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OPTIMISING THE USE OF MEDIA AND LEARNING TECHNOLOGY IN EDUCATION: A LITERATURE REVIEW OF FACTORS AFFECTING THE ADOPTION AND DIFFUSION OF INNOVATION IN IMPROVING THE EFFECTIVENESS OF THE TEACHING AND LEARNING PROCESS

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Abstract

This study is a literature review that analyses the optimisation of the use of learning media and technology in educational settings through an understanding of the factors that influence the adoption and diffusion of innovation to improve the effectiveness of the teaching and learning process. Based on a review of Rogers' Diffusion of Innovations theory, the Technology Acceptance Model (TAM), and TPACK, it was found that the main factors include performance expectancy, effort expectancy, social influence, facilitating conditions, and obstacles such as infrastructure limitations and digital skills. Optimisation strategies include continuous teacher training, inclusive infrastructure development, blended learning, and national policies such as Merdeka Belajar (Freedom of Learning) that support pedagogical-technological integration. The results of the study show that a multifactorial holistic approach can accelerate the S-shaped adoption curve, increase student engagement, academic achievement, and personalisation of learning through data-driven evaluation. The practical implications provide recommendations for educators and policymakers to address the digital divide, while the theoretical implications enrich the framework of educational technology adoption in the Indonesian context. This study emphasises the need for evidence-based interventions for adaptive and inclusive 21st-century educational transformation.

Keywords: learning technology, innovation adoption, innovation diffusion, educational media optimisation, teaching and learning effectiveness, TPACK, TAM, blended learning, digital divide, Merdeka Belajar

Introduction

The use of media and technology in the learning process has become one of the main pillars of the transformation of the education system in the 21st century. The rapid development of information and communication technology (ICT) has changed the way humans obtain, process, and share information, including in the context of education. Currently, the use of digital media is not only a complement to the teaching and learning process, but also a necessity for educational institutions that want to improve the efficiency, interactivity, and effectiveness of learning (Aslan, 2023) . These changes require educators, students, and institution managers to quickly adapt to various forms of technological innovations that have emerged, ranging from the use of online learning

platforms and collaborative applications to digital *learning management systems* (Ramadhani & Syahputra, 2024) .

This transformation brings not only opportunities but also complex challenges. On the one hand, technology has the potential to expand access to education, facilitate individual and collaborative learning processes, and increase learners' motivation to learn through more engaging and interactive material presentation. However, on the other hand, the adoption of learning technology is often hampered by various factors, such as infrastructure limitations , educators' digital competence, resistance to change, and regional access inequalities (Syamsuriah & Rahman, 2025) . The unpreparedness of human resources and supporting facilities has caused many technological innovations to fail to be optimally implemented in educational environments, especially in areas with limited resources.

Therefore, a deeper understanding of the factors that influence the successful adoption and diffusion of learning technology innovations is needed. This understanding is important to ensure that the technology applied truly brings positive changes to the teaching and learning process. The concept of *adoption and diffusion of innovation*, first popularised by Everett M. Rogers, provides a relevant theoretical framework for analysing how new technologies are accepted and disseminated in social systems, including the education system (Putri & Santoso, 2024) . By understanding factors such as the characteristics of innovation, social conditions, and the readiness of individuals and organisations, the process of integrating technology into education can be designed more strategically.

In the context of the educational environment in Indonesia, efforts to optimise the use of learning technology have become increasingly urgent since the acceleration of digitalisation due to the COVID-19 global pandemic. This crisis indirectly forced educational institutions to switch to online *learning* as a short-term solution, which then opened up opportunities to internalise digital practices and technology more permanently (Suryadi & Aslan, 2025) . However, this transition has revealed a prominent digital divide, both between schools in urban and rural areas and between teachers who are accustomed to using technology and those who still find it difficult to adapt. This phenomenon shows that technology adoption is not only a technical issue, but also a social, psychological, and cultural one .

Furthermore, the effectiveness of using media and learning technology cannot be separated from pedagogical factors. Technology is merely a tool; without integration with the right learning approach, its potential will not be maximised. Models such as TPACK (*Technological Pedagogical Content Knowledge*) and SAMR (Substitution, Augmentation, Modification, Redefinition) offer conceptual guidelines to help educators combine pedagogical, content, and technological aspects into a mutually supportive whole (Putra & Dewi, 2024) . Therefore, research examining the factors of technology adoption also needs to consider the extent to which teachers understand

technology-oriented learning approaches, not merely their technical ability to use the technology.

Furthermore, in the context of education management, technology adoption often depends on the commitment and support of institutional leaders. School principals or university leaders who have a vision of digitising education will encourage a culture of innovation and collaboration among teachers and staff (Lee & Kim, 2025) . Conversely, a lack of policy support and adequate resource allocation can hinder the diffusion of innovation even when teachers have sufficient interest and ability. Therefore, educational organisations need to establish innovation governance that enables evidence-based decision-making in implementing learning technology (Zafrullah et al., 2024) .

