

Artificial Intelligence for Strengthening Inclusive Education for Students with Special Needs

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ABSTRACT

The development of Artificial Intelligence (AI) provides new opportunities for transforming inclusive education, particularly in supporting learning for students with special needs. This article aims to analyze the roles, benefits, challenges, and implementation strategies of AI in strengthening inclusive education through a Systematic Literature Review (SLR) approach. The review examined scientific publications from the last five years focusing on AI integration in education, assistive technology, adaptive learning, personalized learning, and accessibility for diverse learners. The findings indicate that AI contributes to more personalized learning experiences through adaptive learning systems, learning analytics, AI-based communication technologies, and assistive devices. Furthermore, AI supports teachers in instructional planning, assessment, and data-driven decision-making processes. However, several challenges remain, including teacher competency readiness, unequal access to technology, data privacy, and ethical concerns regarding AI implementation. Therefore, AI integration in inclusive education should adopt a human-centered, equitable, and responsible approach to ensure that technological advancement contributes to creating accessible and supportive learning environments for all students.

Keywords: *Artificial Intelligence, Inclusive Education, Personalized Learning, Special Needs Students, Technology Accessibility.*

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1. | INTRODUCTION

The transformation of education in the 21st century is marked by the increasing use of digital technology to create a more adaptive, collaborative, and student-centered learning process. The development of Artificial Intelligence (AI) is one of the innovations that provides significant changes to various aspects of education, ranging from learning planning, provision of learning resources, assessments, to evaluation of learning outcomes. AI is no longer seen as just a technological tool, but as an instrument that is able to support data-driven decision-making, provide real-time feedback, and facilitate more personalized learning according to the characteristics of students (Chen et al., 2020; Holmes et al., 2022).

On the other hand, inclusive education is increasingly gaining attention as an educational paradigm that ensures that every student gets equal learning opportunities regardless of physical, intellectual, sensory, social, and emotional conditions. Inclusive education places diversity as a part that must be accommodated through a learning environment that is flexible, accessible, and responsive to individual needs. The implementation of inclusive education requires learning innovations that are able to reduce learning barriers while increasing the participation of all students, especially students with special needs. In this context, AI is seen as having great potential as a supporting technology that is able to expand access to education and improve the quality of inclusive learning services (Salas-Pilco et al., 2022; Pagliara et al., 2024).

Students with special needs have diverse learning characteristics so that they require different learning strategies from students in general. These differences include the need for easily accessible learning media, adaptive material delivery, more flexible communication, and evaluations tailored to individual abilities. In practice, teachers often face various challenges such as limited time, resources, and competence to provide truly individual learning services to all students. This condition shows that technological support is needed that can help teachers in providing more effective, efficient, and inclusive learning (Hopcan et al., 2023; Waterfield et al., 2024).

Various AI developments have produced a variety of applications that can be used in inclusive education, such as adaptive learning, intelligent tutoring system, speech-to-text, text-to-speech, educational chatbots, learning analytics, to image and voice recognition technology. These various technologies allow learning materials to be presented according to students' abilities, provide feedback automatically, help students' communication with sensory barriers, and increase learning independence through a more personalized learning experience. Thus, AI has the potential to become an assistive technology that is able to support the active involvement of students with special needs in the learning process without reducing the role of teachers as the main facilitator of learning (Mateos-Sánchez et al., 2022; Ingavelez-Guerra et al., 2022; Watters et al., 2021).

Although the various benefits of AI in education have been widely reported, its implementation in inclusive education still faces a number of challenges. Several

studies show that teacher readiness, limited digital infrastructure, technology access gap, AI literacy, data security, privacy, and potential algorithm bias are factors that affect the effectiveness of the use of AI in the educational environment. In addition, the use of AI that is not accompanied by adequate policies and ethics has the potential to widen the education gap if it is only accessible to certain groups. Therefore, the integration of AI in inclusive education requires not only technological innovation, but also policies, educator competencies, and governance that ensure its use in a fair, safe, and responsible manner (Bulathwela et al., 2024; Mandinach & Jimerson, 2021; Porayska-Pomsta et al., 2024).

A number of previous studies have examined AI more from the perspective of education in general or only focused on developing certain technologies for students with special needs. Studies that integrate the concept of inclusive education, AI technology, the role of teachers, learning personalization, accessibility, implementation challenges, and development strategies in one conceptual framework are still relatively limited. In fact, a comprehensive understanding of the relationship between AI and inclusive education is needed as a basis for policy formulation and learning practices that are oriented towards equitable distribution of education quality.

Based on this description, this article aims to systematically analyze how Artificial Intelligence can support the implementation of inclusive education for students with special needs, identify various benefits and challenges of its implementation, and formulate strategies to strengthen the application of AI that supports adaptive, accessible, ethical, and sustainable learning. The results of the study are expected to make a conceptual contribution to the development of education policies, improving teacher competence, and optimizing the use of AI technology in realizing an inclusive and quality education system for all students.

