Using Digital Literacy for Empowering Critical Thinking in Higher Education. *Ijite*, *2*(3), 153–167. https://doi.org/10.62711/ijite.v2i3.135

Mardiana, T., & Sardin, S. (2023). *A Systematic Literature Review on Video Media: Application to Mathematics Learning*. 1336–1349. https://doi.org/10.2991/978-2-38476-118-0_152

Marini, A., Nafisah, S., Sekaringtyas, T., Safitri, D., Lestari, I., Suntari, Y., Umasih, Sudrajat, A., & Iskandar, R. (2022). Mobile Augmented Reality Learning Media with Metaverse to Improve Student Learning Outcomes in Science Class. *International Journal of Interactive Mobile Technologies (iJIM)*, *16*(07), 99–115. https://doi.org/10.3991/ijim.v16i07.25727

Moher, D., Liberati, A., Tetzlaff, J., Altman, D. G., & The PRISMA Group. (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. *PLoS Medicine*, *6*(7), e1000097. https://doi.org/10.1371/journal.pmed.1000097

Mukti, F. D. (2023). Transformation Of Education In Elementary Schools: Utilization Of Artificial Intelligence-Based Learning Media In The Digital Era. *DIRASATUL IBTIDAIYAH*, *3*(2), 229–240. https://doi.org/10.24952/ibtidaiyah.v3i2.10200

Muslimin, M., & Indrawati, R. (2024). Digitalization and Education Equity in Remote Areas: Challenges and Strategic Solutions. *Journal of Education, Humaniora and Social Sciences (JEHSS)*, *7*(2), 376–383. https://doi.org/10.34007/jehss.v7i2.2356

Nuradhisti, S. A., & Prasetyanigtyas, F. D. (2025). Development of Mystery Box Learning Media to Improve Elementary School Students' Learning Outcomes. *Jurnal Penelitian Pendidikan IPA*, *11*(3), 907–916. https://doi.org/10.29303/jppipa.v11i3.10801

Nurmawati, Masduki, L. R., Prayitno, E., & Dartani, M. Y. R. (2020). The Use of Interactive Multimedia in Improving Mathematics Learning Outcomes: The Case of the 4th Grade Students of SDN Manyaran 01 Semarang in the Academic Year of 2019/2020. *Proceedings of the 2nd International Conference on Education and Social Science Research (ICESRE 2019)*. 2nd International Conference on Education and Social Science Research (ICESRE 2019), Kota Semarang, Central Java, Indonesia. https://doi.org/10.2991/assehr.k.200318.044

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., … Moher, D. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *BMJ*, n71. https://doi.org/10.1136/bmj.n71

Pīgozne, T., Medveckis, A., & Pelnēna, I. (2024). Students' Digital Learning Resources for Transversal Skills Improvement and Virtues Inculcation. *Pegegog*, *14*(2). https://doi.org/10.47750/pegegog.14.02.02

Praja, I. R., & Andriani, A. E. (2025). Problem-based learning interactive multimedia to optimize elementary school natural and social sciences learning. *Indonesian Journal of Science and Mathematics Education*, *8*(1), 136. https://doi.org/10.24042/ijsme.v8i1.26067

Pramukawati, A., Nur Akhidah, A., & Wahyuni, E. (2024). Education Transformation In Elementary School: Utilization Of Artificial Intelligence-Based Learning Media In The Digital Era. *International Conference on Aplied Social Sciences in Education*, *1*(1), 255–262. https://doi.org/10.31316/icasse.v1i1.6915

Safitri, D., Lestari, I., Maksum, A., Ibrahim, N., Marini, A., Zahari, M., & Iskandar, R. (2021). Web-Based Animation Video for Student Environmental Education at Elementary Schools. *International Journal of Interactive Mobile Technologies (iJIM)*, *15*(11), 66. https://doi.org/10.3991/ijim.v15i11.22023

