

Review Article

Cite this article: Muriira, V., Nallisamy, V., Mwalw'a, S., & Kamundi, H. (2025). Technology-Enhanced Education for Neurodiverse Learners: A Bibliometric Approach to Reducing Educational Inequalities. *Educational Process: International Journal*, 18, e2025428. <https://doi.org/10.22521/edupij.2025.18.428>

Received May 23, 2025

Accepted July 13, 2025

Keywords: Neurodiversity, Technology-Enhanced Learning, Bibliometric Analysis, Inclusive Education, Equal Opportunities

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Technology-Enhanced Education for Neurodiverse Learners: A Bibliometric Approach to Reducing Educational Inequalities

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Abstract

Background/purpose. Neurodiversity, including ASD, ADHD, and dyslexia, has a powerful impact on the learning processes and interaction with education. As fairness issues are growing in technology-enhanced learning (TEL), it is high time to trace research trends and critical contributors, as well as release new themes in this area. This paper examines the current scholarship on neurodiversity and education in the world over the period of 2010 to 2025 to illuminate intellectual frameworks and new trends.

Materials/methods. The bibliometric analysis concerned 336 articles obtained from Scopus. VOSviewer was used to map co-authorship, co-citation, and keyword co-occurrence. Analyses focused on academic production, country leadership, institutions, and thematic areas informing the world of research.

Results. The results indicate a gradual increase in publications over the last decade, with significant contributions from the United States, United Kingdom, and Italy. Harvard University and Vanderbilt University became the top institutions. Three key research clusters were found: (1) Cognitive and Psychological Studies, which centered on the idea of executive functioning and learning difficulties in neurodiverse students; (2) Educational Technology and Learning Strategies, which centered on the concept of adaptive systems and approaches to dealing with the neurodiversity issue; and (3) Assistive Technology and Artificial Intelligence, which revolved around the idea of AI and virtual reality in supporting the neurodiversity issue. Despite advances, obstacles persist in terms of access and socio-economic disparities.

Conclusion. Technology-based learning helps in meeting UN Sustainable Development Goal 4 (Quality Education), yet needs more policy changes, wider access to AI tools, and training of specific teachers to provide equal opportunities. Future research should focus on longitudinal assessments of TEL interventions and address ethical issues related to the use of AI in learning.

1. Introduction

Educational experience of neurodiverse individuals faces significant challenges because neurodiversity includes autism spectrum disorder (ASD), attention-deficit/hyperactivity disorder (ADHD), and dyslexia as its cognitive spectrum of variations. The neurodevelopmental disorders present characteristics of altered working memory along with executive functioning and cognitive processes that influence learning effectiveness and academic attainment and children with ASD generally exhibit worse executive functioning results in a broader range than children with ADHD, according to Corbett et al. (2009). Childhood students with ASD who do not have intellectual disabilities, together with childhood students who have ADHD, show substantial mathematics achievement delays relative to typical peers. Le Cunff et al. (2024) identify shared student experiences that appear in publications covering dyslexia, as well as autistic spectrum disorder and ADHD.

The identification of sensory traits among people who fall within diagnostic categories, including ASD, sensory processing disorder, attention-deficit/hyperactivity disorder, Rett syndrome, dyslexia, and others, enables engineers to design new accessible technologies. Research concentrates on ASD disabilities specifically after attempting to develop new versions of input modalities from sensory perception differences. The unique sensory pattern associated with ASD creates interferences that affect three essential domains: social development, cognitive processing, and communication infrastructure. Providing sensory assistance enables better technology-world interactions for people, according to Boyd et al. (2018). Through mobile applications, regular environments can become more accessible cognitively, which supports neurodiverse populations, including individuals with dementia, autism spectrum disorder, trauma disorder, and attention deficit hyperactivity disorder, to gain their independence while obtaining ongoing support (Rapp et al., 2019).

The widespread existence of neurodiversity meets new emerging technology solutions that help neurodiverse individuals carry out their daily life tasks. The design practice requires better guidelines for researching the inclusion of neurodiverse users because current guidance remains insufficient (Motti, 2019). Borsotti et al. (2024) identify how neurodivergent students encounter multiple access and attitudinal difficulties when learning in educational institutions as well as working with disability support resources. According to Borsotti et al. (2024), assistive technology access barriers, cognitive and physical access barriers, and social access barriers constitute the three main categories of obstacles. The study analyzed how prejudice and disability-specific understanding and multiple forms of discrimination influence institutional practices while discussing how students develop small-scale solutions to increase collective accessibility. However, these actions remain under the radar.

