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Technology-Based Learning Innovations for Improving Student Learning Outcomes: A Literature Review

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Abstract: *The shift toward new media—characterized by interactivity, visual elements, and adaptability—is a consequence of digital technology advancements that have simultaneously challenged the dominance of conventional media. Technology-based learning media now integrate sophisticated features, offering a learning experience distinct from the past. This article aims to analyze the relationship between the use of such media and students' academic achievement. Furthermore, the study examines the impact on primary users and compares the media's effectiveness against traditional alternatives. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) approach was adopted as the framework for this literature-based study. The findings demonstrate the effectiveness of technology-based learning media in boosting student interest and enhancing academic performance. However, this impact is contingent upon teacher readiness, infrastructure availability, and the alignment of the media with subject matter characteristics and educational levels. Conventional media remain relevant in specific contexts. While the visual appeal and interactivity of technology-based media are often considered superior, certain situations necessitate the use of conventional media due to their ability to provide essential context for the learning process. This study concludes that conventional methods are not automatically superseded by technology-based media innovations; rather, technology is best positioned as a strategic support tool, the integration of which requires judicious application tailored to specific learning needs.*

Keywords: *[instructional media; educational technology; learning outcomes; educational innovation.]*

Abstrak: Pergeseran menuju media baru yang bersifat interaktif, visual, dan adaptif merupakan konsekuensi dari kemajuan teknologi digital, yang sekaligus menggeser dominasi media konvensional. Media pembelajaran berbasis teknologi kini terintegrasi dengan berbagai fitur canggih sehingga menawarkan pengalaman belajar yang berbeda dari sebelumnya. Artikel ini bertujuan menganalisis kaitan antara pemanfaatan media pembelajaran tersebut dan capaian akademik siswa. Selain itu, penelitian ini meninjau dampaknya bagi pengguna utama serta membandingkan keefektifannya dengan media tradisional. Pendekatan *Preferred Reporting Items for Systematic Reviews and Meta-Analyses* (PRISMA) dipilih sebagai kerangka kerja dalam penelitian ini melalui metode studi literatur. Efektivitas media pembelajaran berbasis teknologi dalam meningkatkan minat siswa dan meningkatkan prestasi akademik terbukti dari hasil kajian. Meskipun demikian, pengaruh tersebut ditentukan oleh kesiapan guru, ketersediaan infrastruktur, serta kesesuaian media dengan karakteristik materi pelajaran dan tingkat pendidikan. Media konvensional tetap relevan dalam kondisi tertentu. Daya tarik visual serta interaktivitas media berbasis teknologi memang sering dianggap lebih unggul. Meski demikian, terdapat situasi yang menuntut kehadiran media konvensional karena mampu menghadirkan konteks penting bagi proses pembelajaran. Kajian ini menyimpulkan bahwa metode konvensional tidak serta-merta tergantikan oleh inovasi media berbasis teknologi. Pemanfaatan teknologi lebih tepat diposisikan sebagai penunjang strategis yang pengintegrasiannya menuntut kebijaksanaan selaras dengan kebutuhan pembelajaran.

Kata kunci: *[media pembelajaran; teknologi Pendidikan; hasil belajar; inovasi pendidikan.]*

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Introduction

The continuous development of society has consistently shaped the dynamics of education. The integration of digital technology into classrooms represents one of the most tangible manifestations of this transformation. In the past, teaching and learning processes relied heavily on blackboards, chalk, and printed textbooks. However, this dependence has shifted significantly with the emergence of various interactive software applications, instructional videos, online quiz platforms, and the application of artificial intelligence (AI) to support learning activities. This transformation involves more than simply replacing conventional instructional tools; it represents a broader paradigm shift in how knowledge is delivered, acquired, processed, and interpreted by students.