2. | RESEARCH METHOD

This study uses the Systematic Literature Review (SLR) approach to identify, evaluate, and synthesize various research results related to the implementation of Artificial Intelligence (AI) in inclusive education for students with special needs. The SLR approach was chosen because it is able to provide a comprehensive, systematic, and evidence-based picture of research developments, key findings, opportunities, challenges, and strategies for the application of AI in supporting inclusive learning. Through this method, various published research results can be analyzed in a structured manner so as to produce a more objective scientific synthesis than conventional narrative studies.

The literature search process is carried out on several scientific databases that have international reputation, namely Google Scholar, Scopus, ScienceDirect, SpringerLink, IEEE Xplore, and ERIC. The search uses a combination of keywords such as artificial intelligence, AI in education, inclusive education, special education, students with disabilities, assistive technology, adaptive learning, intelligent tutoring system, and

learning analytics. All articles considered are limited to publications in 2020–2024 to obtain an overview of the latest research developments in accordance with the focus of the study.

Literature selection is carried out based on inclusion and exclusion criteria. The inclusion criteria include journal articles that have gone through a peer review process, published in English or Indonesian, discuss the application of AI in the context of education, inclusive education, or education for students with special needs, and have a full text that can be accessed. The exclusion criteria include articles that are not relevant to the focus of research, proceedings, opinions, editorials, and duplicate publications. Articles that meet the criteria are then analyzed through a data extraction process that includes the identity of the publication, the purpose of the research, the methods, the AI technology used, the key findings, benefits, implementation challenges, and development recommendations. The data that has been collected is then synthesized descriptively to identify patterns, tendencies, and relationships between findings so as to produce a comprehensive discussion on the use of AI in supporting the implementation of inclusive education.

3. | RESULTS AND DISCUSSION

The results of the literature synthesis show that the development of Artificial Intelligence (AI) has provided a new direction in the implementation of inclusive education through the provision of a more adaptive, personalized, and accessible learning experience for students with special needs. Various studies reveal that AI not only functions as a learning support tool, but also as a technology that is able to identify students' learning needs, adjust materials according to their ability level, and provide feedback quickly and continuously. These changes show that the use of AI has shifted from just technological innovation to a strategic component in improving the quality of educational services that are oriented towards student diversity (Chen et al., 2020; Holmes et al., 2022; Pagliara et al., 2024). This approach is in line with the principle of inclusive education that places each student as an individual who has different characteristics, abilities, and learning needs so that it requires flexible and responsive educational services (Salas-Pilco et al., 2022).

Based on the results of the study, one of the main contributions of AI in inclusive education is its ability to support personalized learning. AI-based systems are able to analyze students' learning performance in an ongoing manner, then recommend materials, difficulty levels, and learning strategies that are in accordance with individual development. Through this mechanism, students no longer receive uniform materials, but rather gain learning experiences that are tailored to their abilities and needs. This condition provides greater opportunities for students with special needs to follow the learning process optimally without experiencing pressure due to differences in academic abilities and learning characteristics (Hopcan et al., 2023; Standen et al., 2020).

In addition to supporting learning personalization, AI is also evolving as an assistive technology that improves educational accessibility. Various AI-based applications, such as speech-to-text, text-to-speech, speech recognition, image recognition, optical character recognition (OCR), and automatic translation, have helped reduce learning barriers experienced by students with special needs. The technology allows students with visual impairments to obtain material in the form of sound, students with hearing impairments to utilize automatic transcription during the learning process, and students with communication disabilities to receive interaction support through an AI-based system. Thus, AI not only increases learning effectiveness, but also expands the opportunities for learners to actively participate in all learning activities (Watters et al., 2021; Ingavelez-Guerra et al., 2022; Mateos-Sánchez et al., 2022).

The results of the study also show that the implementation of AI has a positive impact on the role of teachers in inclusive learning. The presence of AI is not intended to replace the function of teachers, but to be a tool in carrying out various administrative and academic tasks. AI can be used to compile differentiated learning materials, produce evaluation questions according to learning outcomes, automatically analyze learning outcomes, and provide follow-up recommendations based on student development. Through this support, teachers have more opportunities to focus attention on pedagogical interactions, individual mentoring, and the development of social and emotional aspects of students that cannot be completely replaced by technology. Therefore, AI integration should be understood as a form of collaboration between human intelligence and artificial intelligence in creating a more effective, humanistic, and inclusive learning process (Waterfield et al., 2024; Lakkala et al., 2021; Irawan & Anwar, 2024).