Support services, along with technological solutions, exist to assist students, yet they remain improperly aligned with one another. The widespread concern about stigma and labeling causes a gap to grow in the allocation of resources that neurodiverse students need to succeed in higher education, thus reflecting poor intentions (Clouder et al., 2020). The complete utilization of technology in neurodiversity education requires widespread accessibility and affordability for all learners across diverse socioeconomic backgrounds and geographic locations. Wide availability of assistive technologies, along with their systematic incorporation into educational systems around the world, brings forth the necessity of collective work between governments, educational organizations, and technology developers (Misra, 2022). Achieving SDG 4 depends on the partnership between these entities, which will also guarantee that neurodiverse students obtain essential academic support.

The research on neurodiversity in education has investigated inclusion approaches and learning experiences alongside institutional support for neurodiverse students, according to Clouder et al. (2020). Research on large student datasets (2023) explores higher education trends in neurodiversity

and diversity, but Hamilton & Petty (2023) analyze the framework of compassionate pedagogy. A minimal number of scholarly investigations exist regarding the systematic evaluation of how research patterns alongside scholarly networks and thematic developments in the field develop using bibliometric approaches. Through bibliometric analysis, researchers gain the ability to measure both research growth and volume span and detect key studies and scholarly authors together with their institutions, as well as track developing trends and international research partnerships. The study fulfills an essential requirement by delivering an extensive bibliometric analysis that examines research related to technology-enhanced learning for neurodiverse learners. This research performs a bibliometric analysis of technological neurodiversity educational studies through the Scopus database within the period from 2010 to 2025 using VOSviewer. The investigation will identify the most prominent issues within this research area, their primary authors, and the key institutions and publications driving the research in this field. The examination of the neurodiversity study in education turns out to be the main objective of the current study. Here, an assessment of technology use in neurodiverse student education institutions shall be done. The study assesses its effect on decreasing inequities that prevail in the educational settings. These objectives were to be addressed in the study using a number of research questions and included:

1. What are the trends in technology with regard to neurodiversity education research Between 2010 and 2025?
2. Which authors, journals, and institutions are leading in this field?
3. What are the most common research themes and keywords in technology-neurodiversity education research?
4. What role does technology-enhanced education play in reducing educational inequalities for neurodiverse learners?

The purpose of this research is to examine both literary trends and institutional/author contributions regarding the impact of technological changes on the education of people with neurodiversity, using a bibliometric approach. The analysis of the development of the research in this area from 2010 to 2025 will provide an understanding of major themes, the most active participants in the field, and what technology can help to realize in order to enhance learning opportunities of neurodiverse students. The discussion will also examine the effectiveness of technology-based education in reducing educational disparities, particularly in light of SDG-4, which advocates for inclusive and equitable education for all (Pek et al., 2025).

2. Literature Review

2.1. Defining Neurodiversity and Its Significance in Modern Education

Neurodiversity describes all natural variations of human cognition, which include ADHD and autism, together with dyslexia and various forms of neurodevelopmental differences. The cognitive divergences in human beings exist across the wide continuum of different minds without any implication of inferiority, and each cognitive pattern provides certain benefits and some challenges. Neurodiversity brings many advantages to education in terms of the move towards strengths-based inclusion as opposed to the perspectives on deficit disorders. The model has a perspective that recognizes the presence of an educational environment that allows for divergences in cognition and offers individual guidance to every learner, enabling them to ensure the success of their education through various educational methods and forms of resources (Acevedo & Nusbin, 2020; Hayhoe, 2022).

Learning institutions that incorporate neuroscientific knowledge of diversity will be better positioned to provide diverse neurologic students with personalized learning support structures. The

philosophy promotes equality and inclusion, and neurodiverse students have higher educational success because their diverse senses and cognitive characteristics are considered, which contrasts with the standardization of the learning process. (McDonald et al., 2023; Almufareh et al., 2024).

The majority of recent studies on neurodiversity in schooling focus on diagnosing and treating specific conditions, rather than exploring neurodiversity as a strength-driven learning model (Acevedo & Nusbaum, 2020). The study is a contribution in the sense that it examines how more inclusive, strength-based neurodiversity can be used to enhance educational outcomes, particularly by incorporating technology-based learning systems.

2.2. Technology-Enhanced Education and Its Potential Benefits for Neurodiverse Learners

The learning needs of neurodiverse students are addressed through technology-enhanced education, which enables the provision of flexible instructions and individualised instructional facilitation. Their learning can be supported by artificial intelligence systems for knowledge management, assistive technologies, and adaptive executive functioning programs, all aimed at eradicating learning barriers. AI solutions implement individual learning testing to identify student learning patterns, providing real-time feedback and individualized interventions. These technological tools enable neurodivergent students to have a more preferable learning experience since the material can now be delivered in learning formats that best fit their special needs, leading to increased student involvement and improved academic performance (Prayogi & Verawati, 2024; Zheng et al., 2021). It has been found that various technologies offer viable student learning aids via augmented reality devices, virtual reality devices, and Internet of Things devices. In attempting to extend their learning, AR and VR technologies generate considerable learning value to students with autism and ADHD by offering interactive learning experiences (Sims et al., 2023; Olabisi Oluwakemi Adeleye et al., 2024).

