Research Article

Harnessing Artificial Intelligence for Inclusive Education: A Study of Trends, Technologies, and Challenges

Muhammad Sholikhan¹*, Fujiama Diapoldo Silalahi²

1 Universitas Sains dan Teknologi Komputer ; e-mail : sholikhan@stekom.ac.id
2 Universitas Sains dan Teknologi Komputer ; e-mail : fujiama@stekom.ac.id
* Corresponding Author : Muhammad Sholikhan

Abstract: This study investigates the utilization of Artificial Intelligence (AI) in fostering inclusive education for students with disabilities. Drawing on current literature and visualized trends from 2018 to 2024, this research outlines the rapid growth of AI-related publications addressing inclusive pedagogy. The study maps the key technological applications—ranging from assistive tools and adaptive learning systems to virtual tutoring platforms—and identifies their pedagogical functions in supporting diverse learner needs. It further examines the ethical, infrastructural, and pedagogical challenges encountered in implementation, such as algorithmic bias, limited teacher training, and digital inequality. The findings reveal that AI can significantly enhance accessibility and autonomy for students with disabilities when applied through empathetic, well-regulated, and collaborative frameworks. This paper recommends the development of inclusive and participatory AI design, investment in teacher capacity building, and stronger policy infrastructure to ensure equitable access to AI-powered learning environments. Future directions highlight the importance of ethical considerations and the active involvement of marginalized communities in shaping inclusive digital ecosystems.

Keywords: Artificial Intelligence; Inclusive Education; Students with Disabilities; Assistive Technology; Adaptive Learning Systems

1. Introduction

The digital transformation of education has opened new pathways for enhancing learning quality, including for students with disabilities. Among the most prominent innovations of the past decade is the integration of Artificial Intelligence (AI) as an adaptive tool capable of bridging the diverse learning needs of students (Wilson et al., 2025). Through intelligent learning systems, virtual tutors, assistive technologies, and data-driven analytics, AI provides personalized, responsive, and inclusive support for learners with special needs (Foley & Melese, 2025).

Recent studies have demonstrated that AI can significantly improve accessibility and learning outcomes by delivering interventions tailored to students' cognitive profiles, emotional states, and physical conditions (Hong & Kim, 2024). AI-powered systems such as adaptive learning platforms, intelligent tutoring systems, and immersive technologies like virtual reality (VR) are increasingly used to create multisensory learning experiences that foster inclusion. Furthermore, AI enables more equitable and representative formative assessments, while promoting greater autonomy in students' learning journeys (Alkeraida, 2024)(McGrath et al., 2023).

Despite these potentials, the implementation of AI in inclusive education faces several complex challenges. Technical barriers, limited teacher training, high implementation costs, and ethical concerns—such as algorithmic bias and data privacy—pose critical issues that require serious attention (Zaleski et al., 2024). These challenges

are especially pronounced in resource-limited settings, where access to advanced technologies remains uneven (Gharaibeh et al., 2025).

Given these dynamics, it is essential to explore in depth how AI contributes to strengthening inclusive education, and how such innovations can be developed ethically, sustainably, and in alignment with the diverse needs of all learners (Tzimiris et al., 2023). This article aims to examine current trends, implementation barriers, ethical considerations, and future directions in the use of AI within the context of inclusive education for students with disabilities (Kharbat et al., 2021)(Marino et al., 2023).

2. Literature Review
2.1 Artificial Intelligence and Inclusive Education

The application of Artificial Intelligence (AI) in education has paved the way for more personalized, adaptive, and data-driven learning experiences (Foley & Melese, 2025). In the context of inclusive education, AI plays a vital role in delivering learning systems that tailor content, methods, and styles to the individual needs of students with disabilities (Conti et al., 2020). Technologies such as adaptive learning systems, intelligent tutoring systems, and computer-aided instruction have been shown to enhance student engagement and improve academic outcomes for learners with special needs (Gupta et al., 2023).

2.2 AI-Based Assistive Technologies for Disabilities

AI has been embedded in various assistive technologies, including text-to-speech devices, emotion recognition systems, and early intervention analytics, which support students with sensory, cognitive, and emotional challenges (Hong & Kim, 2024)(Alkeraida, 2024). These tools enable early identification of special needs and provide more precise, targeted interventions. The use of immersive technologies such as virtual reality (VR) and augmented reality (AR) has further enriched inclusive multisensory learning experiences (McGrath et al., 2023)(Kharbat et al., 2021).

