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ADOPTION OF GENERATIVE ARTIFICIAL INTELLIGENCE IN EDUCATION: SYSTEMATIC REVIEW BASED ON THE THEORY OF DIFFUSION OF INNOVATION

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Abstract

The development of Generative Artificial Intelligence (Generative AI) presents both new opportunities and challenges in the field of education. This technology has the potential to transform learning practices, assessment, and knowledge management. However, its adoption process is not linear and is influenced by pedagogical, social, ethical, and institutional factors. This study aims to analyze the adoption of Generative AI in education using the Diffusion of Innovation Theory framework. The research method employed is a Systematic Literature Review (SLR) of 27 reputable national and international journal articles published between 2022 and 2024. The literature selection process followed the PRISMA guidelines, consisting of identification, screening, eligibility, and inclusion stages. The findings indicate that Generative AI offers relative advantages in supporting personalized learning, improving learning efficiency, and expanding access to learning resources. However, complexity of use, compatibility issues with academic integrity values, and concerns regarding ethics and data privacy are major barriers to adoption. The successful utilization of Generative AI in education requires innovation diffusion strategies supported by institutional policies, enhancement of digital literacy, and reinforcement of educational and cultural values.

Keywords : adoption technology, diffusion of innovation, education, generative artificial intelligence, systematic literature review.

INTRODUCTION

Digital transformation in education is experiencing significant acceleration with the development of artificial intelligence (AI) technology, particularly Generative Artificial Intelligence (Generative AI). This technology enables the automated production of learning content in the form of text, images, and interactive multimedia, potentially transforming the way educators and students access, construct, and evaluate knowledge. In the context of education policy, Generative AI is viewed not only as a technological tool but also as an innovation with implications for academic culture, educational values, and institutional governance. The use of generative AI in education in Indonesia is growing rapidly, especially following the emergence of various platforms based on large language models. However, the implementation of this technology still faces various challenges, such as limited digital literacy, educator preparedness, academic integrity issues, data protection and ethical use of the technology. The development of artificial intelligence (AI), particularly generative AI, has brought significant changes to the world of education. As Dewantara and Dewi (2025) noted, generative AI opens up opportunities for learning innovation through personalization, academic efficiency, and cognitive support. However, this can pose serious challenges to academic integrity, such as plagiarism and overreliance on technology. Dewantara and Dewi (2025) emphasized that the use of Generative AI in learning faces a dilemma between pedagogical innovation and threats

to academic honesty. This view is reinforced by Suwartono (2024), who stated that adopting educational technology without pedagogical and institutional readiness has the potential to widen the gap in learning quality. Dwivedi et al. (2023) analyzed the use of generative AI, such as ChatGPT, across various disciplines and highlighted its impact on research practices, policies, and academic ethics. AI is viewed as a potentially productive tool, but requires regulation, digital literacy, and clear institutional policies. UNESCO (2023) reinforces this view by providing normative guidance on the use of generative AI based on the principles of ethics, inclusivity, transparency, and data protection. In a pedagogical context, Holmes, Bialik, and Fadel (2019), as well as Luckin et al. (2016), emphasized that AI should function as a learning support system, not a substitute for teachers. Selwyn (2019) criticized the deterministic narrative of AI and emphasized the importance of social, pedagogical, and humanitarian dimensions in education. These findings are reinforced by Zawacki-Richter et al. (2019), who, through a systematic review, showed that AI research in higher education is still dominated by technical aspects, while critical, pedagogical, and ethical studies are still limited. Ng et al. (2023) developed an AI literacy framework that encompasses conceptual understanding, ethical use, and critical reflection on the impact of AI in education. This literacy is key to enabling educators and students to utilize AI responsibly.

LITERATURE REVIEW

Diffusion of Innovations Theory is a classic theory widely used to explain how innovations are introduced, spread, and adopted by individuals or groups within a social system. First proposed by Everett M. Rogers, this theory remains relevant today for explaining the adoption of innovations in various fields, such as education, business, digital technology, and public policy. According to Rogers (2003), the diffusion of innovation is not an instantaneous event, but rather a gradual communication process. This process involves conveying information about an innovation through specific communication channels, takes time, and occurs within a social system with its own norms and structures.