The IoT system enables environmental monitoring through pseudo number texting, thereby assisting students in creating better learning conditions (Sims et al., 2023; Olabisi Oluwakemi Adeleye et al., 2024). As it becomes evident, many studies refer to the opportunities provided by TEL among neurodiverse students. Yet, few studies refer to the long-term factor or the efficiency of a combination of technology tools that address various learning needs (Senja Shafira et al., 2024). The analysis will examine how the integration of TEL can positively influence the education experience of neurodiverse learners by referring to current trends and the most fruitful implementation areas of the technological application.

2.3. Reducing Inequalities in Education

The initiative to mitigate education disparities and the realization of inclusiveness in the field of education are among the themes that are advanced in SDG 4 (Esayas Teshome Taddese & Aslam, 2025). To this end, neurodiverse learners need technological interventions to gain access to their right to education in imitation equity. These barriers to learning, related to sensory processing, attention deficit, and other neurodiversity conditions, can be overcome through the use of assistive technologies, enabling students with neurodiverse conditions to participate in a more level playing field of learning. The application of these tools will ensure that neurodiverse students can learn alongside their peers in a personalised learning trajectory and the SDG 4 objective of lessening education disparity (Tegon, 2021; Cierzniewska & Podgórska-Jachnik, 2021). Inclusive technology is an AI-innovative adaptive learning system capable of tailoring the educational experience to address the specific learning deficiencies of each student. Learning and social equity are not left behind in this technological support since it ensures that all students equally access educational environments, regardless of cognitive or sensory differences (Olabisi Oluwakemi Adeleye et al., 2024).

Including assistive technologies in education serves a greater purpose: not only enhancing the learning of neurodiverse students, but also lessening educational inequities that contribute to the overall achievement of the global agenda of SDG 4. Despite the apparent learning outcomes of assistive technology, there exists limited literature concerning the organized examinations of the mechanism by which the technology is introduced to the education systems in regard to accessibility and affordability (Almufareh et al., 2024). The study addresses this gap by examining how assistive technologies can be made more accessible in regular school environments and how they can mitigate educational disparities, particularly for neurodiverse children (Acevedo & Nusbaum, 2020).

2.4. Neurodiversity Education, Assistive Technology, and Equal Opportunities in Education

Studies on bibliography for education and neurodiversity show that research on sensory- and cognitive-based educational methods used with neurodiverse students has been increasing steadily. Studies about assistive technologies show an increasing pattern that clarifies these technologies' crucial function for inclusive learning experiences of neurodiverse students enrolled in regular education settings. The integration of SDG 4's education inequalities objective into educational programs is essential due to research that demonstrates technology-based educational improvements and their effectiveness in connecting neurodivergent students across education. Research indicates that the scientific community is increasingly focusing on developing AI-driven and digital tools that promote inclusive learning settings, leading to improved academic outcomes for individuals with neurodiversity. Research on these subjects should continue to progress, while frameworks need to develop a complete integration of technology and inclusion principles (Tegon, 2021; Gloria et al., 2024). Bibliometric research examines the benefits of AI-driven learning management systems in educational technology, as these assistive tools enhance neurodiverse student learning. The combination of technology serves essential functions to decrease educational inequalities while providing equal learning resources to neurodivergent students. When educational practices implement SDG-related objectives, specifically SDG 4, the learning environment becomes more suitable for neurodiverse students and more inclusive for all students (Acevedo & Nusbaum, 2020; Gloria et al., 2024).

Though numerous studies support the idea that technology may help minimize educational disparities, there is a lack of information regarding how exactly TEL can be used to support the needs of neurodiverse students and how institutions can implement TEL to eliminate educational inequalities with references to institutional support and changes in policy (Hayati et al., 2022). This study aims to contribute to SDG-4 since it will examine the contributions technology-enhanced learning has made in the attainment of SDG-4 to determine how TEL can better address issues of educational inequalities and the learners with neurodiversity. It will also give some ideas on how the educational policies can be modified to better assist students with neurodiversity (Senja Shafira et al., 2024).