2.3 Ethical and Implementation Challenges

Despite its potential, the use of AI in inclusive education faces significant ethical and practical challenges (Marino et al., 2023). Algorithmic bias, data privacy concerns, and teachers' limited readiness to adopt AI tools remain pressing issues. Furthermore, cost and infrastructure limitations—particularly in underserved regions—hinder broad-scale implementation (Omri et al., 2025) (Balachandran & Rabbiraj, 2025). The literature emphasizes the importance of responsible, learner-centered AI adoption, with meaningful involvement from individuals with disabilities in the development process (Meng & Wong, 2024).

2.4 Innovation Pathways and the Future of AI in Inclusive Education

Emerging trends indicate growing adoption of AI for creating smart classrooms, personalized learning environments, and flexible educational experiences that support lifelong learning (Qusef et al., 2025)(Almufareh et al., 2023). Cross-sector collaboration and the active participation of disability communities are key to ensuring that AI innovations remain inclusive and do not reinforce digital inequalities (Wang et al., 2025). AI in inclusive education is projected to become a strategic field in promoting social justice through technology-enhanced learning (Rice & Dunn, 2023).

3. Methodology
3.1 Research Design

This study employs a qualitative descriptive approach grounded in digital document analysis. The primary objective is to explore the application of Artificial Intelligence (AI) technologies in inclusive education for students with disabilities (Almufareh et al., 2024). Data were collected from relevant online sources, including peer-reviewed journal articles, reports from international organizations (e.g., UNESCO, WHO), educational media, and AI-based educational technology platforms.

3.2 Data Sources and Collection Techniques
Data were obtained through the following methods:
1) A systematic literature search conducted on academic databases such as Scopus and Google Scholar, using keywords including artificial intelligence, inclusive education, assistive technology, and learners with disabilities (Rice & Dunn, 2023).
2) Digital documentation analysis involving policy reports, case studies, and online educational content such as YouTube videos, edtech websites, and AI-focused educational articles.
3) Review and synthesis of data visualizations and summaries from various academic and institutional sources, used to identify trends in publication, research focus areas, and thematic directions in the field (Miller et al., 2025).

3.3 Data Analysis Techniques

The data were analyzed using thematic content analysis. Information was categorized into themes such as the types of AI technologies utilized, the forms of support provided to students with disabilities, implementation challenges, and future directions. This process was conducted manually with the support of reference management software (e.g., Zotero, Mendeley), and the results were synthesized into structured academic narratives.

4. Results and Discussion
4.1 Trends in Research on AI Utilization in Inclusive Education
A review of recent literature reveals a consistent upward trend in scientific publications concerning the use of Artificial Intelligence (AI) in inclusive education over the past seven years. A particularly notable increase occurred after 2020, driven by the accelerated digital transformation resulting from the COVID-19 pandemic. Educational institutions worldwide were compelled to adapt to online learning systems and AI-powered technologies, leading to greater academic interest and experimentation in this domain.

The following figure illustrates the number of relevant publications from 2018 to 2024:

**Figure 1.** Trends in AI Publications on Inclusive Education (2018–2024)
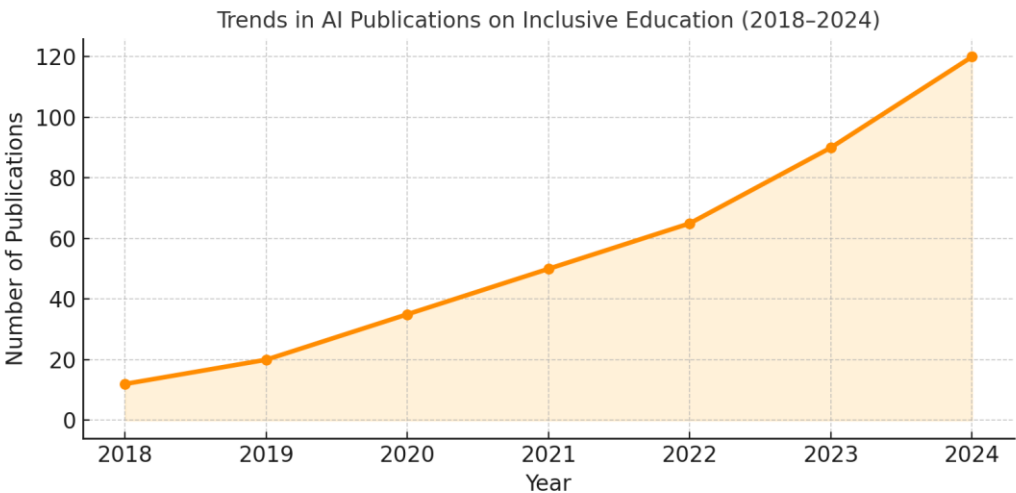
In 2018, only 12 publications addressed this topic. This number steadily increased, surpassing 120 publications by 2024. The trend reflects the growing academic commitment to exploring AI as a tool to support more equitable and responsive learning systems that meet diverse student needs.