1. An innovation is an idea, practice, or object that is perceived as new by an individual or unit of adoption. Rogers (2003) emphasizes that the novelty of an innovation is subjective, depending on the perception of the recipient. Thus, something that has long been generally known can still be perceived as an innovation even if an individual has never used it.
2. Communication channels are the media used to convey information about innovations from one individual to another. Rogers (2003) explains that interpersonal communication is often more effective in influencing adoption decisions than communication through mass media, especially at the persuasion stage.
3. Time is a crucial aspect in the diffusion of innovation because adoption does not occur simultaneously. Time is related to the innovation decision-making process, the rate of adoption, and the differences in adopter categories.
4. A social system is a collection of individuals, groups, or organizations that interact with each other and participate in the diffusion process. Social norms, power structures, and the roles of leaders and opinion leaders within a social system significantly influence the success of innovation diffusion.

Rogers (2003) explains that the adoption of innovation by individuals goes through five stages known as the innovation-decision process, as follows:

1. Knowledge, namely the stage where individuals begin to realize the existence of innovation and understand how it works.
2. Persuasion, namely the stage where individuals form a positive or negative attitude towards innovation based on the information obtained.
3. Decision, namely the individual decides to adopt or reject the innovation.
4. Implementation, namely the innovation begins to be used in real practice.
5. Confirmation, namely individuals seek reinforcement for decisions that have been taken and evaluate the benefits of innovation.

These stages demonstrate that innovation adoption is a rational process influenced by experience, information, and social interactions. AI adoption in education is part of the innovation diffusion process, which is influenced by social, organizational, and cultural factors. Therefore, the success of AI integration depends heavily on the readiness of educational institutions and stakeholders. Rogers' (2003) Diffusion of Innovation Theory offers a relevant conceptual framework for understanding the dynamics of Generative AI adoption in education. This theory allows for a systematic analysis of the factors that drive and hinder the acceptance of innovation in a social system. Innovation attributes consist of five aspects: (1) relative advantage, which is the degree to which an innovation is perceived as superior to previous ideas or technologies; (2) compatibility, which is the degree to

which an innovation fits the values, experiences, and needs of potential users; (3) complexity, which is the degree to which an innovation is difficult to understand and use; (4) trialability, which is the extent to which an innovation can be tested before being fully adopted; and (5) observability, which is the degree to which the results of an innovation's use are visible to others. These attributes are widely used in empirical research to analyze the adoption of digital technology and organizational innovation. Several studies in education show that the successful adoption of innovation is significantly influenced by the technology's suitability to the social, cultural, and institutional context of education. Krisnawati et al. (2022) highlight the importance of design research as a systematic approach in developing technology-based learning innovations. Suwartono (2024) complements this by emphasizing the role of classroom action research as a means of reflecting on and improving learning practices. Meanwhile, Subakti (2020) contributes to the academic aspect by analyzing the rhetorical structure of relevant scientific articles in the context of using AI for academic writing.

Thus, in general, AI in education has great potential to improve the quality of learning. However, this must be balanced with strengthening AI literacy, ethical policies, and a human-centered pedagogical approach. AI integration is not simply a technological issue, but rather a holistic transformation of the education system. A systematic study is needed on the adoption of Generative AI in education using the Diffusion of Innovation Theory as the primary analytical lens. The purpose of this study is to analyze the characteristics of Generative Artificial Intelligence adoption in education, viewed from the five attributes of innovation in the Diffusion of Innovation Theory, and what factors encourage and hinder the adoption of Generative Artificial Intelligence in the pedagogical, social, ethical, and cultural contexts of education. The novelty of this study lies in its effort to integrate the pedagogical, social, ethical, and policy dimensions of education within a comprehensive analytical framework relevant to the educational and cultural context in Indonesia.

METHOD

This study uses a Systematic Literature Review (SLR) approach to synthesize empirical findings related to the adoption of Generative Artificial Intelligence in education. This approach was chosen because it provides a comprehensive overview of research developments and adoption patterns of evidence-based innovations.

Systematic Review Procedure

The SLR process followed the PRISMA guidelines, which encompass four main stages: identification, screening, eligibility assessment, and inclusion. During the identification stage, a literature search was conducted through Scopus, Google Scholar, and Garuda databases using the keywords generative AI, artificial intelligence in education, diffusion of innovation, and technology adoption. This stage yielded 86 articles. Next, during the screening stage, duplications were removed and an initial selection was made based on the title and abstract, leaving 42 articles. The eligibility assessment stage was conducted by reviewing the full text of the articles based on the inclusion and exclusion criteria. This process resulted in 27 articles meeting the criteria and subjected to in-depth analysis.

