

Impact of artificial intelligence on special needs education



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ABSTRACT

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This study examines the role of Artificial Intelligence (AI) in the education of students with special educational needs (SEN) through a systematic literature review (SLR) and bibliometric analysis of 120 studies published between 2015 and 2025, following the PRISMA protocol. It explores technological advancements, pedagogical applications, thematic trends, and ethical challenges. AI applications, including machine learning, natural language processing, and adaptive systems, demonstrate significant potential for personalizing learning, enhancing accessibility, and supporting the emotional development of students with SEN. However, implementation faces limitations related to teacher training, digital divides, and inadequate regulatory frameworks. Bibliometric analysis revealed sustained growth in publications since 2021, with influential journals such as *Educational Technology and Society* and the *Journal of Special Education Technology* standing out. Key research lines include digital accessibility, emotional recognition, personalized learning, and the use of chatbots or smart sensors. Despite progress, a disconnect persists between technological development and effective classroom application, alongside limited representation of studies from the Global South. The study concludes that AI can be a powerful ally for educational inclusion, provided its implementation is guided by ethical principles, inclusive frameworks, and contextual sensitivity. It recommends promoting longitudinal and intersectional research to assess the real impact of these technologies and foster truly equitable education grounded in educational justice.

Contribution/ Originality: This study uniquely integrates a systematic literature review and bibliometric analysis to examine Artificial Intelligence applications in special needs education from 2015 to 2025. It identifies technological, pedagogical, and ethical challenges while offering an evidence-based, contextualized framework that advances inclusive education and provides new insights for policy, research, and classroom implementation.

1. INTRODUCTION

Digital transformation has redefined educational processes at all levels, promoting the adoption of emerging technologies like Artificial Intelligence (AI) to optimize teaching and learning. In this context, AI has emerged as a key tool not only for personalizing educational experiences but also for more effectively addressing the needs of students with special educational needs (SEN).

These technologies, including machine learning algorithms, natural language processing, adaptive systems, and emotional recognition, have shown immense potential to break down access barriers, enhance participation, and tailor content to students' cognitive, sensory, or emotional needs [1, 2].

However, deploying AI-based solutions in special education poses significant challenges. While there is growing enthusiasm for their potential to promote inclusion, concerns remain about their technical feasibility, pedagogical relevance, and ethical implications. Issues such as the digital divide, limited teacher training in emerging technologies, lack of specific regulatory frameworks, and the risk of dehumanizing the educational process must be carefully considered [3, 4].

Although some studies propose promising models for detecting specific needs using EEG signals or computer vision [5, 6] the real-world application of these technologies in school settings still requires more contextualized analysis.

The education of students with SEN demands person-centered approaches, sensitive to diversity and grounded in equitable pedagogical practices. In this sense, AI should not be seen as a replacement for educators but as a complement that enhances their work, facilitating the design of more accessible, personalized, and emotionally responsive learning environments [7].

This vision requires effective articulation between technological innovation and principles of educational justice, necessitating rigorous research to critically analyze existing applications and their actual impact on the learning and well-being of this population.

Despite the growing number of publications on the topic, there is conceptual and methodological fragmentation in studies on AI in special education. Many focus on specific technological solutions without connecting findings to inclusive theoretical frameworks or global educational policies [8, 9]. Consequently, a systematic perspective is needed to map the state of the art, identifying technological advances, thematic trends, and cross-cutting challenges shaping the field.

This study aims to fill this gap through a systematic literature review (SLR) and bibliometric analysis, following the PRISMA protocol. It focuses on exploring how the intersection of AI and the education of students with SEN has developed scientifically between 2015 and 2025.

In doing so, it seeks to provide a critical, evidence-based, and up-to-date perspective that identifies both contributions and persistent challenges in achieving equitable, accessible, and truly inclusive education supported by technology.

2. METHODOLOGY

This study adopts a mixed-method approach, combining a Systematic Literature Review (SLR) and a Bibliometric Analysis, following the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) protocol. This methodology enables the exploration, mapping, and analysis of scientific production on the use of Artificial Intelligence (AI) in educational contexts for students with special needs.

2.1. Research Design and Search Protocol

The PICO model was used to formulate the research question:

- P (Population): Students with special educational needs (SEN).
- I (Interest): Applications of Artificial Intelligence (AI) in teaching-learning processes.
- Co (Context): Educational settings (School-based, virtual, inclusive).

General Research Question: What is the impact of artificial intelligence on the education of students with special needs?

2.1.1. Sub-Questions

- Q1: What research trends exist regarding AI in special education?
- Q2: Which AI applications have proven effective in supporting students with SEN?
- Q3: What ethical, technological, and pedagogical challenges are reported in the literature?

2.2. Information Sources and Search Strategy

The databases used were Scopus and Web of Science due to their multidisciplinary coverage and validation in scientific research. The search strategy incorporated Boolean operators, truncations, and exact phrase searches.