4.2 Thematic Focus of Research and Technological Innovations

Based on thematic classification, five major topics dominate the landscape of AI research in inclusive education. These themes highlight the core areas of innovation and academic inquiry, ranging from technical solutions to ethical and pedagogical considerations.

Figure 2. Distribution of Key Research Topics on AI in Inclusive Education

Distribution of Key Research Topics on Artificial Intelligence in Inclusive Education
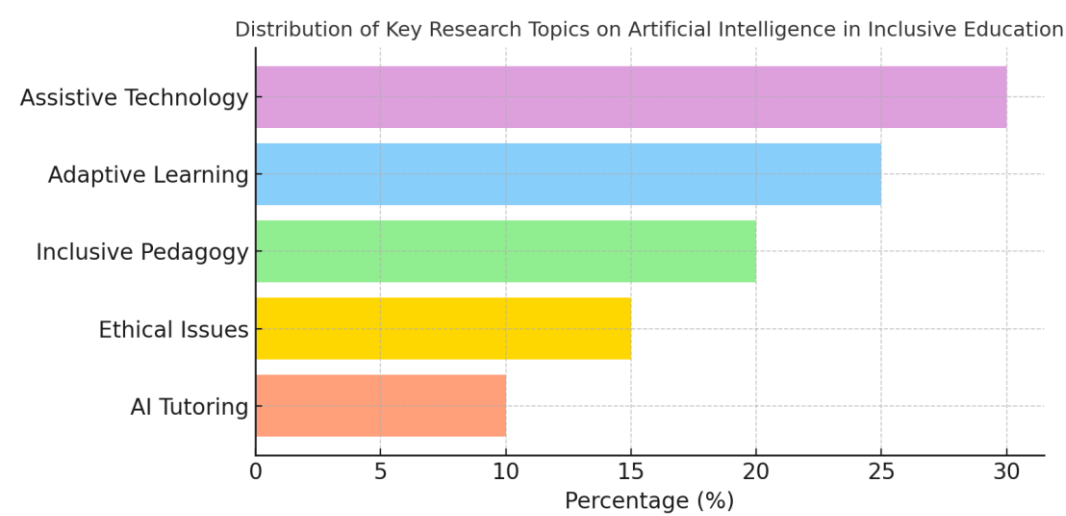
The breakdown is as follows:

1) Assistive Technology (30%) – AI-powered tools that enhance accessibility for students with disabilities, such as screen readers, speech-to-text applications, and communication aids.
2) Adaptive Learning (25%) – Systems that customize instructional content, pacing, and delivery methods based on individual student profiles.
3) Inclusive Pedagogy (20%) – Teaching approaches that integrate inclusive principles with AI to create equitable and supportive learning environments.
4) Ethical Issues (15%) – Research addressing algorithmic bias, data privacy, and the responsible use of AI in education.
5) AI Tutoring (10%) – The use of chatbots and virtual tutors to support self-directed learning and provide scaffolding for students with special needs.

These focal areas reveal the multidimensional nature of AI's integration into inclusive education and reflect ongoing efforts to bridge technological innovation with human-centered learning practices.

4.3 Types of AI Technologies and Support for Students with Disabilities

Various AI-based technologies have been developed and applied in inclusive educational settings to more adaptively, empathetically, and responsively address the learning needs of students with disabilities (Farhah et al., 2025). These innovations include adaptive learning systems, speech recognition tools, virtual tutors, and interactive media powered by virtual and augmented reality. Such technologies not only

enhance access to information but also expand opportunities for student participation and independence within inclusive learning environments.