The implementation of learning media based on information and communication technology (ICT) has become increasingly widespread, particularly since the introduction of the *Merdeka Curriculum*, which encourages teachers to adopt greater flexibility and innovation in designing learning experiences (Nirmala et al., 2023). Various forms of educational innovation have emerged, ranging from the use of animation to enhance students' learning motivation (Melati et al., 2023), the development of digital teaching materials for specific subjects (Nurhafsah et al., 2024), to the exploration of artificial intelligence technologies to support students' understanding of scientific concepts (Hasibuan & Yani, 2025). Technology-based media now occupy a central position in instructional strategies rather than merely serving as supplementary learning tools. Educational institutions at various levels, from primary schools to higher education, have increasingly integrated these technologies into teaching and learning processes.

Nevertheless, excessive optimism regarding educational technology should be approached critically. Previous studies have demonstrated that learning outcomes do not automatically improve simply because digital media are incorporated into instruction. Appropriate instructional design remains a fundamental requirement, particularly when considering students' needs, characteristics, and learning contexts. Therefore, the relationship between technology-based learning media and student learning outcomes requires more critical examination. Such an examination should not merely assess the sophistication or novelty of the technologies employed but should also consider how these technologies are designed and implemented and how students respond to their use in learning environments.

The position of conventional learning media within the rapid development of digital innovation has also become an important issue of debate. Some educators regard direct interaction between teachers and students as a distinctive strength of conventional instructional methods. In contrast, others argue that technology-based media can provide more engaging, interactive, and adaptive learning experiences (Mubaidilla, 2025). These differing perspectives provide a strong rationale for conducting a systematic review of the existing literature. Such a review can synthesize recent empirical evidence concerning the comparative effectiveness of technology-based and conventional learning media. Consequently, educators seeking to determine appropriate instructional strategies for particular learning contexts can obtain a more comprehensive and balanced understanding of the advantages and limitations of both approaches.

Based on these considerations, this article was designed to collect, examine, and synthesize

recent research findings concerning innovations in technology-based learning media. The review focuses on three principal aspects: the relationship between technology-based learning media and student learning outcomes, the effects of these innovations on students as the primary users, and the effectiveness of technology-based learning media compared with conventional learning media. Through a systematic literature review, this study is expected to provide a more comprehensive and balanced understanding of the role of technology in contemporary education.

Research Questions

Based on the background described above, this study addresses three main research questions:

1. What is the relationship between the use of technology-based learning media and student learning outcomes according to recent research findings?
2. How do technology-based learning innovations affect students as the central participants in the learning process?
3. To what extent are technology-based learning media effective compared with conventional learning media?

Research Objectives

In accordance with the research questions, this study has three main objectives:

1. To analyze the relationship between the use of technology-based learning media and student learning outcomes.
2. To identify the effects of technology-based learning innovations on students, particularly in terms of learning motivation, engagement, and potential challenges.
3. To compare the effectiveness of technology-based learning media with conventional learning media based on empirical evidence reported in published studies.

Significance of the Study

Theoretically, this study is expected to enrich the literature in the field of educational technology, particularly by mapping recent research trends concerning innovations in technology-based learning media. By synthesizing findings from previous studies, this review provides a broader perspective on the relationship between technological innovation and student learning outcomes.

Practically, the findings are expected to provide a useful reference for teachers in selecting and designing learning media that are appropriate to students' characteristics, learning needs, and subject matter. The findings may also support schools in developing policies related to the provision and integration of educational technology infrastructure. Furthermore, future researchers may use the results of this review as a foundation for designing more comprehensive empirical studies on the effectiveness, implementation, and long-term impact of technology-based learning media.

Method

This study employed a systematic literature review guided by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework. PRISMA was adopted to ensure transparency and systematic procedures throughout the identification, screening, eligibility assessment, and final inclusion of the studies analyzed. The framework was selected because it helps minimize potential researcher subjectivity during the selection of scholarly publications while making the literature selection process traceable and reproducible by other researchers.