- Web of Science: TS= ("Artificial intelligence" OR "machine learning") AND ("Special education" OR "learning disabilities" OR "inclusive education").
- Scopus: TITLE-ABS-KEY ("Artificial intelligence" OR "AI") AND TITLE-ABS-KEY ("Special education" OR "inclusive education").

2.3. Inclusion and Exclusion Criteria

2.3.1. Inclusion

- Publications from 2015–2025.
- Publications in English or Spanish.
- Original articles (Reviews, conference papers, bibliometric studies, and editorials excluded).

2.4. Data Extraction and Cleaning Procedure

Search results were exported in .csv format from Scopus and .xlsx from Web of Science. Duplicates and irrelevant records were removed through a process involving title, abstract, and, when necessary, full-text review. The PRISMA flow diagram was used to transparently document the selection and exclusion stages (Figure 1). The process adhered to the PRISMA 2020 guidelines [10], ensuring transparency and reproducibility.

2.5. Bibliometric Analysis

The bibliometric analysis was conducted using R software (version 4.4.2) [11]. Specialized packages were used for data processing and cleaning:

- Readxl: To import Web of Science records in .xls format.
- Data.table: For efficient reading and management of large Scopus .csv files.
- Dplyr: For data manipulation, including merging datasets, filtering records based on Boolean search terms, and selecting relevant variables.
- Openxlsx: To export cleaned and merged datasets in .xlsx format.
- Ggplot2 and gridExtra: To generate visualizations of publication and citation trends over the analyzed period.

Bibliometric records from Web of Science and Scopus were integrated after standardizing titles to lowercase. Duplicates were identified and removed by comparing titles.

Boolean filtering ensured thematic relevance, selecting only articles explicitly including terms like “artificial intelligence” or “machine learning” and “special education,” “learning disabilities,” or “inclusive education” in the title or abstract. Reviews and exclusively bibliometric studies were excluded to maintain an empirical focus.

Productivity (number of publications) and impact (citations received) were synthesized by year and visualized using cumulative area charts and bar charts to highlight emerging trends. Influential journals were also analyzed.

Finally, VOSviewer (version 1.6.20) was used to generate co-occurrence maps of keywords, providing a visual representation of the structure and interconnections within the research field on machine learning.