Sekarningrum, M., Ellianawati, E., Subali, B., Linuwih, S., & Nugultham, K. (2025). Development of Digital Student Worksheet Based on Process Differentiation with STEM-PjBL Approach on Light Wave Material. *JIPF (Jurnal Ilmu Pendidikan Fisika)*, *10*(1), 1. https://doi.org/10.26737/jipf.v10i1.5609

Sherly Marlita Ariyani & Nurdyansyah. (2024). The Effectiveness of Technology-Based Interactive Learning Media to Improve Students' Cognitive Skill at Islamic Elementary School. *JIP Jurnal Ilmiah PGMI*, *10*(1), 1–15. https://doi.org/10.19109/jip.v10i1.22575

Simões, A. V., Moreira, G., & Oswald, T. (2023). *Empowering Efl Learners for the Global Stage: A Collaborative Approach to Cultivating 21st-Century Skills and Intercultural Competence in Higher Education*. https://doi.org/10.21125/iceri.2023.2516

Sujarwo, Herawati, S. N., Sekaringtyas, T., Safitri, D., Lestari, I., Suntari, Y., Umasih, Marini, A., Iskandar, R., & Sudrajat, A. (2022). Android-Based Interactive Media to Raise Student Learning Outcomes in Social Science. *International Journal of Interactive Mobile Technologies (iJIM)*, *16*(07), 4–21. https://doi.org/10.3991/ijim.v16i07.25739

Suranto, T., Sumarni, W., Widiarti, N., & Subali, B. (2024). Pengembangan E-Modul Berbasis Gamifikasi Terhadap Minat Dan Hasil Belajar Siswa Sekolah Dasar. *Pendas: Jurnal Ilmiah Pendidikan Dasar*, *9*(04), 234–249.

Sweet, K. S., LeBlanc, J. K., Stough, L. M., & Sweany, N. W. (2019). Community Building and Knowledge Sharing by Individuals With Disabilities Using Social Media. *Journal of Computer Assisted Learning*, *36*(1), 1–11. https://doi.org/10.1111/jcal.12377

Syawaluddin, A., Afriani Rachman, S., & Khaerunnisa. (2020). Developing Snake Ladder Game Learning Media to Increase Students' Interest and Learning Outcomes on Social Studies in Elementary School. *Simulation & Gaming*, *51*(4), 432–442. https://doi.org/10.1177/1046878120921902

Ulfah, W. A., Subagyo, S., Santoso, N., Putranto, D., & Ramadan, G. (2025). Application of video animation to increase students' interest and physical skills in primary school physical education. *Retos*, *66*, 766–772. https://doi.org/10.47197/retos.v66.113610

Vargas-Murillo, A. R., Pari-Bedoya, I. N. M. D. L. A., & Ypanaque-Pereira, I. L. (2023). Analyzing the impact of Moodle as an Interactive Tool to Improve Students' Engagement and Motivation in the Learning Process: A Systematic Literature

Review. *2023 9th International Conference on E-Society, e-Learning and e-Technologies*, 46–53. https://doi.org/10.1145/3613944.3613952

Vebrianto Susilo, S., Ferga Prasetyo, T., Abidin, Y., & Mulyati, T. (2020). Mobile learning android based teaching materials: Efforts to provide Indonesian learning based on technology in elementary school. *Journal of Physics: Conference Series*, *1477*(4), 042034. https://doi.org/10.1088/1742-6596/1477/4/042034

Vera-Mera, M. G., Pinda-Román, N. J., Loayza-Solórzano, M. S., Ordoñez-Calva, A. F., & Olmedo-Zambrano, V. X. (2023). Use of Information and Communication Technologies to Promote the Learning Process of Students With Intellectual Disabilities. *International Research Journal of Management It and Social Sciences*, *10*(5), 328–335. https://doi.org/10.21744/irjmis.v10n5.2370