Literature Search Strategy

The literature search was conducted using three major academic databases: Google Scholar, Garba Rujukan Digital (Garuda), and the Directory of Open Access Journals (DOAJ). Several combinations of Indonesian and English search terms were used, including *"media pembelajaran berbasis teknologi," "hasil belajar siswa," "inovasi pembelajaran digital," "technology-based learning media,"* and *"student learning outcomes."* The search was restricted to studies published between 2022 and 2026 to

ensure that the evidence represented recent developments and remained relevant to contemporary educational contexts.

Inclusion and Exclusion Criteria

Studies were included in the review when they met three principal criteria. First, the study had to be published as a peer-reviewed scientific journal article. Second, the article had to have been published between 2022 and 2026. Third, the study had to explicitly examine technology-based learning media and their relationship with student learning outcomes, learning motivation, or student engagement.

Articles that did not meet these requirements were excluded from the review. Accordingly, publications outside the specified period, studies that did not directly address technology-based learning media, and articles whose focus was unrelated to learning outcomes, motivation, or student engagement were not included in the final analysis.

Study Selection Process

The study selection process followed four major stages of the PRISMA framework: identification, screening, eligibility, and inclusion. During the identification stage, potentially relevant records were retrieved from Google Scholar, Garuda, and DOAJ using the predetermined search terms. A total of 140 records were initially identified.

During the screening stage, duplicate records were removed, and the titles and abstracts of the remaining publications were examined for relevance to the objectives of the review. This process reduced the number of potentially relevant articles to 55. Subsequently, full-text assessment was conducted during the eligibility stage. The articles were evaluated against the predefined inclusion and exclusion criteria, resulting in 24 articles considered eligible for further assessment. Following the final evaluation, 12 articles were included in the systematic review and subjected to in-depth analysis.

Table 1. Article Selection Process Based on the PRISMA Approach

PRISMA Stage	Description of the Selection Process	Number of Articles
Identification	Initial articles were identified through keyword searches in Google Scholar, Garuda, and DOAJ.	140
Screening	Articles were screened based on the relevance of their titles and abstracts, while duplicate records were removed.	55
Eligibility	Full-text articles were assessed according to the predefined inclusion and exclusion criteria.	24
Included	Articles that fulfilled all criteria were retained for in-depth review and analysis.	12

As summarized in Table 1, the systematic selection process reduced the initial pool of 140 records to 12 studies that met the criteria for final analysis. This staged procedure was intended to ensure that the synthesis was based on studies directly relevant to the objectives of the review.

Data Analysis

The 12 selected articles served as the primary data sources and were analyzed using a thematic analysis approach. Each article was examined with particular attention to three components: the principal findings, the research

methodology employed, and the implications of the findings for student learning outcomes.

The extracted findings were subsequently organized into three major analytical themes. The first theme addressed the relationship between technology-based learning media and student learning outcomes. The second focused on the effects of technology-based learning innovations on students, particularly in relation to motivation, engagement, and learning experiences. The third examined the comparative effectiveness of technology-based and conventional learning media.

These themes were developed in accordance with the research questions and objectives of the review. The thematic organization enabled findings from studies employing different methodologies and educational contexts to be systematically compared and synthesized. Through this process, the review sought to generate a structured and comprehensive interpretation of current evidence concerning the role of technology-based learning innovations in improving student learning outcomes.

Results and Discussion

The articles that met the inclusion criteria predominantly focused on the primary school level, although the subject areas investigated were diverse, including mathematics, science, social studies, and civic education. Methodologically, the selected studies employed a range of approaches, including quantitative research with quasi-experimental designs, research and development (R&D), and systematic literature reviews. This methodological diversity provides a broad perspective on the implementation and evaluation of technology-based learning media across different educational settings. A summary of the studies analyzed is presented in Table 2. Markdown yang ditempel (1)