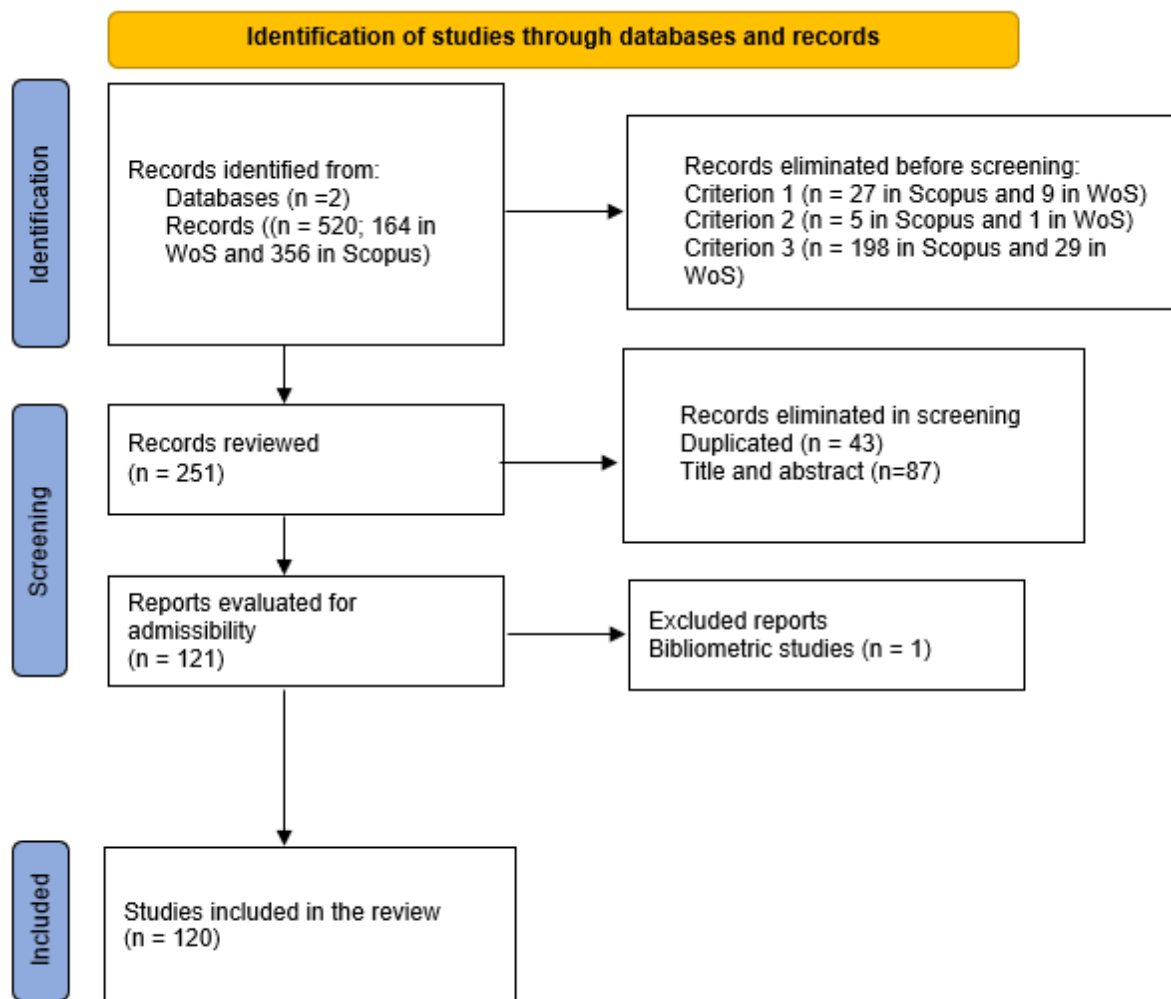


Figure 1. PRISMA 2020 flow diagram of the study selection process.

The initial search was conducted on July 2, 2025. After applying the PRISMA-guided selection protocol, 120 studies meeting the methodological and thematic requirements were selected for analysis, forming the final corpus of this review.

3. RESULTS

3.1. Productivity and Citation Analysis

Figure 2 graphically represents the annual evolution of the number of published documents and citations received in the field of AI use in the education of students with special needs. This figure identifies temporal patterns in productivity and academic impact.

Scientific productivity showed sustained growth over the analyzed period. Between 2015 and 2020, production was low and stable, with only 1 or 2 documents per year. However, a rising trend began in 2021, with a significant increase in 2023 (14 documents) and a peak in 2024 (51 publications, 33.6% of the total). In 2025, although the number slightly decreased to 35 documents, it remained high compared to earlier years, suggesting a consolidation of research interest.

Regarding citation impact, three significant peaks were recorded: in 2015 (111 citations), 2022 (453 citations), and 2023 (234 citations). The year 2022 stands out as having the highest relative impact, accounting for 34.4% of total citations despite only 8 documents, indicating a high average citability per article. This may be due to the publication of seminal studies or comprehensive reviews widely referenced in the field. In contrast, 2025 shows a

significant drop in citations (51) despite a high number of documents, likely due to the limited exposure time of recent publications, a common phenomenon in bibliometric studies.

Overall, Figure 2 suggests that the field has undergone a process of scientific maturation. Initially, a low number of documents was offset by high citation rates (e.g., 2015 and 2019), while in recent years, the expansion of production has not yet translated into proportional citations. These results reflect a shift from an emerging literature to a more active and diversified research community, likely to continue evolving in the coming years.