To provide a more systematic overview, the following table summarizes the main types of AI technologies along with the specific forms of support they offer to students with disabilities during the learning process (Grote-Garcia et al., 2025).

Table 1. Types of AI Technologies and Their Support Functions in Inclusive Education

AI Technology	Type of Support
Text-to-Speech (TTS)	Supports students with visual impairments
Speech Recognition	Assists verbal communication for students
Adaptive Learning Systems	Adjusts instructional content to students' individual needs
Virtual Tutors / Chatbots	Provides self-guided learning support for students with autism/ADHD
Augmented & Virtual Reality	Enables multisensory and exploratory learning experiences

These technologies have been shown to support a wide range of learning aspects, such as improving conceptual understanding, increasing motivation, reducing anxiety, and enhancing students' autonomy in managing their own learning paths.

4.4 Implementation Challenges and Ethical Issues

Despite the significant potential of artificial intelligence in supporting inclusive education, its implementation in real-world settings faces various critical challenges. One of the most pressing issues is algorithmic bias, which occurs when AI systems are trained on datasets that fail to represent diverse populations. As a result, the outputs and recommendations generated by these systems may inadvertently discriminate against individuals with disabilities.

Another major concern is the lack of teacher training in the pedagogical and ethical use of AI tools. Many educators do not yet possess sufficient digital competencies to effectively integrate AI into inclusive teaching practices. This creates a gap between the potential of the technology and its practical execution in classrooms.

Technological infrastructure limitations also pose serious barriers, particularly in remote and underserved regions where access to devices and reliable internet connectivity is still uneven. Such disparities contribute to digital inequality and restrict participation for students with special needs.

In addition, growing attention is being paid to ethical and privacy-related concerns. Many AI systems involve real-time monitoring of students' behavior, emotional responses, and academic performance. Without strict regulations and transparent data practices, there is a heightened risk of privacy violations and misuse of sensitive information—especially among vulnerable groups such as children with disabilities.

4.5 The Future of AI in Inclusive Education

Looking ahead, AI is projected to become a strategic partner in shaping a more inclusive and equitable education system. Global trends suggest that AI is evolving beyond its role as a technical tool to become a transformative agent in fostering human-centered, diversity-oriented learning ecosystems (Lister et al., 2021).

Ethical, transparent, and empathetic AI development is becoming a central focus. This requires the meaningful involvement of the disability community from the early stages of technology design and development to ensure that AI systems genuinely reflect users' needs. A participatory approach is also essential in building trust and reducing the risk of unintentional digital exclusion.

Cross-sector collaboration—bringing together educators, technology developers, policymakers, and civil society—will be vital in guiding AI adoption in inclusive and sustainable directions. This synergy paves the way for innovations that are not only advanced but also aligned with the rights and potentials of every learner, without exception (Voultsiou & Moussiades, 2025).

5. Conclusion and Recommendations

5.1 Conclusion

This study demonstrates that the application of Artificial Intelligence (AI) in inclusive education holds significant transformative potential for students with disabilities. Through technologies such as adaptive learning systems, text-to-speech tools, educational chatbots, and virtual reality platforms, AI enables the creation of learning environments that are more adaptive, personalized, and human-centered.

The growing number of related publications in recent years reflects increasing academic interest, particularly in the areas of assistive technologies and inclusive pedagogy. However, implementation remains challenged by several key issues, including ethical concerns, algorithmic bias, digital divides, and infrastructural disparities across regions.

AI should not be seen as a replacement for teachers, but rather as a strategic partner in designing learning experiences that are inclusive, equitable, and responsive to students' individual needs. Its integration must always align with the values of equity, diversity, and strong advocacy for marginalized and vulnerable groups.

5.2 Recommendations

Based on the findings and discussions presented, the use of AI in inclusive education presents both immense opportunities and complex challenges. A holistic strategy is required to ensure that AI becomes not merely a technological tool but also a driver of a more equitable, human-centered educational movement. The following three recommendations are proposed to guide future development of AI in inclusive education:

1) **Inclusive and Participatory AI Design**
   AI systems for inclusive education should be developed with more than just technical efficiency in mind. It is essential to involve persons with disabilities as active participants in the innovation process. Collaboration among developers, educators, psychopedagogical experts, and the disability community ensures that technological solutions are truly aligned with the needs and contexts of learners with special needs.