Table 2. Summary of Studies Analyzed in the Literature Review

Author(s) (Year)	Focus of the Study	Main Findings
Novianti et al. (2022)	"Takbar" learning media to enhance motivation in elementary mathematics	Student learning motivation increas significantly
Melati et al. (2023)	Use of animation as technology-based learning media	Animation increased students' motivation and interest in learning
Nirmala et al. (2023)	Implementation of ICT-based learning media in the *Merdeka Curriculum*	ICT-based media were relevant to the requirements of the new curriculum
Aulia et al. (2026)	Effects of learning media on mathematics learning outcomes	A significant positive effect on learning outcomes was identified
Nurhafsah et al. (2024)	Development of digital teaching materials for social studies	Digital teaching materials were feasible and effective for learning
Sunaryati (2024)	Comparison of conventional and technology-based learning in science	Interactive media provided advantages but required adaptation to students' needs
Tiara Genisa et al. (2025)	Use of digital technology to promote interest in civic education	Digital technology increased students' learning interest
Mifta Huljanah & Erwin Krisman Zai (2025)	Effectiveness of digital media in increasing elementary students' learning interest	Digital media were effective in enhancing learning interest
Hasibuan & Yani (2025)	Use of AI technology in science learning	AI contributed to improved learning outcomes
Setiawati et al. (2026)	Comparison between conventional and deep-learning-based media	Technology-based media demonstrated significant differences in learning outcomes
Sd (2026)	Systematic literature review of the effectiveness of technology-based media	Technology-based media contributed to achievement and learning motivation

The reviewed studies consistently indicate positive contributions of technology-based media to achievement, motivation, engagement, and learning interest, although the effectiveness of these media varies according to instructional design and educational context. Markdown yang ditempel (1)

Relationship Between Technology-Based Learning Media and Student Learning Outcomes

The findings across the reviewed studies consistently indicate that student learning outcomes tend to improve when technology-based learning media are appropriately integrated into instruction. Novianti et al. (2022), for example, developed a mathematics learning medium called "Takbar" for elementary school students. Their findings demonstrated that the use of this medium significantly increased students' learning motivation. This improvement in motivation was also associated with better understanding of mathematical concepts. Similarly, Nirmala et al. (2023) reported a positive relationship between the utilization of technology-based learning media and students' mathematics learning outcomes. Markdown yang ditempel (1)

This positive relationship is not limited to mathematics education. Nurhafsah et al. (2024) developed digital teaching materials for social studies and found that the materials were feasible and effective in strengthening students' understanding of relatively abstract social concepts. Similar findings were reported by Melati et al. (2023), who demonstrated that animation-based learning media facilitated the presentation of complex instructional content. Animated visualization enabled difficult concepts to be presented in more accessible forms, stimulated students' curiosity, and contributed to improved academic achievement. Markdown yang ditempel (1)

Nevertheless, the relationship between technology-based media and learning outcomes should not be interpreted as automatic or strictly linear. The effectiveness of ICT-based media depends considerably on the extent to which the technology is aligned with curricular requirements and instructional objectives. Nirmala et al. (2023) emphasized that the *Merdeka Curriculum* requires flexibility and differentiated learning, making the alignment of instructional media with diverse learner needs particularly important. Consequently, technology should not be incorporated merely as an attractive addition to classroom instruction; rather, its design and application should be pedagogically connected to the intended learning objectives.

This interpretation is reinforced by Hasibuan and Yani (2025), who reported that artificial intelligence could contribute to improved science learning outcomes when it was positioned as a tool for supporting personalized learning. However, the integration of AI does not eliminate the importance of teachers. Teachers continue to play a central role in determining how technological tools are selected, contextualized, and integrated into meaningful learning activities. Markdown yang ditempel (1)

Overall, the reviewed evidence suggests that educational technology has considerable potential to improve students' academic achievement. However, this potential is conditional rather than inherent. Carefully planned pedagogical design, compatibility between the technology and the characteristics of the subject matter, alignment with learning objectives, and teachers' competence in managing technology in the classroom remain essential determinants of successful implementation. Markdown yang ditempel (1)

Effects of Technology-Based Learning Innovations on Students

In addition to their influence on academic achievement, technology-based learning innovations produce important changes in students' learning experiences. One of the most frequently reported outcomes is increased learning motivation and interest.