2.5. Integration of Technology in Addressing Inequalities in Education for Neurodiverse Learners

Bibliometrics-related studies demonstrated that technology plays a fundamental transformative role in solving educational problems in which neurodiverse learners experience. The neurodivergent learners will benefit in their learning programs through adaptive learning systems, mixed reality, and mobile-based applications, and the use of AI, which will create their own learning opportunities that are beneficial to their cognitive and sensory learning requirements. It is a synopsis of these technology solutions that enable neurodiverse students to access educational content within their capabilities, thereby reducing their educational barriers. Children with ADHD and other cognitive differences can use executive function assistive technologies like task management software to help

them remain organized and focused (Zheng et al., 2021; Artyukhov et al., 2024). The technologies allow neurodiverse students to process the content material in a non-traditional manner. The risk-free learning potential of interactive virtual reality and augmented reality programs makes them beneficial to the autism student since the programs provide room to enhance social and cognitive skills.

Evidence from the literature suggests that this teaching technique can empower confident students who are competent in most modes of teaching that are not possible in the traditional classroom. The use of modern mobile applications provides educators with the full freedom to make real-time changes between visual and auditory stimuli (Saphira et al., 2023). The two-fold benefits of technical education transformation applications as part of learning models include reduced educational gaps and institutionalized academic learning activities among the neurodiverse students. Educational inclusion increases as technology becomes more accessible, providing students with the opportunity to work in personalized educational environments. (Senja Shafira et al., 2024)(Hayati et al., 2022). A growing number of bibliometric studies show that researchers investigate how to apply technology solutions for overcoming educational inequalities that impact neurodiverse student populations. Personalized adaptive assistive technologies, powered by AI and fuzzy logic, enable the achievement of SDG 4 objectives by enhancing student learning experiences.

Limited research has been conducted on the ethical considerations and possible bias regarding AI technologies in education, especially in regard to the way such technologies support neurodiverse students (Acevedo & Nusbaum, 2020). This paper will research the increasing involvement of AI in neurodiverse schooling, as well as look into the advantages and the complexity of this tendency. This study aims to assess the effectiveness and benefits of AI in educational practice for neurodiverse learners.

3. Methodology

3.1. Search Strategy

The research evaluates the connections between neurodiversity studies and technology-assisted teaching strategies, as well as assistive tech usage by neurodivergent students, based on bibliometric data analysis. The authors selected the Scopus database to collect data because it provides extensive peer-reviewed content spanning education, technology, and healthcare fields. Academic researchers prefer Scopus because it provides wide-ranging databases alongside substantial, high-quality scholarly material for bibliometric work. A specific search query was executed on Scopus on the 20th of February 2025 to retrieve every available document that focused on neurodiversity in education with technological interventions.

The search strategy involved the following structured query: TITLE-ABS-KEY ("neurodiversity" OR "neurodivergent" OR "cognitive diversity" OR "autism spectrum disorder" OR "ADHD" OR "dyslexia" OR "dyspraxia" OR "dyscalculia") AND TITLE-ABS-KEY ("education" OR "learning" OR "teaching strategies" OR "inclusive education" OR "higher education" OR "pedagogy" OR "special education" OR "personalized learning") AND TITLE-ABS-KEY ("technology-enhanced learning" OR "assistive technology" OR "digital tools" OR "AI in education" OR "learning management systems" OR "technology interventions") AND PUBYEAR > 2010 AND PUBYEAR < 2025 AND (LIMIT-TO (PUBSTAGE, "final")) AND (LIM-TO (LANGUAGE, "English")) This search query was developed so that the articles about neurodiversity could be found in terms of education and technology aspects. The search criteria combine various search terms, including neurodivergent conditions (such as ADHD, autism, dyslexia, and many other keywords), with procedures rooted in the inclusive model of education and individualized learning and pedagogy practices (Arruda et al., 2022).

AI, such as assistive technologies and learning management systems related to education, is the bedrock of the study since it represents the image of the digital resources in enhancing neurodiverse learning spaces. The selected criteria functioned to maintain both relevance and quality for the analyzed literature. The selected literature consisted of peer-reviewed articles, conference papers, and review content to achieve reliable data. The time span covered by the chosen articles started from the year 2010 up until the year 2025 to include contemporary research in the field. The reviewed research included only final publication-stage articles written in the English language, resulting in a total of 336 articles for CSV data export. During the exportation process, bibliometric data with elements like author names and metadata about keywords, titles, publication year, and journal information are prepared for further stages of analysis. The CSV files serve as crucial elements for complete bibliometric analysis, which reveals patterns and trends between bibliographic items about neurodiversity and technology-enhanced education.