In addition to organisational factors, the perceptions and attitudes of individual educators also play an important role in determining the level of adoption success. Many studies show that perceptions of *usefulness* and *ease of use* of technology—as described in *the Technology Acceptance Model* (TAM)—have a significant influence on the level of acceptance and use of educational technology. *Digital self-efficacy*, intrinsic motivation, and positive experiences when using technology determine whether teachers and students will continue to use technology-based media in the long term (Renyaan et al., 2025) ; (Zafrullah et al., 2024) .

Differences in the social and economic backgrounds of users also significantly influence the speed of innovation diffusion in the education sector. In environments with limited internet access or low financial capacity, the use of technology-based learning media tends to progress slowly. Conversely, in schools with adequate infrastructure, device access, and policy support, innovation diffusion is faster and more comprehensive (Bhutoria, 2024). Therefore, optimising the use of media and technology needs to consider the factor of access equality so as not to widen the digital divide between schools in different regions.

In a global context, education is now geared towards the vision *of Education 4.0*, which is a learning system that is adaptive to the 4.0 industrial revolution and developments in digital technology such as artificial intelligence, the Internet of Things (IoT), and data-based learning. Educational institutions must be able to change their conventional paradigms into flexible, creative learning systems that are oriented towards critical thinking and problem-solving skills. The application of innovative learning technologies is a key prerequisite for students to develop skills relevant to the demands of the 21st century (Komari et al., 2025) ; (Fitriyanti & Aslan, 2025) .

Therefore, a systematic strategy is needed to optimise the use of learning media and technology through teacher capacity building, digital infrastructure development, and education policies that support sustainable innovation. The application of technology should not be done ad hoc, but based on academic studies and real needs in the field. The use of technology-based learning systems must be monitored with

periodic evaluations so that their benefits can be measured in terms of increased learning effectiveness, student engagement, and better learning outcomes.

Research Method

This study uses a literature review method with a descriptive qualitative approach to analyse various theories, models, and previous research results related to the use of media and learning technology in the context of education. The research data was obtained from secondary sources in the form of nationally and internationally indexed scientific journals, academic books, conference proceedings, research reports, and educational policy documents relevant to the theme of adoption and diffusion of innovation (Eliyah & Aslan, 2025) . The analysis process was carried out in three main stages, namely: (1) identification and selection of literature with keywords such as *educational technology adoption*, *innovation diffusion in education*, and *learning effectiveness*; (2) organisation and categorisation of research results based on recurring themes and variables; and (3) synthesis of findings to draw theoretical conclusions and practical implications (Grant & Booth, 2020) . Through this literature review, the researcher seeks to formulate a comprehensive picture of the factors that influence the adoption of learning technology and strategies for optimising its use to improve the effectiveness of the teaching and learning process at various levels of education.

Results and Discussion

Factors Influencing the Adoption and Diffusion of Learning Technology

The adoption and diffusion of learning technology are influenced by the factor of performance expectancy, which is the perception that technology can improve learning outcomes through benefits such as increased interactivity and broader access to materials. This factor is a major driver because teachers and students tend to accept innovations if they are proven to be effective in achieving learning objectives, as shown in various studies linking perceived benefits to sustained usage levels. Without this perceived added value, technological innovations often fail to spread widely in educational settings (Bhutoria, 2024) .

Effort expectancy, or ease of use of technology, plays a crucial role in reducing initial resistance to adoption, where teachers feel confident in operating digital platforms without complex technical barriers. Research confirms that perceived ease of use significantly influences usage intentions, especially for educators with low digital literacy. This factor becomes an obstacle if the technology interface is too complex, thereby hindering diffusion to the majority of users (Sari et al., 2025) .

Social influence from peers, institutions, and cultural norms shapes attitudes towards learning technology, where support from the teaching community accelerates the persuasion process and adoption decisions. This social influence includes pressure from school leaders and collaboration between educators, which often determines

whether innovations spread through interpersonal networks. In the Indonesian educational context, these collective norms reinforce or hinder diffusion based on the level of cultural acceptance of digital change (Wijaya & Setiawan, 2024) .

Facilitating conditions such as infrastructure, technical support, and device access are essential enablers for successful implementation, as without stable Wi-Fi or training, adoption stalls at the knowledge stage. A systematic study identified these supporting conditions as key predictors alongside self-efficacy and system accessibility. Infrastructure deficiencies in rural areas are often a major barrier to innovation diffusion in developing countries (Susanto & Nugroho, 2010) .