Vitalievna, S. E., Yuryevna, N. S., Nikolaevna, S. T., & Vasilievna, M. T. (2025). Development of a model to form reading literacy of primary schoolchildren involving media design technology in a booktrailing format. *Perspectives of Science and Education*, *72*(6), 691–707. https://doi.org/10.32744/pse.2024.6.43

Wahyuni, D. S., & Ariadi, G. (2022). The Impact of Cognitive Skill, and Individual Innovativeness on Digital Formal Learning Mediated by Attitude to Use Interactive Worksheet Digital. *Jurnal Nasional Pendidikan Teknik Informatika (Janapati)*, *11*(3), 330–338. https://doi.org/10.23887/janapati.v11i3.51967

Widyadhari, B. (2024). The Influence of Technology-Based Learning Strategies on Student Performance/Motivation in Primary Schools. *IJoSE*, 265–270. https://doi.org/10.62966/ijose.vi.778

Winarni, E. W., Purwandari, E. P., & Raharjo, F. O. (2024). The effect of integrating STEAM and virtual reality using PjBL on scientific literacy in elementary schools. *Education and Information Technologies*, *29*(18), 24991–25011. https://doi.org/10.1007/s10639-024-12853-2

Wu, J., Jiang, H., Long, L., & Zhang, X. (2024). Effects of AR mathematical picture books on primary school students' geometric thinking, cognitive load and flow experience. *Education and Information Technologies*, *29*(18), 24627–24652. https://doi.org/10.1007/s10639-024-12768-y

Zainil, M., Kenedi, A. K., Rahmatina, Indrawati, T., & Handrianto, C. (2022). The Influence of a STEM-Based Digital Classroom Learning Model and High-Order Thinking Skills on the 21st-Century Skills of Elementary School Students in Indonesia. *Journal of Education and E-Learning Research*, *10*(1), 29–35. https://doi.org/10.20448/jeelr.v10i1.4336

Zimmermann, P. A., Stallings, L., Pierce, R. L., & Largent, D. (2018). Classroom Interaction Redefined: Multidisciplinary Perspectives on Moving beyond Traditional Classroom Spaces to Promote Student Engagement. *Journal of Learning Spaces*, *7*(1), 45–61.

Journal Template in English ok.doc

ORIGINALITY REPORT

18%	14%	10%	15%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Submitted to Transylvania University Student Paper	9%
2	Submitted to Academic Library Consortium Student Paper	3%
3	repository.iainlhokseumawe.ac.id Internet Source	1%
4	Submitted to Universitas Muhammadiyah Sidoarjo Student Paper	<1%
5	prosiding.nobel.ac.id Internet Source	<1%
6	Mohd Shahidan Shaari, Noorazeela Zainol Abidin, Temitayo B. Majekodunmi, Mohd Juraij Abd Rani et al. "Female empowerment and crime patterns in Malaysia: A non-linear analysis", Social Sciences & Humanities Open, 2024 Publication	<1%
7	Trey Martindale, Tonya B. Amankwatia, Lauren Cifuentes, Anthony A. Piña. "Handbook of Research in Online Learning", Walter de Gruyter GmbH, 2024 Publication	<1%
8	pmc.ncbi.nlm.nih.gov Internet Source	<1%
9	Submitted to University of Warwick Student Paper	<1%

10	Submitted to Universitas Pakuan Student Paper	<1 %
11	Clifford O. Odimegwu, Yemi Adewoyin. "The Routledge Handbook of African Demography", Routledge, 2022 Publication	<1 %
12	Submitted to Erasmus University of Rotterdam Student Paper	<1 %
13	dm.ageditor.ar Internet Source	<1 %
14	Al-Nabhani, Iman Nabhan Suleiman. "AI-Driven Integration of Omani Cultural Elements in Grade 9 Language Learning Materials: Design-Based Research", Sultan Qaboos University (Oman) Publication	<1 %
15	Submitted to Assumption College Student Paper	<1 %
16	olj.onlinelearningconsortium.org Internet Source	<1 %

Exclude quotes	On	Exclude matches	< 15 words
Exclude bibliography	On		