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# A Global Bibliometric Analysis of Inclusive Education: Research Trends, Conceptual Challenges, and Emerging Technologies (2021–2025)

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**Abstract.** This bibliometric study analyzes 348 Scopus-indexed documents (2021–2025) to map global research trends in inclusive education using VOSviewer. Five major keyword clusters emerged: (1) inclusive education and teacher training, (2) assistive technology and disability support, (3) COVID-19 and digital distance learning, (4) artificial intelligence and immersive technologies, and (5) curriculum development and policy. The analysis reveals a significant global shift toward technology-enhanced inclusive education, with growing interest in AI-driven adaptive learning and user-centered assistive technologies. However, persistent barriers include digital inequality, limited teacher competence, and weak institutional readiness. This study identifies research gaps and proposes priority areas for future investigation: UDL-based curriculum design, technology-supported teacher development, and cross-country comparative studies to strengthen policy implementation.

**Keywords:** inclusive education, educational technology, artificial intelligence, teacher competence, digital equity.

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## INTRODUCTION

Inclusive education has become a defining global commitment within the Sustainable Development Goals (SDGs), especially SDG 4, which emphasizes inclusive, equitable, and quality education for all learners. As nations expand educational participation, inclusive education is increasingly understood not merely as integrating learners with disabilities but as ensuring equitable participation across cultural, linguistic, socioeconomic, and geographic differences (Rodríguez & Frumuselu, 2023). Despite strong global advocacy, the practical implementation of inclusion remains fragmented, with significant disparities in teacher preparedness, digital access, and institutional readiness (Ndlovu & Walton, 2023).

Technological advancement has reshaped the landscape of inclusive education over the last decade. Digital innovations such as assistive technologies, AI-powered tutoring systems, multimodal learning platforms, and the Universal Design for Learning (UDL) framework are increasingly integrated into inclusive classrooms (Verde et al., 2023; Smolansky et al., 2024). These technologies make learning more adaptive and accessible for students with disabilities and those living in underserved and remote areas. During the COVID-19 pandemic, digital

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tools played a crucial role in maintaining continuity of learning, especially for learners who rely heavily on structured and individualized support (Calderón et al., 2023; Layachi & Pitchford, 2024).

However, the rapid digital transition has also exposed new challenges. Digital inequality remains one of the most persistent barriers to inclusive education globally. Students in rural or low-income communities continue to face limited internet access, inadequate devices, and low levels of digital literacy (Bayor et al., 2025). Teachers encounter structural challenges such as insufficient training, fragmented professional development programs, and emotional fatigue when working under poorly supported inclusive digital systems (Daems et al., 2023; Reyes et al., 2025). These challenges highlight the urgent need for high-quality, sustained, and context-responsive professional development. Meanwhile, emerging fields such as learning analytics, adaptive learning, AI-based assessment, and immersive technologies (AR/VR) offer significant opportunities for developing data-driven inclusive pedagogies (Khasawneh, 2024; Vongkulluksn et al., 2024).

Given these opportunities and challenges, a systematic and comprehensive mapping of global research is needed. Bibliometric analysis provides a rigorous method to examine patterns, conceptual structures, and evolutions in inclusive education scholarship. This study aims to conduct a global bibliometric analysis of inclusive education research published between 2021 and 2025 in Scopus-indexed journals, guided by four research questions: (1) What are the global research trends related to inclusive education during 2021–2025? (2) Which educational technologies are most widely used to support inclusive education worldwide? (3) What conceptual challenges emerge in technology-supported inclusive education? (4) What are the future research directions and opportunities from a global educational science perspective?

## METHODOLOGY

This study employed a quantitative bibliometric design to map global research developments in inclusive education from 2021 to 2025. The Scopus database was selected as the primary source because it provides comprehensive coverage of international peer-reviewed publications and consistent metadata needed for bibliometric analysis (Verde et al., 2023). Data retrieval was conducted in April 2025.

Research Design and Data Collection

A systematic search strategy was developed using key terms associated with inclusive education and emerging educational technologies, limited to 2021–2025. The search generated 476 initial records. A PRISMA-guided screening process ensured relevance and quality. Inclusion criteria required studies to be: (1) published in Scopus-indexed journals; (2) written in English; (3) published between 2021–2025; and (4) focused on inclusive education, digital inclusion, assistive technologies, or teacher readiness. Books, editorials, non-English papers, and duplicates were excluded. After screening, 348 documents were retained for analysis.