According to Rogers' Innovation Diffusion Theory, innovation characteristics such as relative advantage and compatibility with existing practices greatly influence the rate of adoption among early adopter teachers. This process involves the stages of knowledge, persuasion, decision, implementation, and confirmation, where compatibility with the curriculum accelerates confirmation of long-term use. Complex or incompatible innovations tend to spread slowly to the late majority (Widodo, 2024) ; (Aslan, 2024) . The Technology Acceptance Model (TAM) explains that perceived usefulness and perceived ease of use together determine attitudes and behavioural intentions towards learning technology. This model has been widely validated to predict adoption in education, with external factors such as training influencing both perceptions. The addition of variables such as perceived enjoyment increases the accuracy of predictions in the context of digital learning (Aslan & Rasmita, 2025) .

The TPACK framework moderates the relationship between ease of use and usefulness of technology by integrating technological, pedagogical, and content knowledge, so that teachers with high TPACK adopt 1:1 computing more quickly. This framework emphasises the overlap of the three types of knowledge for optimal learning, where a deficiency in any one hinders diffusion. In primary schools, TPACK is a key factor in cross-subject adoption (Widodo, 2024) .

Teachers' digital skills and knowledge are primary determinants, where deficiencies cause anxiety and low self-efficacy in using e-learning. Research in Yogyakarta shows that digital training increases adoption by boosting confidence. This factor is interrelated with age and experience, where younger teachers are more adaptive. Organisational barriers such as lack of school vision, teachers' tight schedules, and management support hinder technology integration, even when infrastructure is available (Jauhari, 2010) . Studies identify limited time as a major barrier, requiring school policies for training allocation. Without leadership commitment, diffusion is limited to individual initiatives. Access inequalities, including device and connectivity costs, widen the digital divide between regions, resulting in faster adoption in urban areas. These factors include email ownership and computer access, which influence the search for online learning resources. In Indonesia, this is a crucial issue for the inclusiveness of innovation diffusion (Jaidan & Jauhari, 2015) .

Inhibiting factors such as perceived cyber risk and technological complexity reduce adoption intentions, especially on metaverse or AI-based learning platforms. Personal innovativeness in IT (PIIT) acts as a positive moderator of perceived usefulness. These barriers can be overcome through security demonstrations and design simplification (Chen & Wang, 2025) .

Overall, this multifactorial interaction—individual, organisational, social, and technological—determines Rogers' S-shaped adoption curve, where early adopters trigger diffusion to the majority through networks. The synthesis of the study indicates the need for holistic interventions to overcome barriers and maximise enablers in optimising learning technology.

Strategies for Optimising the Use of Media and Technology to Improve Learning Effectiveness

Continuous teacher training is a key strategy for optimising learning technology, where programmes tailored to individual skill levels ensure teachers master digital tools intuitively and effectively integrate technology into the curriculum (Pongpalilu & Aslan, 2025) . This approach includes online webinars, live workshops, and flexible self-paced courses, thereby addressing the digital literacy gap and boosting teachers' confidence in implementing blended learning or interactive platforms (Triyuni et al., 2024) . Through regular evaluation of training outcomes, educational institutions can tailor content to be relevant to specific subjects and teaching styles, thereby accelerating the diffusion of innovation across the teaching staff.

The development of robust technological infrastructure, including stable internet connections and device distribution, is an essential foundation for reducing access gaps and enabling the optimal use of learning media in all regions (Chen & Wang, 2025) . In Indonesia, initiatives such as laptop distribution and the Merdeka Mengajar platform demonstrate how infrastructure investment can support equitable access, especially in rural schools, so that students can fully participate in online activities without technical barriers. This strategy must be complemented by regular maintenance and technical support to ensure long-term sustainability (Adeshola & Adepoju, 2025) .

Integrating technology into lesson plans through pedagogical approaches such as TPACK ensures that digital media is not merely a substitute but an enhancer of learning effectiveness by aligning content, pedagogy, and technology. Teachers can utilise tools such as Socrative for interactive exercises or Thinglink for multimedia images, which enhance visual and auditory student engagement while supporting differential learning. This approach results in dynamic lesson plans, where technology becomes a catalyst for critical thinking and collaboration, rather than mere digital entertainment (Nuraeni & Hidayat, 2025) .

The implementation of blended learning as a hybrid model combines face-to-face and online learning to improve academic achievement, student-teacher interaction, and independent learning skills, as evidenced in various studies that show significant improvements compared to conventional methods. This strategy is effective during and after the pandemic, with elements such as video reviews of material and flexible online discussions that adapt to individual learning rhythms. Periodic evaluation through learning analytics allows for model adjustments to optimise it for various student levels (Widjaja & Aslan, 2022) .