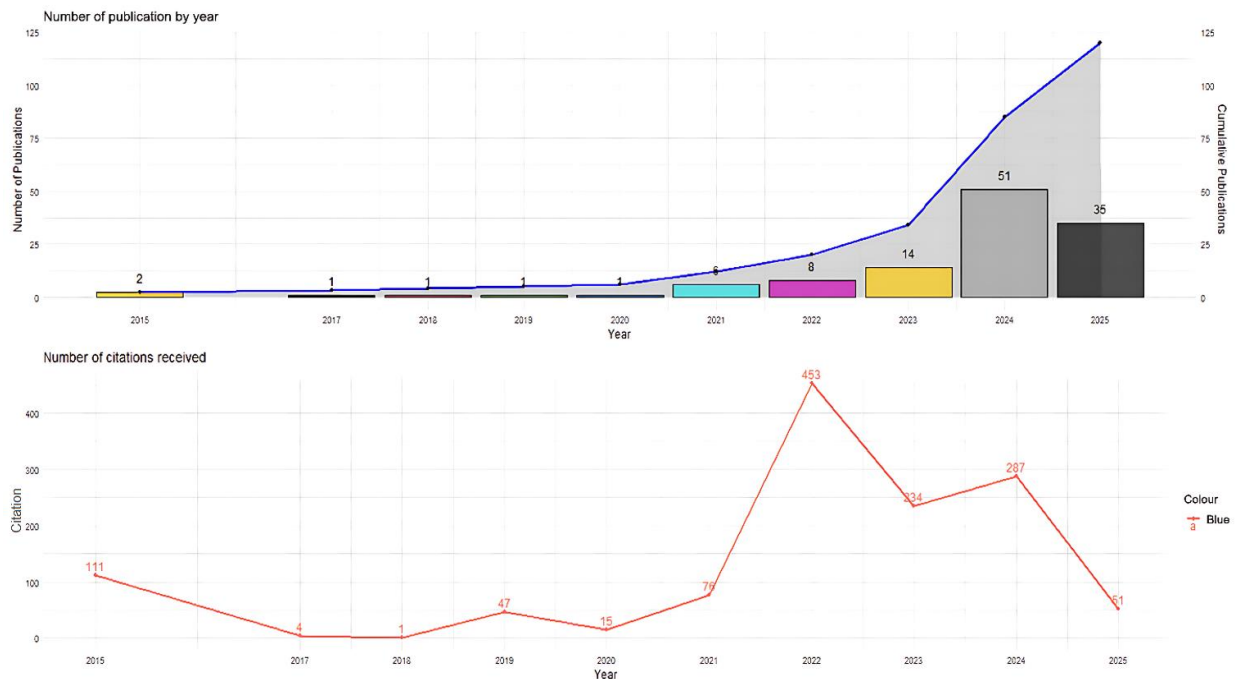


Figure 2. Annual evolution of scientific productivity and citations on AI in special education (2015–2025).

The most cited studies in the analyzed corpus provide a robust empirical foundation for understanding the evolution of AI use in special education. These works stand out for their impact in the scientific community and their diversity in methodological and thematic approaches.

- Chen et al. [12], with 367 citations, conducted a bibliometric review of two decades of research, identifying trends, gaps, and future challenges at the intersection of AI and special education.
- Iuculano et al. [13] provided neuroscientific evidence demonstrating, through neuroimaging studies, that personalized cognitive tutoring induces brain neuroplasticity in children with dyscalculia.
- Hopcan et al. [14] systematically explored AI applications in special education, highlighting both their pedagogical potential and risks of exclusion.
- Barua et al. [15] developed an adaptive learning system for children with developmental mental disorders, focusing on emotional health.
- Bulathwela et al. [8] questioned the isolated efficacy of AI, advocating for integration with open educational resources and digital inclusion policies.
- Marino et al. [16] discussed the future of AI in inclusive contexts, emphasizing its potential for personalized learning and improved accessibility.
- Ouherrou et al. [17] compared facial recognition algorithms to detect emotions in children with learning disabilities, contributing to the design of responsive environments.
- Lamos et al. [18] proposed an AI tool to predict specific educational needs in inclusive classrooms.
- Rakap [9] investigated the use of chatbots for individualized support for novice special education teachers.
- Gulati et al. [19] explored predictive models to enhance reading in virtual environments.

- Yao and Wang [3] analyzed factors influencing the acceptance of AI-based technologies by future special education teachers.
- Seshadri et al. [1] used EEG signals to classify children with learning difficulties, highlighting the role of biomarkers in early detection.
- Toyokawa et al. [20] identified opportunities for applying AI in inclusive education, particularly through active and adaptive reading approaches.
- Garcia-Argibay et al. [5] applied machine learning models to predict developmental disorders such as ADHD, combining genetic and environmental factors.
- Vistorte et al. [21] evaluated AI use for measuring emotions during learning, while Yao and Wang [3] emphasized digital literacy in teacher training.
- Karyotaki and Drigas [22] presented digital applications to enhance cognitive skills in individuals with autism.
- Tafazoli [23] discussed opportunities and challenges of using ChatGPT in teaching English to students with special needs.
- Alwaqdani [24] investigated teachers' perceptions of AI in school settings, and Alarcon et al. [25] developed a lexical simplification system to improve web accessibility for individuals with intellectual disabilities.

Collectively, these studies have defined priority research lines, including personalized learning, digital accessibility, teacher support, emotional assessment, and ethical design of inclusive technologies, explaining their high citation rates and central role in the field's recent development.

3.2. Most Influential Journals

Table 1 presents the main journals contributing to the field, identifying ten journals with at least two relevant publications, distinguished by both volume and citation impact.

The most influential journal is *Educational Technology and Society*, with only two articles but accumulating 370 citations, indicating high impact per article. It is followed by *Journal of Special Education Technology* (5 articles, 99 citations) and *Education and Information Technologies* (4 articles, 81 citations), showing a combination of high productivity and solid citation levels.

Technology-focused journals like *IEEE Access* (3 articles, 24 citations) and *Sensors* (3 articles, 19 citations) also play a significant role, reflecting the interdisciplinary nature of the topic. In contrast, journals like *Teaching Exceptional Children* have lower impact (2 articles, 2 citations), possibly due to their more practical or pedagogical orientation.

This analysis confirms that impact is not solely tied to publication volume but also to the perceived quality and visibility of articles within the scientific community.

Table 1. Main Scientific journals at the intersection of AI and inclusive education (2015–2025).