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Tiara Genisa et al. (2025) found that the use of digital technology in civic education significantly stimulated students' interest in learning. Digital media can provide greater variation in learning activities than conventional lecture-based instruction, thereby creating more engaging learning experiences.

Similarly, Mifta Huljanah and Erwin Krisman Zai (2025) reported that digital learning media were effective in increasing elementary school students' interest in learning. Their interactive characteristics and capacity to respond to children's curiosity were identified as important factors contributing to this effectiveness. These findings suggest that the benefits of educational technology extend beyond academic achievement and encompass affective dimensions of learning. Markdown yang ditempel (1)

Another important effect is increased active student participation. Interactive quizzes, simulations, educational games, and other forms of interactive digital media create opportunities for students to participate directly in learning activities rather than merely receiving information from teachers. Such learning environments can enhance both cognitive and emotional engagement.

Technology-based learning also contributes to the development of digital literacy. As students interact with various digital devices, applications, and platforms, they develop experience in accessing, processing, and interacting with digitally presented information. Hasibuan and Yani (2025) indicate that students' familiarity with digital learning tools can support the development of technological competence from an early stage of education. Markdown yang ditempel (1)

However, the effects of technological innovation are not universally positive. Sunaryati (2024) noted that some technology-based learning materials may insufficiently accommodate individual students' needs and learning preferences. This limitation can reduce their effectiveness for learners whose characteristics are not adequately addressed by the design of the media.

Furthermore, unequal access to technology may generate disparities in educational benefits. Students who are already familiar with digital devices may gain greater advantages, whereas students with limited technological experience or those living in areas with inadequate digital infrastructure may receive fewer benefits. Thus, technology-based innovation should be accompanied by adequate teacher guidance and equitable access to infrastructure. This is essential not only to prevent new educational inequalities but also to ensure that technological innovation expands rather than restricts opportunities for learning. Markdown yang ditempel (1)

Comparison Between Technology-Based and Conventional Learning Media

The third major theme concerns the effectiveness of technology-based learning media compared with conventional instructional media. Setiawati et al. (2026) conducted a quasi-experimental study comparing learning outcomes among young children taught using conventional media and AI-based learning media. The average learning outcomes of the technology-based group were statistically higher than those of the conventional-media group. These findings highlight the potential advantage of technology-based media in presenting instructional content adaptively according to individual learners' capabilities. Markdown yang ditempel (1)

Despite these advantages, conventional learning media continue to have educational value. Sunaryati (2024) found that interactive learning resources, including instructional videos and applications, could significantly enhance students' motivation and academic performance in science. However, the effectiveness of these resources depended on careful instructional design. Importantly, this requirement applies not only to technology-

based media but also to conventional instructional materials.

Therefore, instructional effectiveness cannot be determined solely by whether a medium is digital or conventional. Instead, effectiveness depends largely on how the medium is pedagogically designed, implemented, and aligned with learning objectives. Both conventional and technology-based media require appropriate instructional planning and implementation to support meaningful learning. Markdown yang ditempel (1)

The systematic review cited as Sd (2026) further suggests that technology-based learning media generally contribute positively to students' academic achievement and motivation. Nevertheless, these findings should not be interpreted as justification for completely replacing conventional learning media. In educational contexts where electricity, internet connectivity, devices, or other technological infrastructure are limited, conventional media may remain more practical, accessible, and reliable. Markdown yang ditempel (1)

The synthesis therefore indicates that technology-based media generally offer advantages in terms of visual appeal, interactivity, flexibility, and adaptability to individual learning needs. Conventional media, however, maintain distinctive strengths, including simplicity, accessibility without digital infrastructure, and opportunities for direct face-to-face interaction between teachers and students. Rather than treating the two approaches as mutually exclusive, a more appropriate pedagogical strategy is to integrate them proportionally according to the learning context, student characteristics, instructional objectives, and available resources. Markdown yang ditempel (1)

Critical Analysis and Limitations of the Review

A critical examination of the reviewed literature reveals several important limitations. First, most of the studies included in this review focused on primary education. Many also employed relatively small-scale quasi-experimental designs involving only one or two classes within a single school. Consequently, the findings may not be readily generalized to broader educational populations, particularly secondary schools and higher education institutions, where learner characteristics and the complexity of instructional content may differ substantially.