3.2. Cleaning of the Data

After the bibliometric data was exported out of Scopus in the form of a CSV file, a thesaurus file was used to standardize the differences in the keywords and abbreviations, and to reduce the differences in keywords and abbreviations, so that consistency in the given dataset is achieved (Ramadhani et al., 2022). This is because, in this process, uniformity of terms was achieved, and thus, a higher network mapping and analysis of keywords was possible. They were eliminated to systematically remove duplicated records using conventional deduplication techniques, as these could be generated when indexing a similar publication multiple times (Arruda et al., 2022). Such duplicates need to be eliminated to prevent the over-representation of one document, thereby ensuring the soundness of the bibliometric analysis. Furthermore, all the documents that did not have most of the metadata (including, but not confined to, the names of authors, the year of publication, or the number of citations) were rejected in the process of developing the final dataset due to the possibility of biasing the results (Arruda et al., 2022). The presence of such data cleaning operations ensured that only quality information with relevance was addressed, and therefore, the highest reliability and accuracy of the bibliometric analysis conducted was achieved.

3.3. Data Analysis

Many researchers depend on VOSviewer as their bibliometric analysis tool to analyze large-scale publication datasets while generating visual representations. Scholarly networks within different academic fields become accessible through VOSviewer, which helps researchers detect publication trends combined with citation patterns and research topic development (Al Husaeni & Nandiyanto, 2021). The usage of VOSviewer performs a bibliometric study to evaluate research about neurodiverse groups in TEL that relates to Sustainable Development Goal 4 regarding education inequality reduction. The examination includes three main aspects, which are co-authorship analysis, co-citation analysis, and keyword mapping. Thorough processing and cleaning of bibliometric data lead to accurate analysis results. At the beginning, research groups use duplicate record removal to safeguard against distorted citation counts and co-authorship structures due to multiple indices of the same publication. Such data integration between Scopus, Web of Science, and Google Scholar requires close attention because multiple entries tend to occur in overlap (Pek et al., 2025).

Co-authorship analysis serves the purpose of discovering which researchers, together with their institutions, hold major influence within this field. This technique visualizes joint work networks, which show the degree of worldwide cooperation and diverse field participation. The study of co-authorship has previously shown effectiveness in exposing education research leaders, according to Patty et al. (2024), while revealing institutional and author-level impacts.

The field of neurodiversity and TEL requires co-citation analysis to evaluate its important research publications and scientific authors, as well as leading journals. This method enables

researchers to interpret research domains related to intellectual structure by identifying patterns in cited literature. Research studies demonstrate that VOSviewer displays co-citation clusters to follow development patterns of research themes (Rahim & Widodo, 2024).

Research performed through keyword mapping seeks to identify the most prominent terms linked to all three domains of neurodiversity, TEL, and SDG 4. The research displays new trends and research themes through the presentation of keyword co-occurrence networks. The analysis method proves successful for monitoring research modifications across periods, especially within education technology and inclusive learning (Baako & Abroampa, 2023). The bibliometric indicators measure research impact by examining citation counts as well as H-index and publication growth trends, according to Arruda et al. (2022). The evaluation of global research partnerships happens through co-authorship networks alongside keyword co-occurrence analysis, which determines research trends (Al Husaeni & Nandiyanto, 2021; Kirby, 2023). A thorough evaluation of TEL-based neurodiversity research becomes possible when these evaluation metrics are integrated.

4. Results

4.1. Publication Per Year

In Figure 1, research publications about neurodiversity in technology-enhanced education have shown increasing publication numbers across the 2010 to 2025 period, according to bibliometric analyses. Scopus documentation reveals that the quantity of suitable publications has increased consistently since 2010, before reaching its highest point of 64 documents in 2024. The number of publications in 2025 decreased sharply to reach only six released documents as of the current year. The observed tendency results from various causes, starting with the research limitations and continuing with the standard publishing time frame.

Research publication volumes remained consistently low between 2010 and 2018, with a maximum of nineteen publications per year. Neurodiversity applied to technology-enhanced education remained a mostly understudied research field during this particular time period. The research production exhibited a slow upward trend during 2019, which transformed into a significant surge of academic papers, particularly in 2023-2024. Research interest in academic topics increased throughout this period due to the expansion of neurodiversity knowledge and the growing understanding of digital educational intervention methods in developmental practices following the COVID-19 pandemic. The decreased frequency of reported publications in 2025 stems from methodological and structural elements regarding the publication search performed on February 20, 2025. Scopus indexing occurs after publication, so many 2025-prepared articles may not show in their database when data collection takes place on February 20, 2025. Additionally, the study analyzed only published publications but excluded those that awaited final approval. Such tendencies indicate the global trend of awareness about inclusive education and growing investment in educational technologies. The increase that occurred after 2019 is related to the COVID-19 pandemic as one of the reasons driving the demand for digital learning solutions recently, and specifically in underserved neurodiverse communities.