Source title	Quantity	Citations
Journal of Special Education Technology	5	99
Frontiers in education	4	7
IEEE ACCESS	3	24
SENSORS	3	19
Educational technology and society	2	370
Education and information technologies	4	81
Research in developmental disabilities	2	14
Journal of disability research	2	13
Applied sciences-Basel	2	9
Teaching exceptional children	2	2

The scientific production in these influential journals reflects a diverse and expanding body of research addressing AI applications in inclusive educational contexts. *Educational Technology and Society* leads with high-impact publications like Chen et al. [12], which maps two decades of thematic and methodological evolution in educational

AI, and Zhang et al. [26], which examines the impact of intelligent learning environments on motivation and academic performance.

In the *Journal of Special Education Technology*, Marino et al. [16] explore future AI trends in special education, while Rakap [9] highlights the utility of chatbots in supporting pedagogical planning.

Education and Information Technologies are key areas for technical developments. Ouherrou et al. [17] evaluate emotion recognition algorithms for children with learning difficulties, and Alwaqadani [24] investigates teachers' attitudes toward AI integration, revealing opportunities and resistance.

Frontiers in Education includes research like Jiao et al. [27] evaluating adaptive tutoring systems for personalized learning. *Sensors* and *IEEE ACCESS* contribute a technical dimension with studies like Gulati et al. [19] applying neural networks to enhance online reading comprehension.

Ethical and social aspects are also addressed, such as Bulathwela et al. [8] in *Sustainability*, advocating for inclusive policies alongside AI deployment, and El-Ashram et al. [28] identifying contextual requirements for effective AI implementation in Global South educational settings.

Recent studies in *Teaching Exceptional Children* [4] address AI in early childhood education, while Garcia-Argibay et al. [5] in *Molecular Psychiatry* introduce biomedical applications predicting disorders like ADHD using AI.

The journals listed in Table 1 lead in publication volume and host research spanning algorithmic analysis to educational policy frameworks, consolidating their influence in AI-mediated inclusive education.

3.3. Thematic Areas

Figure 3 generated using VOSviewer, shows the co-occurrence map of the most relevant keywords in the analyzed literature includes 336 items grouped into 37 clusters, with 1,170 links and a total link strength of 1,260, indicating a highly interconnected network.

The terms with the highest occurrences and link strength are *artificial intelligence* (38 occurrences, link strength 182), *machine learning* (15, 66), *special education* (13, 54), and *inclusive education* (10, 36). These keywords reflect the study's central thematic axes: the application of intelligent technologies in inclusive contexts and special educational needs.

Complementary terms like *chatbots*, *adaptive learning*, *accessibility*, *dyslexia*, *visual impairment*, and *professional development* suggest that the literature also covers practical implementation, specific conditions, and teacher training.

Emerging concepts such as *generative artificial intelligence*, *ethical AI use*, or *transformative practice* indicate the field's evolution toward contemporary issues like technological ethics and innovative pedagogical design. Terms like *learning disability*, *students with disabilities*, and *special education leadership* highlight a continued focus on administrative and policy approaches to educational inclusion.

The map also reveals low-occurrence but significantly connected terms like *AI in education*, *neurodevelopmental disorders*, or *contextualized word embeddings*, suggesting future research opportunities in underexplored areas.

The keyword co-occurrence map in Figure 3 reveals the most frequent thematic connections in recent literature on AI in inclusive education, supported by findings from 60 selected studies representing the field's conceptual and methodological diversity.