The involvement of all stakeholders, including parents, students, and administrators, in decision-making accelerates technology adoption by fostering a sense of ownership and an inclusive digital culture. Evening workshops with childcare for parents or student surveys on tool preferences can ensure a smooth transition, thereby reducing resistance and increasing school community support. This collaborative approach builds an ecosystem where cross-stakeholder feedback becomes the basis for continuous improvement (Nuraeni & Hidayat, 2025) .

The use of data-driven learning and analytics for early identification of students experiencing difficulties enables timely intervention, allowing technology optimisation to focus on personalising the learning experience. Platforms such as learning management systems can track progress in real time, provide customised learning plans, and gamification for intrinsic motivation, which has been proven to improve knowledge retention. This strategy emphasises the alignment of measurable learning outcomes with digital activities for optimal results (Ouyang et al., 2024) . National education policies that support innovation, such as the Merdeka Belajar reform in Indonesia, provide a framework for the distribution of digital resources and integrated platforms such as PMM and Rapor Pendidikan. This strategy includes incentives for innovative schools and public-private partnerships for infrastructure, thereby accelerating the national diffusion of technology. Policies must be evidence-based with regular impact evaluations for contextual adjustments (Hendriarto et al., 2021) .

Promoting a culture of innovation through an open mindset towards change encourages teachers to become technology integrators rather than transmitters of traditional knowledge, with training emphasising skills such as online platform management and data-driven assessment. In the era of digital transformation, teachers are trained as facilitators of adaptive learning using AI and VR for immersive experiences. This culture is reinforced through online communities of practice for sharing best practices (U.S. Department of Education, 2023) . Effective screen time management with clear guidelines prevents digital fatigue while maximising the benefits of technology, where teachers model best practices such as hybrid activity rotation. This strategy includes rules on duration of use and integration with non-digital activities for a holistic balance of learning. This approach ensures that technology supports, rather than dominates, the learning process (Pratama & Sari, 2025) .

The development of an innovative curriculum that naturally integrates technology enables students to apply 21st-century skills such as online collaboration and real-world problem-solving through VR-based projects or simulations. This curriculum uses Bloom's taxonomy for clear outcomes, with interactive multimedia and regular deadlines for learning momentum. The result is increased engagement and relevance of education to the future world of work (Ridwan et al., 2025) ; (Andrian et al., 2024) .

Overcoming obstacles through a synchronous framework that builds capacity, infrastructure, pedagogy, and ecosystems simultaneously ensures holistic adoption without weak points. In a K-12 context such as Indonesia, this means cross-stakeholder training and partnerships for affordability. This strategy results in sustainable implementation with measurable success metrics (Pratama & Sari, 2025) .

Continuous evaluation and adjustment based on user feedback enables periodic optimisation, where learning impact data determines the scalability of the strategy. Targeted professional development programmes for lecturers or teachers address specific challenges such as the integration of English with edtech. This approach ensures that technology remains relevant to the evolving needs of education (Kusumawardhani & Santoso, 2019) .

Overall, this multifaceted combination of strategies—from training to inclusive policies—enhances learning effectiveness by maximising the potential of digital media while addressing systemic barriers, thereby creating an adaptive and high-achieving educational environment. Phased implementation with full support ensures a smooth transition to sustainable technology-enabled learning across various contexts.

Conclusion

Optimising the use of learning media and technology in educational settings depends heavily on a deep understanding of the factors of innovation adoption and diffusion, such as performance expectancy, effort expectancy, social influence, and facilitating conditions that include infrastructure and organisational support. Rogers' Innovation Diffusion Theory and the Technology Acceptance Model (TAM) emphasise that compatible innovation characteristics, ease of use, and social influence are key drivers, while barriers such as limited digital skills and access inequalities often hinder diffusion to the majority of users. Overall, this multifactorial interaction forms an S-shaped adoption curve, in which early adopters play a catalytic role in systemic educational transformation.

Effective optimisation strategies include continuous TPACK-based teacher training, inclusive infrastructure development, blended learning implementation, and supportive national policies such as Merdeka Belajar in Indonesia, all of which contribute to enhancing the effectiveness of the teaching and learning process through personalisation, interactivity, and data-driven evaluation. This holistic approach not only addresses organisational and individual barriers but also ensures that technology

becomes a sustainable pedagogical enhancer ( ), resulting in higher academic achievement and optimal student engagement. Gradual implementation with the involvement of all stakeholders accelerates the diffusion of innovation towards an adaptive digital education ecosystem.

This research provides theoretical implications by enriching the framework of educational technology adoption and practical implications in the form of recommendations for educators, school managers, and policymakers to design evidence-based interventions to optimise the use of learning media. Suggestions for further research include longitudinal empirical studies in the Indonesian context to quantitatively test the effectiveness of this strategy, as well as exploring the integration of AI and VR in overcoming the digital divide. Thus, this study provides a foundation for 21st-century education that is inclusive and oriented towards high-quality learning outcomes.

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