Inclusion and Exclusion Criteria

Inclusion criteria include: (1) peer-reviewed scientific journal articles, (2) published in the 2022–2024 period, (3) discussing the use or adoption of Generative Artificial Intelligence in educational contexts, and (4) available in full text. Exclusion criteria include articles in the form of proceedings, editorials, opinion pieces, non-educational articles, and AI studies that do not specifically discuss Generative AI.

Data Analysis Techniques

Data analysis was conducted qualitatively using a meta-synthesis approach. Each article was coded based on themes relevant to Rogers' five innovation attributes, then compared and integrated to identify adoption patterns, inhibiting factors, and theoretical and practical implications.

RESULTS AND DISCUSSION

The adoption pattern of Generative Artificial Intelligence in education based on the attributes of the Diffusion of Innovation Theory is presented in Table 1 which is a synthesis of the main findings of the Systematic Literature Review.

Table 1 Synthesis of Findings on the Adoption of Generative Artificial Intelligence in Education Based on the Theory of Diffusion of Innovation

No	Attributes of Innovation Diffusion	Key Findings	Educational and Cultural Implications
1	Relative Advantage	Generative AI improves personalization of learning, efficiency of teaching material design, and accessibility of learning resources.	Supporting the transformation of 21st century learning and equal access to technology-based education.
2	Compatibility	Aligned with digital learning, but poses challenges to academic integrity and learning culture.	Requires institutional policies and ethical guidelines for technology use.
3	Complexity	The digital literacy of educators and students influences the ease of use of Generative AI.	Demanding continuous training and strengthening of educational human resource capacity.
4	Trialability	Limited trials gradually increase understanding and acceptance of the technology.	Institutions need to provide controlled experimental spaces.
5	Observability	Documented good practices accelerate adoption and increase user trust.	Dissemination of good practices is a key strategy for the diffusion of educational innovation.

Source: Author's meta-synthesis results (2025)

Analysis/Discussion

Analysis of the findings of the adoption of generative AI in education based on the Diffusion of Innovation Theory, as follows:

1. Relative Advantage

The findings indicate that Generative AI offers significant advantages over conventional learning methods, particularly in terms of personalized learning, efficient material development, and accessibility of learning resources. This aligns with Rogers' (2003) view that innovations are more readily adopted when they provide tangible benefits to their users. Singh & Strzelecki (2025) assert that academics are likely to adopt Generative AI when the technology is proven to improve teaching quality and academic productivity. At a macro level, the realistic diffusion model developed by Sziklai et al. (2025) and the statistical mechanics of innovation approach by Masali et al. (2025) explain that widely observed benefits will accelerate the spread of innovation within a social system.

Sugiono (2024) and Zahroh et al. (2025) emphasize that Generative AI's relative superiority supports the transformation of 21st-century learning and aligns with the vision of the Independent Curriculum, which is adaptive, inclusive, and technology-based. Thus, Generative AI has the potential to be a catalyst for equitable access to digital-based education. In the context of higher education and schools, Generative AI enables differentiated learning based on individual student needs, supports adaptive learning, and accelerates educators' work in instructional planning (Holmes et al., 2019; Dwivedi et al., 2023). Meanwhile, Dewantara and Dewi (2025) emphasized that these advantages make Generative AI a catalyst for 21st-century learning transformation, particularly in Indonesia's digital education ecosystem. Its cultural implications include a shift in the learning paradigm from teacher-centered to learner-centered, while simultaneously expanding equitable access to technology-based education, as emphasized by UNESCO (2023).

2. Compatibility

Generative AI is considered compatible with established digital learning ecosystems, such as Learning Management Systems (LMS) and online learning. However, challenges arise in terms of academic integrity, originality of work, and learning culture (Selwyn, 2019; Dwivedi et al., 2023). This can disrupt academic values and norms, particularly those related to academic integrity, originality of work, and a culture of independent

learning. Rogers (2003) stated that innovations that are not fully aligned with social values are likely to encounter resistance.