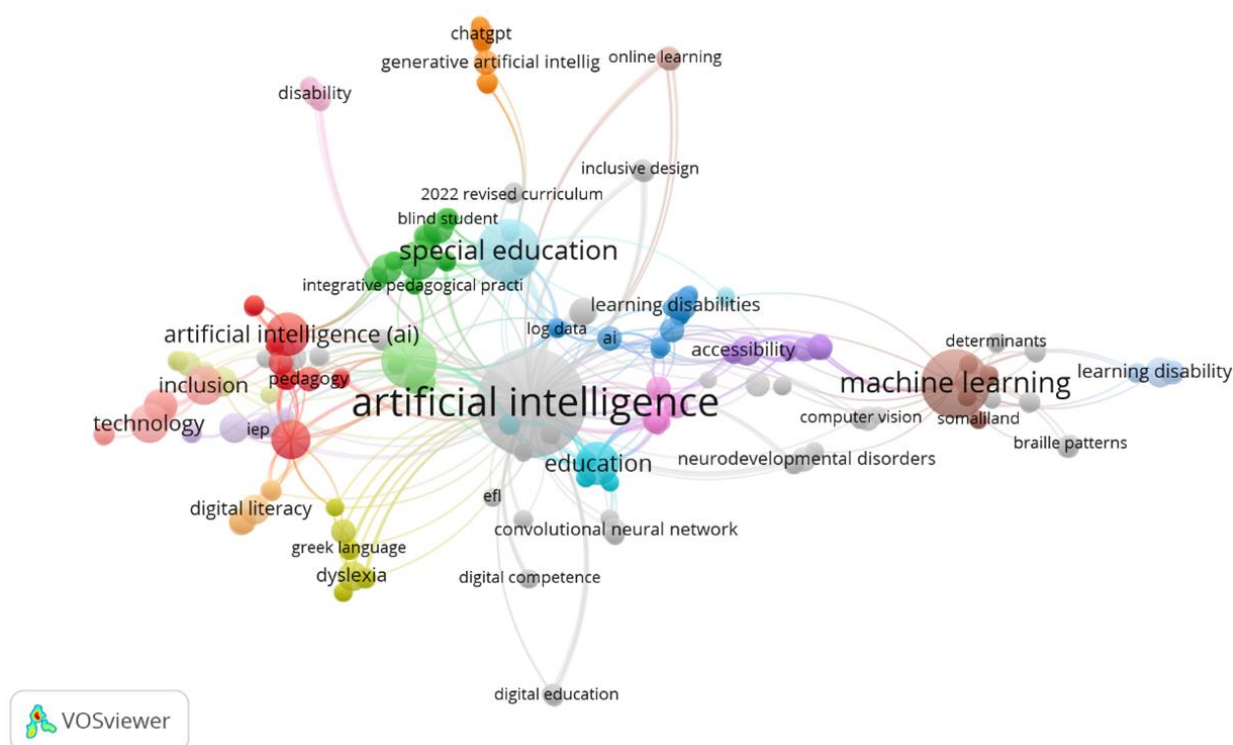


Figure 3. Keyword Co-occurrence Map in research on AI and special educational needs.

Central terms like *artificial intelligence*, *inclusive education*, and *special education* relate to studies like Vitale and Iacono [7], who evaluate social robots as pedagogical tools in inclusive settings, and Sushchenko et al. [29], proposing a Society 5.0-based pedagogical approach for inclusive excellence. Similarly, Howorth et al. [2] integrate emerging technologies to enhance the socioemotional skills of students with disabilities. In the *machine learning*, *deep learning*, and *smart sensors* line, Bublin et al. [30] developed an AI-based system to assess handwriting in children with dyslexia using neural networks to detect graphic patterns.

Studies focusing on *teacher training* and *professional development*, like [9], address the use of educational chatbots to support novice teachers in developing inclusive practices. Meanwhile, Alwaqdani [24] explores teachers' perceptions and readiness for AI use, identifying barriers related to digital training.

Regarding *natural language processing* and *accessibility*, works like Gulati et al. [19] develop AI-assisted reading comprehension systems, while Alarcon et al. [25] present a lexical simplification model to enhance web navigation for individuals with cognitive disabilities. Tafazoli [23] explores ChatGPT's use in teaching English to students with special needs, highlighting its potential for adapting linguistic content.

Emerging ethical themes, such as *responsible AI* and *equity*, are also present. Bulathwela et al. [8] argue that learning democratization requires not only technology but also open educational resources and inclusive policies. Vistorte et al. [21] propose an emotionally sensitive AI platform to foster classroom well-being.

Studies like Barua et al. [15] and Marino et al. [16] emphasize the design of adaptive and personalized learning systems tailored to diverse neurocognitive profiles. Ouherrou et al. [17] advance the integration of computer vision and emotional analysis to enhance the educational experience of students with disabilities.

The richness of terms like *educational robotics*, *chatbots*, *cognitive load*, *dyslexia*, *emotional recognition*, and *digital equity* in the nodes and links of Figure 3 reflects predominant themes and interdisciplinary challenges faced by the scientific community.

The conceptual breadth of this network supports the notion that AI in special education is an expanding field, converging pedagogy, computer science, neuroscience, and ethics.

4. DISCUSSION

4.1. Integrating Artificial Intelligence into Inclusive Special Education

The findings of this study demonstrate a steady and significant growth in the integration of Artificial Intelligence (AI) into special and inclusive education between 2015 and 2025, reflecting a notable transformation in the way pedagogical processes are being conceptualized. While the results highlight an increase in publications from 2021 onwards, peaking in 2024 with 51 studies, this expansion aligns with broader technological advances and heightened interest in personalized learning strategies.

Several highly cited studies provide critical context for these findings. [Chen et al. \[12\]](#) mapped two decades of AI and special education research, identifying persistent challenges in bridging technological development with effective classroom implementation. Consistent with our results, their analysis revealed that while the field has evolved rapidly, there remains a mismatch between the technical sophistication of AI systems and their actual integration into pedagogical practices. Similarly, [Hopcan et al. \[14\]](#) concluded that despite the increasing number of AI-based educational tools, their practical application is often constrained by gaps in teacher training, funding, and institutional support, which resonates with the trends observed in the current corpus.