Data Analysis

Metadata extracted included authors, titles, abstracts, keywords, affiliations, and citations. Analytical procedures were conducted using VOSviewer 1.6.21. Keyword co-occurrence mapping identified conceptual relationships between topics, while network and overlay visualization techniques captured thematic clusters and the chronological evolution of research trends. Keyword normalization ensured consistency in the clustering process.

## RESULTS AND DISCUSSION

Bibliometric findings based on 348 Scopus-indexed articles published between 2021 and 2025 identified 40 frequently occurring keywords grouped into five clusters: (1) inclusive education, disability, higher education, and teacher training; (2) information technology, computer-aided instruction, autism spectrum disorders, and learning platforms; (3) special education, COVID-19, distance learning, and digital communication; (4) artificial intelligence, adaptive learning, augmented reality, and immersive environments; and (5) curriculum design, educational computing, and personnel training.

Global Research Trends in Inclusive Education

Technological integration has become a central pillar in the evolution of global inclusive education. Dominant keywords such as educational technology, assistive technologies, and adaptive learning environments indicate a shift from conventional approaches toward adaptive systems responsive to individual learner needs (Khasawneh, 2024). Technologies for students with visual impairments are particularly prominent, with Verde et al. (2023) developing Py2UML, a text–audio-based tool enabling visually impaired learners to understand UML

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diagrams. Similarly, Smolansky et al. (2024) designed digital learning tools for low-vision students. Despite these advancements, digital inequality remains a significant concern, with gaps in both technology access and digital competence among students with disabilities (Bayor et al., 2025).

Teacher competence in implementing technology-supported inclusive approaches is central to successful digital inclusive education. Well-designed technology-integrated training enhances teacher confidence and pedagogical effectiveness (Daems et al., 2023). However, many training programs are short-term, fragmented, and lack contextual adaptation. Institutional readiness also plays a critical role, as weak digital infrastructure and limited managerial support can hinder sustainable implementation (Kawane et al., 2025). Furthermore, institutional policy often treats technology as complementary rather than integral to inclusive education (Van Hove et al., 2024).

The COVID-19 pandemic served as a transformative catalyst for digital inclusive education. Layachi and Pitchford (2024) evaluated a personalized mathematics learning app for Arabic-speaking children, reflecting the urgent need for flexible, home-accessible learning tools. The post-pandemic era reinforces learning models that prioritize flexibility, mobility, and cross-sector collaboration.

Conceptual Challenges and Supporting Technologies

The concept of inclusion has broadened beyond integrating students with disabilities into regular classrooms. Recent literature shows a shift toward a multidimensional perspective encompassing cultural, linguistic, and socioeconomic diversity (Rodríguez & Frumuselu, 2023). However, many policy frameworks focus narrowly on disability while overlooking socioeconomic and gender disparities, creating inconsistencies in classroom implementation (Ndlovu & Walton, 2023).

Five major types of supporting technologies emerged: (1) Assistive technologies overcome sensory barriers; (2) Artificial intelligence personalizes learning by adapting content to individual learner profiles (Khasawneh, 2024); (3) Augmented and Virtual Reality (AR/VR) offers immersive learning experiences, though still underexplored; (4) Learning Management Systems enhance online learning with inclusive features (Kawane et al., 2025); and (5) Universal Design for Learning (UDL) provides a framework for flexible curricula ensuring meaningful participation.

## CONCLUSION

Global research on inclusive education from 2021 to 2025 is increasingly driven by digital transformation, with dominant themes of assistive technology, artificial intelligence, UDL-based design, digital inclusion, and hybrid learning signaling a shift toward adaptive and technology-enabled inclusion. Despite technological progress, significant barriers persist: limited teacher readiness, unequal digital infrastructure, and slow policy alignment demonstrate that technological innovation alone cannot guarantee equitable learning without strong institutional capacity and pedagogical support. Recommended priorities include strengthening digital equity through improved connectivity and device access, enhancing teacher competence in integrating assistive and AI-based technologies, aligning national policies with digital inclusion frameworks, expanding cross-country collaboration, and conducting deeper empirical studies to complement bibliometric patterns. Future research should emphasize ethical and responsible use of emerging AI tools to safeguard privacy, accessibility, and fairness in inclusive learning environments.

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