2) **Strengthening Teacher Competency in AI Literacy and Inclusive Pedagogy**
   Teachers play a pivotal role in bridging the gap between technology and student learning experiences. Therefore, enhancing teachers' capacity to understand, assess, and creatively integrate AI into inclusive education should be a key priority. Continuous professional development programs must empower teachers to become not only proficient users of AI but also active partners in its ethical and empathetic application.

3) Policy and Infrastructure Support for Inclusive Technology Access
Governments and educational institutions must establish policies and ecosystems that guarantee equitable access to AI technologies, especially in underserved regions. This includes the provision of disability-friendly hardware and software, fair funding mechanisms, and the integration of digital inclusion principles into national curricula and educational assessment systems.

Reference

Alkeraida, A. (2024). Teachers' Competencies in Implementing Technologies and Artificial Intelligence Applications to Teach Students with Disabilities in Inclusive Classrooms in Saudi Arabia. *Eurasian Journal of Educational Research*, *2024*(112), 177 – 195. https://doi.org/10.14689/ejer.2024.112.10

Almufareh, M. F., Kausar, S., Humayun, M., & Tehsin, S. (2024). A Conceptual Model for Inclusive Technology: Advancing Disability Inclusion through Artificial Intelligence. *Journal of Disability Research*, *3*(1). https://doi.org/10.57197/JDR-2023-0060

Almufareh, M. F., Tehsin, S., Humayun, M., & Kausar, S. (2023). Intellectual Disability and Technology: An Artificial Intelligence Perspective and Framework. *Journal of Disability Research*, *2*(4), 58 – 70. https://doi.org/10.57197/JDR-2023-0055

Balachandran, M., & Rabbiraj, C. (2025). Artificial intelligence: a support system in inclusive education. *International Journal of Knowledge and Learning*, *18*(1), 52 – 64. https://doi.org/10.1504/IJKL.2025.143069

Conti, D., Trubia, G., Buono, S., Di Nuovo, S., & Di Nuovo, A. (2020). Social robots to support practitioners in the education and clinical care of children: The CARER-AID project. *Life Span and Disability*, *23*(Specialissue1), 17 – 30. https://www.scopus.com/inward/record.uri?eid=2-s2.0-85090755951&partnerID=40&md5=226139ae21b6bf069f7dc7332c5854f8

Farhah, N. S., Wadood, A., Alqarni, A. A., Uddin, M. I., & Aldhyani, T. H. H. (2025). Enhancing Adaptive Learning with Generative AI for Tailored Educational Support for Students with Disabilities. *Journal of Disability Research*, *4*(3). https://doi.org/10.57197/JDR-2025-0012

Foley, A., & Melese, F. (2025). Disabling AI: power, exclusion, and disability. *British Journal of Sociology of Education*. https://doi.org/10.1080/01425692.2025.2519482

Gharaibeh, M., Ayasrah, M. N., & Almulla, A. A. (2025). Supplemental role of ChatGPT in enhancing writing ability for children with dysgraphia in the Arabic language. *Education and Information Technologies*. https://doi.org/10.1007/s10639-025-13605-6

Grote-Garcia, S., Ortlieb, E., & Cardona, S. L. (2025). What's Hot in Literacy: Misguided Trends in a Divided Field. *Literacy Research and Instruction*, *64*(1), 1 – 16. https://doi.org/10.1080/19388071.2024.2409130

Gupta, S., Gupta, M., & Gupta, S. B. (2023). Analysis of AI-enhanced educational tools developed in India for linguistic minorities and disabled people. *Life Span and Disability*, *26*(2), 221 – 243. https://doi.org/10.57643/lsadj.2023.26.2_09

Hong, H., & Kim, Y. (2024). Applying artificial intelligence in career education for students with intellectual disabilities: The effects on career self-efficacy and learning flow. *Education and Information Technologies*, *29*(18), 25237 – 25256. https://doi.org/10.1007/s10639-024-12809-6