Documents by year

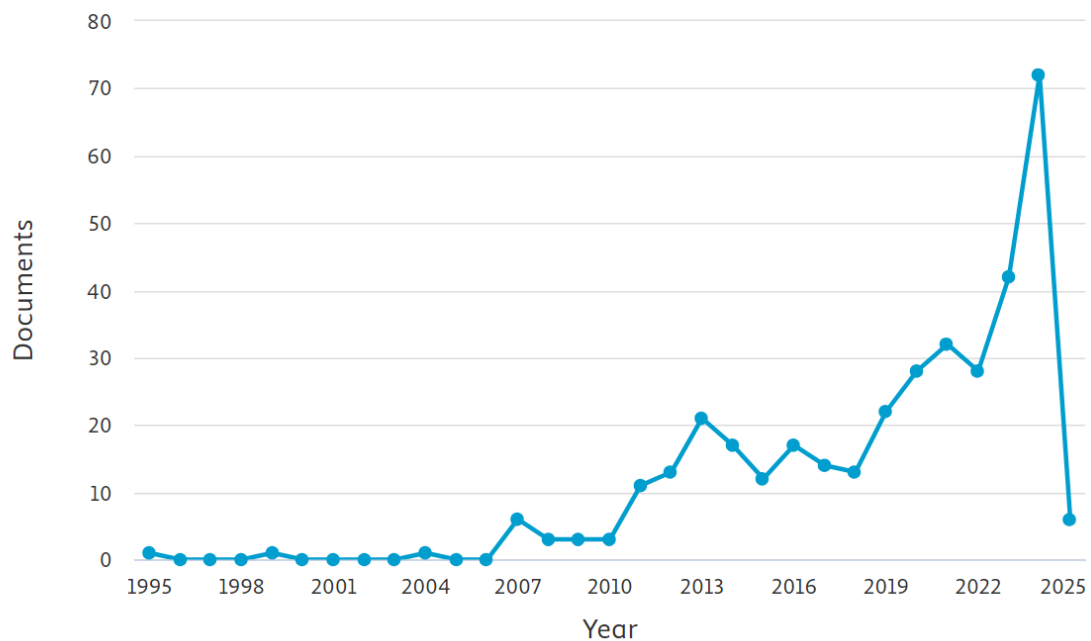


Figure 1. Publication by Year

4.2. Publication by Document Type

Table 1 shows that Journal articles (39.0%) and conference papers (36.9%) emerge as the leading publication types in publications about neurodiversity and technology-enhanced education since peer-reviewed studies and conference discussions predominate in this field. The proportion of published review papers and conference reviews has increased significantly to reach 7.7% and 7.1%, respectively, in this scholarly field. Book chapters, along with books, constitute 6.5% and 2.1% of all publications, yet remain less pervasive than journal articles in examining topics related to neurodiversity. A small portion (0.3%) of the papers in this field consist of errata, while short surveys make up another 0.3%, suggesting that survey-based and correction-based studies remain less prevalent. The journal and conference format represents a fundamental feature of research in neurodiversity and assistive technologies because it centers on the quick dissemination of knowledge.

Table 1. Publication by Document Type

Document Type	Number of Publications	Percentage of Total Publications (%)
Article	131	39.0%
Conference Paper	124	36.9%
Review	26	7.7%
Conference Review	24	7.1%
Book Chapter	22	6.5%
Book	7	2.1%
Erratum	1	0.3%

Short Survey	1	0.3%
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4.3. Documents by Affiliation