Other findings show that the use of AI also strengthens the data-driven decision-making process through the application of learning analytics. Data on learning activities, participation levels, academic achievements, and patterns of students' difficulties can be analyzed more quickly so that teachers are able to identify students who need intervention from an early age. This information is the basis for designing learning strategies that are more targeted at the target, including adjusting media, methods, and forms of assessment according to individual needs. Thus, AI not only serves as a means of automation, but also as an analytical instrument that supports the continuous improvement of the quality of inclusive education services. These findings show that the success of AI implementation relies heavily on its ability to integrate personalized learning, accessibility, and data-driven decision-making in a single learning ecosystem centered on learners' needs (Bulathwela et al., 2024; Mandinach & Jimerson, 2021; El Naggat et al., 2024).

Although Artificial Intelligence (AI) has great potential in strengthening inclusive education, the results of the literature review show that its implementation still faces various challenges that need to be critically considered. One of the main challenges is

the readiness of human resources, especially the competence of teachers in understanding, selecting, and using AI-based technology appropriately. The use of AI in inclusive education not only requires technical skills, but also pedagogical understanding so that the technology can be applied according to the characteristics and needs of students with special needs. Without adequate competencies, AI has the potential to become just an add-on device without having a significant impact on improving the quality of learning. Therefore, strengthening AI literacy for educators is an important aspect in ensuring that technology is used effectively, ethically, and oriented to the needs of students (Hopcan et al., 2023; Waterfield et al., 2024).

In addition to teacher competence, other challenges that are often found are related to the aspects of ethics, security, and student data protection. AI systems in education work through the process of collecting and analyzing large amounts of data, including data on learning activities, academic abilities, and individual characteristics of students. This condition raises the need for a strong data protection mechanism so that students' personal information is not misused. In addition, AI algorithms also have the potential to produce biased decisions if the data used in the system training process does not represent the diversity of students. In the context of inclusive education, algorithm bias is an important concern because it can reinforce inequality for certain groups of learners. Therefore, the application of AI must be supported by the principles of transparency, fairness, accountability, and responsible technology governance (Mandinach & Jimerson, 2021; Bulathwela et al., 2024; Porayska-Pomsta et al., 2024).

The gap in access to technology is also a factor that affects the success of AI implementation in inclusive education. While AI offers a variety of solutions to improve learning accessibility, not all educational institutions have adequate digital infrastructure, supporting devices, and connectivity to optimize the technology. This condition shows that technological innovation must be followed by an equal access strategy so that AI does not actually widen the education gap. The inclusive use of AI requires policy support, technology investment, and implementation planning that takes into account the conditions and needs of various educational environments. Thus, the success of AI in education is not only determined by technological sophistication, but also by the readiness of the education ecosystem in providing equitable access for all learners (Salas-Pilco et al., 2022; Pierrès et al., 2024).

Based on the results of the literature analysis, the AI optimization strategy in inclusive education needs to be directed towards a human-centered approach. This approach places technology as a supporting tool that strengthens the capacity of teachers and students, not as a substitute for human interaction in the educational process. The implementation of AI needs to be carried out through collaboration between educators, technology developers, policy makers, students, and families so that the solutions developed are truly in accordance with learning needs. In addition, the development of AI technology needs to consider the principle of universal design (Universal Design for Learning / UDL) so that educational products and services can

be used by students with various ability characteristics (Pagliara et al., 2024; Knox et al., 2020).

Overall, the results of the study show that AI has a great opportunity to be a catalyst in strengthening inclusive education if applied strategically and responsibly. AI is able to improve learning personalization, provide assistive technology, assist teachers in decision-making, and expand access to learning resources. However, the success of its implementation is highly dependent on human readiness, supportive policies, adequate infrastructure, and a commitment to ethical and justice principles. With the right approach, AI can be an important instrument in building an education system that is more flexible, adaptive, and able to meet the diverse needs of students with special needs in the future (El Nagggar et al., 2024; Irawan & Anwar, 2024).

4. | CONCLUSION

The use of Artificial Intelligence (AI) in inclusive education shows great opportunities in improving the quality of learning services for students with special needs. The results of the study show that AI is able to support the creation of more adaptive, personalized, and accessible learning through various technologies such as adaptive learning, assistive technology, learning data analysis, and artificial intelligence-based learning support systems. The presence of AI allows students to gain a learning experience that is more in line with their individual characteristics, abilities, and needs, while assisting teachers in designing more effective learning strategies. However, the implementation of AI in inclusive education still faces various challenges, especially related to teachers' digital competence, infrastructure readiness, technology access gaps, data security, and ethical aspects of AI use.

Therefore, the application of AI cannot only focus on the technological aspect, but must consider a human-centered approach by placing teachers as the main guide in the learning process. AI can be a strategic instrument in strengthening inclusive education if it is applied wisely, fairly, and responsibly. AI optimization requires policy support, increasing educators' technology literacy, developing inclusive systems, and collaboration of various parties. With this approach, AI has the potential to create an educational ecosystem that is more flexible, equitable, and able to meet the diverse needs of all students.

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The authors declare that there is no conflict of interest.

Ethical Approval and Originality Statement

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Data Disclosure Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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