Furthermore, [Marino et al. \[16\]](#) argued that although adaptive technologies and intelligent tutoring systems provide transformative potential, inclusion depends on ensuring contextual sensitivity and human-centered design. This reinforces the importance of not perceiving AI as an autonomous replacement for teachers but rather as a tool to enhance educators' capacity to deliver personalized learning pathways, a theme consistently echoed across studies in this review.

The growing attention to personalized adaptive systems aligns closely with empirical contributions like those of [Barua et al. \[15\]](#), who developed AI-enabled assistive tools for students with neurodevelopmental disorders. Their research highlights how integrating machine learning-driven emotion recognition into adaptive platforms fosters more inclusive and emotionally supportive learning environments, supporting our observation that the intersection between AI and socio-emotional development has become a central research frontier.

4.2. Contrasting Pedagogical Strategies Across Studies

A cross-comparison of the studies analyzed in this review reveals significant variation in pedagogical objectives and implementation contexts for AI-based systems. For instance, [Vitale and Iacono \[7\]](#) explored the role of social robots as mediators for inclusive learning, emphasizing their potential to improve storytelling-based instruction for mathematics in students with cognitive impairments. In contrast, [Seshadri et al. \[1\]](#) prioritized early detection and intervention, employing EEG-based neural network models to identify cognitive and learning disorders before they manifest in academic performance.

These contrasting approaches highlight a critical insight supported by our findings: the application of AI in inclusive education spans a continuum from detection to personalized intervention. While platforms like [Ouherrou et al. \[17\]](#) demonstrated the feasibility of emotion recognition using facial analytics in children with learning disabilities, [Gulati et al. \[19\]](#) developed AI-assisted reading comprehension systems aimed at improving engagement and learning efficiency in virtual classrooms.

Comparing these works underscores that while early diagnostic tools focus on identifying special educational needs through predictive analytics, adaptive learning environments seek to transform instructional delivery once challenges are recognized. This dual function of AI diagnostic and instructional emerges as one of the most critical findings of the literature synthesized in this study.

Furthermore, the geographical and institutional diversity of these applications adds nuance to the discussion. Studies conducted in technologically advanced settings, such as those by [Toyokawa et al. \[20\]](#) in Japan and [Zhou et al. \[6\]](#) in China, report high feasibility and accuracy in AI-driven educational tools. In contrast, research from the Global South, including [El-Ashram et al. \[28\]](#), reveals persistent limitations due to digital inequities, inadequate

infrastructure, and restricted teacher preparation issues also confirmed by Bulathwela et al. [8], who warned of “techno-solutionism” when AI tools are developed without addressing systemic educational inequalities.

4.3. The Ethical and Socio-Emotional Dimensions of AI Integration

The expansion of AI in inclusive education raises profound ethical considerations, especially in contexts involving children with disabilities. As highlighted in the results, research on biometric and emotion-sensitive technologies has grown substantially since 2021, with Vistorte et al. [21] proposing an emotionally responsive platform capable of analyzing real-time affective states during learning. While these innovations offer unprecedented personalization, they introduce significant ethical dilemmas regarding data privacy, consent, and potential emotional manipulation.

Moreover, this review confirms a critical gap in studies from low-resource educational environments, where AI implementation faces obstacles linked to cultural adaptation and regulatory absence. Yao and Wang [3] showed that teachers’ acceptance of AI-based tools depends heavily on digital literacy, perceived usefulness, and institutional support, suggesting that teacher empowerment is an essential prerequisite for effective AI integration.

Equally important is the recognition of AI’s influence on emotional well-being. Barua et al. [15] highlighted that adaptive systems can integrate affective computing techniques to support students’ socio-emotional health, while Vitale and Iacono [7] showed how social robots improved engagement and reduced learning-related anxiety among students with dyslexia and autism spectrum disorders. These results reinforce the importance of human-AI collaboration in inclusive learning environments rather than replacing pedagogical relationships with technological automation.

4.4. Teacher Readiness, Training, and Institutional Support

The findings strongly suggest that teacher preparation and digital competencies are decisive factors influencing the successful implementation of AI-based interventions. Despite increasing technological sophistication, studies such as Alwaqadani [24] revealed that many educators remain skeptical about AI due to limited training opportunities and a perceived lack of institutional alignment with inclusive practices.

Rakap [9] introduced the use of chatbots to guide novice special education teachers in developing Individualized Education Program (IEP) goals, demonstrating significant improvements in instructional planning. Similarly, Howorth et al. [2] reported that integrating emerging technologies into teacher preparation curricula enhanced educators’ confidence in using adaptive platforms to foster equity.

These findings align with broader trends observed in this review, revealing that technological readiness alone is insufficient for meaningful integration. Institutional leadership, funding priorities, and policies surrounding digital inclusion remain pivotal. Bulathwela et al. [8] cautioned that excluding teachers from AI design processes reinforces pre-existing inequalities, arguing for participatory development frameworks where educators play a central role in shaping the tools they use.