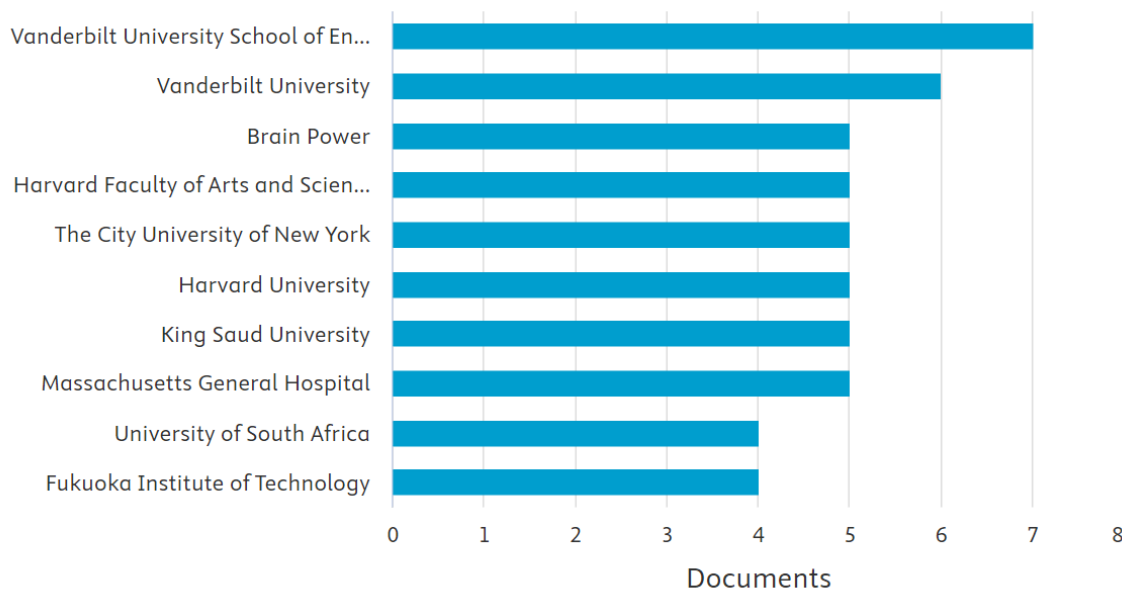


Figure 2. Documents by Affiliation

Figure 2 demonstrates how research on neurodiversity and technology-enhanced education contains its main contributing institutions. The Vanderbilt University School of Engineering publishes seven publications, placing it at the forefront, followed by Vanderbilt University with six publications. Brain Power, along with Harvard Faculty of Arts and Sciences, the City University of New York, Harvard University, King Saud University, and Massachusetts General Hospital, presents five published works. The University of South Africa, along with the Fukuoka Institute of Technology, publishes four documents that demonstrate expanding worldwide recognition of education-based assistive technologies and neurodiversity studies. These educational research facilities show combined work between academic exploration, technological development, and healthcare delivery purposes, which demonstrates interdisciplinary features of the field. The research output between these institutions demonstrates intensive work in inclusive education, combined with assistive technology development, along with AI-based treatment approaches, and their team-up produces substantial findings. International organizations affirm the global perception concerning technology as a tool for supporting neurodiverse students and reducing inequality in the education sector. The focus of U.S. universities and higher education institutions, such as Vanderbilt and Harvard, indicates that a leading position requires a well-developed research system and stable investment in inclusive education technology. The interdisciplinary nature of this field is enhanced through cooperation with the engineering and the medical faculties.