Lack of preparedness in academic policies and norms can slow the diffusion of this innovation. Therefore, as Rogers (2003) theorized, the level of compatibility needs to be strengthened through institutional policies, ethical guidelines, and structured AI literacy (Ng et al., 2023; UNESCO, 2023). From an educational culture perspective, Generative AI demands a redefinition of the values of academic honesty and intellectual responsibility in the context of human-machine collaboration. Chen (2024) and Rahmawaty et al. (2025) emphasized that academic cultural unpreparedness can slow the diffusion of educational innovation. This is reinforced by the findings of Singh & Strzelecki (2025) who demonstrated educators' ambivalence toward Generative AI despite recognizing its benefits. Therefore, educational implications require the presence of institutional policies, ethical guidelines, and ethical technological literacy, as recommended by Amanah et al. (2024) and Fitriani et al. (2024). Compatibility is not only a technical issue, but also a cultural and normative one.

3. Complexity

The level of complexity of Generative AI is strongly influenced by the digital and AI literacy of educators and students. The higher the perceived complexity, the slower the adoption of innovation (Rogers, 2003). Several recent studies have shown that a lack of understanding of how AI works, algorithmic bias, and ethical constraints are key barriers to meaningful adoption (Ng et al., 2023; Zawacki-Richter et al., 2019). Therefore, strengthening the capacity of educational human resources through continuous training, communities of practice, and reflective approaches is a strategic necessity (Suwartono, 2024). Laksana et al. (2024) and Amanah et al. (2024) indicate that limited technical and pedagogical understanding is a major barrier to utilizing AI in learning. Technological literacy is a key factor in reducing the complexity of innovation. Consequently, educational institutions need to develop ongoing training, pedagogical mentoring, and human resource capacity building so that Generative AI is not merely adopted symbolically but used effectively and meaningfully.

4. Trialability

Small-scale pilot projects of Generative AI have been shown to increase understanding, reduce resistance, and accelerate technology adoption. This is consistent with Rogers' (2003) concept of trialability, where the opportunity to try innovations without significant risk encourages adoption. Educational institutions need to provide controlled experimental spaces, for example through classroom action research (CAR), design research, or educational technology policy sandboxes (Krisnawati et al., 2022; Suwartono, 2024). This approach allows for technology adaptation to the socio-cultural context of Indonesian education. Chen (2024), Zahroh et al. (2025), and Sugiono (2024) emphasize the importance of the experimental phase in educational innovation. Modern innovation diffusion models (Guidolin & Manfredi, 2023; Sziklai et al., 2025) also show that trialability strengthens the social learning process within institutional networks.

5. Observability

Observability of Generative AI adoption is evident in documented best practices and dissemination of implementation results. When the benefits of innovation can be clearly observed, trust and interest from other users increase (Rogers, 2003). Publication of good practices, forums for sharing educator experiences, and national policy support accelerate the diffusion of Generative AI innovations in the education system (UNESCO, 2023; Dwivedi, et al., 2023). Within the context of academic culture, observability also strengthens the legitimacy of using AI as a responsible learning tool. Rahmawaty et al. (2025), Laksana et al. (2024), and Amanah et al. (2024) show that successful educational technology implementation often spreads through the dissemination of good practices and professional networks. This is also supported by the social network approach to innovation diffusion (Guidolin & Manfredi, 2023). Thus, disseminating good practices through seminars, scientific publications, and learning communities is a key strategy to accelerate the systemic adoption of Generative AI in education.

Based on the analysis of the findings above, the adoption of Generative AI in education is influenced by the balance between pedagogical benefits, academic cultural readiness, and policy support. Rogers' (2003) Diffusion of Innovation Theory provides a strong conceptual framework for understanding these adoption dynamics, while recent literature confirms that the success of Generative AI implementation is highly dependent on AI literacy, ethics, and institutional leadership. Adoption success is determined not only by technological sophistication, but also by perceived benefits, value alignment, level of complexity, opportunities for trial, and visibility of results. Therefore, Generative AI implementation strategies need to be designed holistically, integrating technological,

pedagogical, cultural, and policy dimensions so that this innovation can contribute significantly to educational and cultural transformation.

CONCLUSION

Generative Artificial Intelligence (AI) is an educational innovation with significant potential to support personalized learning, streamline learning processes, and expand access to learning resources. However, the adoption of this technology still faces challenges related to the complexity of its use, compatibility with academic integrity values, and ethical and data privacy issues. Therefore, the successful use of Generative AI in education requires a comprehensive innovation diffusion strategy, supported by institutional policies, increased digital literacy, and the strengthening of educational and cultural values.

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