4.5. Emerging Research Frontiers and Technological Innovations

The results of this study also reveal a shift toward generative AI, contextualized word embeddings, and multi-sensory adaptive systems, marking a potential paradigm shift in inclusive learning. Tafazoli [23] demonstrated the capacity of ChatGPT-powered applications to enhance linguistic accessibility for students with special needs, while Alarcon et al. [25] developed a lexical simplification engine that improved web usability for individuals with cognitive disabilities.

These findings point toward a new wave of educational innovation, where natural language processing (NLP) and adaptive tutoring converge to deliver hyper-personalized learning environments. Similarly, Garcia-Argibay et al. [5] and Seshadri et al. [1] advanced the integration of genetic, environmental, and neural biomarkers into AI-driven predictive models, opening new possibilities for early detection and targeted intervention.

Furthermore, the incorporation of multi-modal learning analytics and human-computer interaction frameworks could facilitate dynamic personalization, aligning academic goals with cognitive and emotional profiles, a promising direction for future empirical work.

4.6. Limitations of Current Research and Identified Gaps

Despite significant progress, this review reveals persistent gaps requiring urgent attention:

- Underrepresentation of the Global South: Studies like [El-Ashram et al. \[28\]](#) emphasize that infrastructural and cultural barriers restrict effective AI implementation in resource-limited contexts.
- Fragmented ethical frameworks: Few studies, such as [Bulathwela et al. \[8\]](#), provide comprehensive approaches for balancing personalization with privacy and equity.
- Limited longitudinal data: Most analyzed studies adopt short-term evaluation designs, leaving uncertainty regarding the long-term cognitive and emotional impacts of AI-assisted learning.
- Neglect of intergenerational and cultural dimensions: Very few investigations explore how socioeconomic context mediates students' responses to AI-based instruction, underscoring an important direction for future research.

By addressing these challenges, the integration of AI in inclusive education can advance toward evidence-based, ethically grounded, and globally representative frameworks.

4.7. Synthesis and Implications for Policy and Practice

The convergence of technological innovation and inclusive pedagogical frameworks highlights a transformative opportunity for global education systems. This review provides evidence that AI applications can enhance accessibility, personalize learning, and strengthen emotional engagement among students with diverse cognitive profiles. However, achieving these benefits requires:

- Expanding teacher training programs integrating adaptive technologies.
- Promoting cross-sector collaboration among researchers, educators, policymakers, and technologists.
- Designing inclusive policies that address regulatory, ethical, and infrastructural challenges.
- Encouraging participatory innovation where students, teachers, and families co-develop tools aligned with contextual needs.

4.8. Future Directions

Given the accelerated pace of technological advancement, three key priorities emerge for the next decade:

1. Ethically aligned AI development: Future frameworks must balance innovation with transparency, privacy, and educational justice.
2. Culturally Responsive Pedagogies: AI systems must integrate linguistic and cultural diversity, particularly in the Global South, ensuring scalability without reinforcing inequities.
3. Multi-disciplinary collaborations: Bridging neuroscience, computer science, and pedagogy will be essential to design systems that not only optimize learning outcomes but also promote well-being and inclusion.

5. CONCLUSIONS

This study provides an updated and structured overview of the evolution of Artificial Intelligence (AI) use in the education of students with special educational needs (SEN), integrating bibliometric analysis and systematic review. Beyond specific findings, it offers a critical and comprehensive perspective on how the field is being shaped from scientific, technological, and educational standpoints.

A key contribution is the articulation of a robust conceptual foundation linking emerging technologies with inclusive pedagogical practices. Rather than treating AI as an end in itself, the adopted approach frames it as a

potentially transformative tool whose effectiveness depends on contextual, ethical, and human factors. This integrative vision is crucial for understanding that AI's true impact lies not in its technical capacity but in its implementation with pedagogical purpose, social sensitivity, and a commitment to equity.

Strategically, the study identifies gaps for future research agendas: limited representation from the Global South, weak integration of ethical-legal frameworks in educational technology design, and the need for participatory methodologies involving students, teachers, and families in development and implementation processes. Recognizing these gaps does not imply weakness in the field but rather an opportunity to strengthen its inclusive and transformative orientation.

Practically, the findings can inform decision-making in educational policy, teacher professional development, and the design of accessible virtual environments. They also provide an empirical basis to guide researchers, educational software developers, academic institutions, and international organizations promoting educational equity through technology.

Ultimately, this study not only maps the state of the art on AI and special education but also proposes a critical, contextualized, and ethical perspective on its application. Its contributions are expected to drive more inclusive research, context-sensitive public policies, and genuine interdisciplinary dialogue between technology and education.

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