Second, many of the studies were conducted over relatively short periods or adopted cross-sectional designs. As a result, the existing evidence provides limited insight into the long-term effects of technology-based learning media on academic achievement, learning independence, and sustained student engagement. Markdown yang ditempel (1)

Third, relatively few of the reviewed studies explicitly investigated the potential negative consequences or risks associated with technology-based learning. Such risks may include distraction caused by digital devices, excessive dependence on technology, unequal access to technological resources, and possible changes in classroom social interaction. Since most of the reviewed articles emphasized the positive effects of educational technology, the available evidence may reflect a degree of technological optimism.

Future research should therefore adopt a more balanced approach by examining both the benefits and potential risks of technology-based learning. Studies involving larger and more diverse samples, longer observation periods, different educational levels, and explicit evaluation of digital inequalities would provide stronger evidence concerning the sustainability and broader applicability of technology-based educational innovation. Research should also investigate practical mitigation strategies that teachers and schools can employ to minimize technological risks while preserving the educational benefits of

digital learning environments. Markdown yang ditempel (1)

Conclusion

The review of twelve articles published between 2022 and 2026 yielded several important findings. A relatively consistent positive relationship was identified between the use of technology-based learning media and improvements in student learning outcomes. However, this relationship is not determined by technology alone. The quality of instructional media design, alignment with the curriculum, and teachers' competence in integrating technology into the learning process substantially influence its effectiveness. Technology-based learning innovations also produce various effects on students, including increased learning motivation, active participation, and digital literacy. Nevertheless, unequal access to technology and inadequate instructional support may create disparities in the benefits received by students. Compared with conventional learning media, technology-based media tend to provide greater interactivity and visual appeal. However, conventional media remain relevant and necessary in particular educational contexts. Therefore, technology-based and conventional learning media should be regarded as complementary rather than mutually exclusive approaches.

Technology-based learning innovations have considerable potential to support improvements in student learning outcomes when they are implemented appropriately and proportionally. The sophistication of the technology itself should not be considered the primary determinant of educational success. Instead, effectiveness depends largely on the extent to which learning media are designed according to students' needs, instructional objectives, characteristics of the subject matter, and the social and infrastructural conditions of the learning environment. Accordingly, meaningful technology integration requires pedagogical considerations to remain central to instructional decision-making.

Recommendations

The use of technology in education should not focus merely on adopting the most advanced or sophisticated digital tools. Priority should instead be given to selecting learning media that are appropriate to the characteristics of the subject matter, instructional objectives, and students' learning needs. Meaningful direct interaction between teachers and students should also be maintained to balance learning experiences that increasingly rely on digital technologies.

Improving teachers' digital literacy and technological pedagogical competence should become an important priority for schools and educational policymakers. Equitable access to technological infrastructure should also be strengthened to ensure that the benefits of technology-based learning innovations are available to all students, including those studying in areas with limited digital infrastructure.

Future studies should employ more diverse research designs, larger samples, and broader educational levels to strengthen the generalizability of findings. Longitudinal research is also recommended to investigate the sustained effects of technology-based learning on academic achievement, motivation, digital literacy, and learning independence. In addition, future research should provide a more balanced examination of both the benefits and potential challenges of technology-based learning, including digital distraction, technological dependence, unequal access, and changes in classroom social interaction. Such research would contribute to a more comprehensive and objective understanding of the role of technology in contemporary education.

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