Kharbat, F. F., Alshawabkeh, A., & Woolsey, M. L. (2021). Identifying gaps in using artificial intelligence to support students with intellectual disabilities from education and health perspectives. *Aslib Journal of Information Management*, *73*(1), 101 – 128. https://doi.org/10.1108/AJIM-02-2020-0054

Lister, K., Coughlan, T., Kenny, I., Tudor, R., & Iniesto, F. (2021). Taylor, the disability disclosure virtual assistant: A case study of participatory research with disabled students. *Education Sciences*, *11*(10). https://doi.org/10.3390/educsci11100587

Marino, M. T., Vasquez, E., Dieker, L., Basham, J., & Blackorby, J. (2023). The Future of Artificial Intelligence in Special Education Technology. *Journal of Special Education Technology*, *38*(3), 404 – 416. https://doi.org/10.1177/01626434231165977

McGrath, C., Cerratto Pargman, T., Juth, N., & Palmgren, P. J. (2023). University teachers' perceptions of responsibility and artificial intelligence in higher education - An experimental philosophical study. *Computers and Education: Artificial Intelligence*, *4*. https://doi.org/10.1016/j.caeai.2023.100139

Meng, X., & Wong, B. E. (2024). Anxiety Sentiment Evaluation and Coping Strategies in English Audio-visual Smart Classroom Based on Artificial Intelligence. *Pakistan Journal of Life and Social Sciences*, *22*(2), 9917 – 9927. https://doi.org/10.57239/PJLSS-2024-22.2.00749

Miller, C. A., Meadan, H., Olszewski, A., Kientz, J. A., & Xionge, J. (2025). Supporting Speech-Language Pathologists in Schools With Interdisciplinary Team Science: A Viewpoint From the National Artificial Intelligence Institute for Exceptional Education. *Language, Speech, and Hearing Services in Schools*, *56*(2), 431 – 438. https://doi.org/10.1044/2025_LSHSS-24-00113

Omri, A., Slimani, S., & Afi, H. (2025). The Role of Artificial Intelligence and Digital Solutions in Transforming Educational and Employment Access for Individuals With Disabilities. *British Journal of Sociology*. https://doi.org/10.1111/1468-4446.13225

Qusef, A., Murad, S., Alsalhi, N. R., & Gharaibeh, F. Al. (2025). Leveraging Artificial Intelligence to Identify Students with Learning Challenges. *International Journal of Learning, Teaching and Educational Research*, *24*(5), 623 – 643. https://doi.org/10.26803/ijlter.24.5.32

Rice, M. F., & Dunn, S. (2023). The Use of Artificial Intelligence with Students with Identified Disabilities: A Systematic Review with Critique. *Computers in the Schools*, *40*(4), 370 – 390. https://doi.org/10.1080/07380569.2023.2244935

Tzimiris, S., Nikiforos, S., & Kermanidis, K. L. (2023). The Effect of Emergency Remote Teaching on Students with Special Educational Needs and/or Disability during the COVID-19 Pandemic: The Parents' View. *International Journal of Information and Education Technology*, *13*(4), 684 – 689. https://doi.org/10.18178/ijiet.2023.13.4.1853

Voultsiou, E., & Moussiades, L. (2025). A systematic review of AI, VR, and LLM applications in special education: Opportunities, challenges, and future directions. *Education and Information Technologies*. https://doi.org/10.1007/s10639-025-13550-4

Wang, M., Tlili, A., Khribi, M. K., Lo, C. K., & Huang, R. (2025). Generative artificial intelligence in special education: A systematic review through the lens of the mediated-action model. *Information Development*. https://doi.org/10.1177/02666669251335655

Wilson, S. E., Wiggins, J. B., Wong, L. N., Ulrich, T. G., Causey, B., Parra, J., Gage, N. A., & Blackorby, J. (2025). Leveraging Design-Based Research in the Development of a Technology-Based Intervention for Students With Disabilities. *Journal of Special Education Technology*, *40*(2), 195 – 207. https://doi.org/10.1177/01626434251317989

Zaleski, A. L., Berkowsky, R., Craig, K. J. T., & Pescatello, L. S. (2024). Comprehensiveness, Accuracy, and Readability of Exercise Recommendations Provided by an AI-Based Chatbot: Mixed Methods Study. *JMIR Medical Education*, *10*(1). https://doi.org/10.2196/51308