4.4. Publication by Author

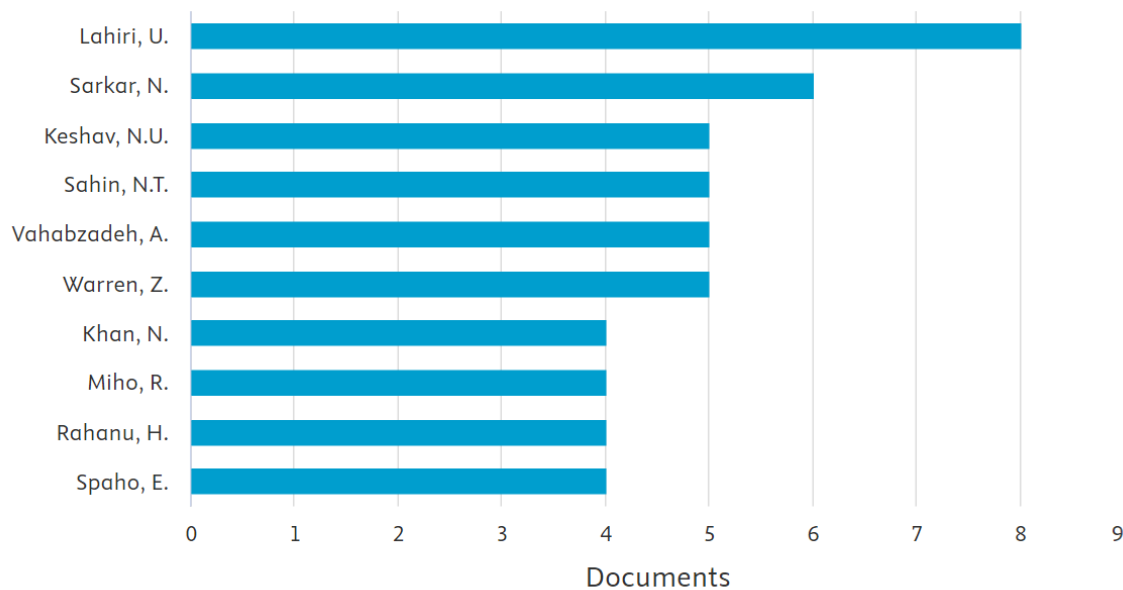


Figure 3. Document by Author

The most cited articles in Figure 3 emerge from the collection. U. Lahiri takes a leading position in research about neurodiversity and technology-enhanced education through his eight publications, which examine assistive technologies together with inclusive learning practices. The researchers, led by Sarkar N., have published six articles that demonstrate their leading role in this field, possibly developing adaptive learning tools and AI-based educational interventions. Sahin et al. (2018) have collectively published five studies on digital tools for neurodiverse learners, while remaining active researchers in this field. Their publications appear to cover three key educational areas, which involve customized learning methods together with virtual reality instruction and devices that benefit students with cognitive differences. The researchers (Basha et al., 2025) collaborate to produce scholarly works that contribute to the development of inclusive teaching methods and learning equality proposals, alongside inclusive educational technologies.

The range of research papers and contributions indicates a collective effort towards neurodiversity research through partnerships between authors who advance technology and educational practice and regulatory work. (Boyd et al., 2018) The range of published articles seems to show distinctions between academic niches together with institutional research priorities and available funding in the discipline. The interest among academic researchers to use technological solutions for neurodiverse students increases as efforts worldwide aim to embrace inclusive educational practices throughout mainstream classrooms (Spaeth & Pearson, 2023). This research field warrants further investigation by future bibliometric research, which should examine citation impact patterns, co-authorship network structures, and thematic changes. The concentration of publications among a limited number of authors indicates the creation of special scholarly communities. This group of advocates is also possibly driving the field agenda since it is interested in VR, AI, and adaptive learning solutions for neurodiverse students.

4.3. Documents Per Year by Source

The research showcase in Figure 4 demonstrates Lecture Notes in Computer Science Including Subseries. Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics has emerged as the leading source with 31 publications, which is demonstrating increased academic production, especially since 2022. Research activity involving computer science and artificial intelligence with neurodiversity grows stronger based on publication data analysis. Each year, the ACM International Conference Proceedings Series releases 15 publications, confirming the significant role conferences play in advancing field research and stimulating collaboration. Research on assistive technologies and their use with neurodivergent learners is published in both Communications in Computer and Information Science and Disability and Rehabilitation Assistive Technology, with a total of 8 publications between them. Children and Procedia Computer Science together published 5 articles, which represented a consistent but less significant contribution to neurodiversity research regarding child-focused educational interventions and computer science technology. The fact that 1 conference proceeding, such as Lecture Notes in Computer Science, leads to high output indicates fast innovation within this field, where first results on a topic are published often. This indicates a rapidly changing educational technology, especially AI and assistive ones.

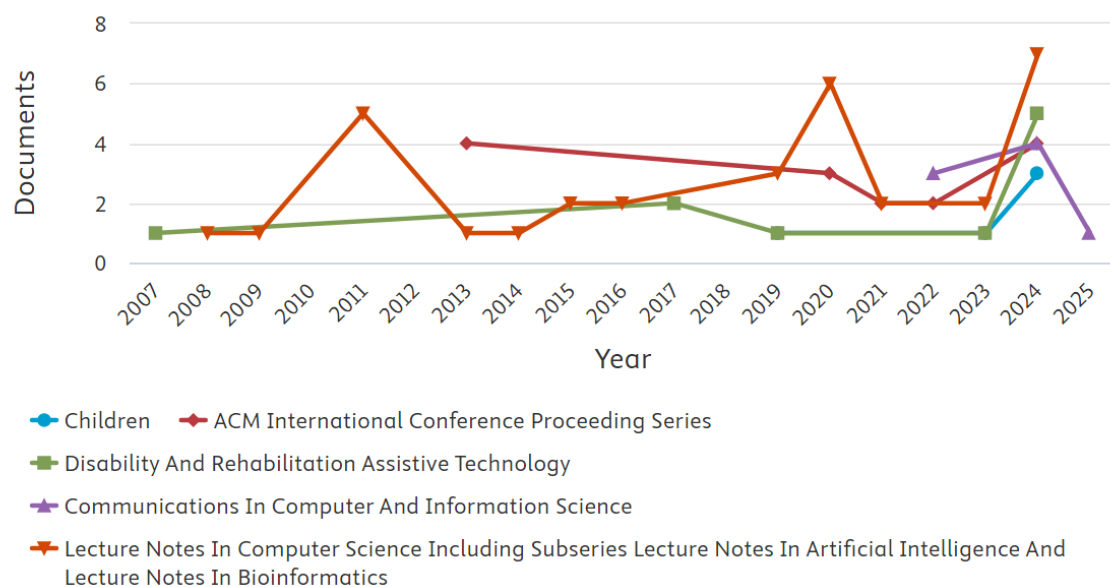


Figure 4. Documents Per Year by Source

4.4. Publication by Source

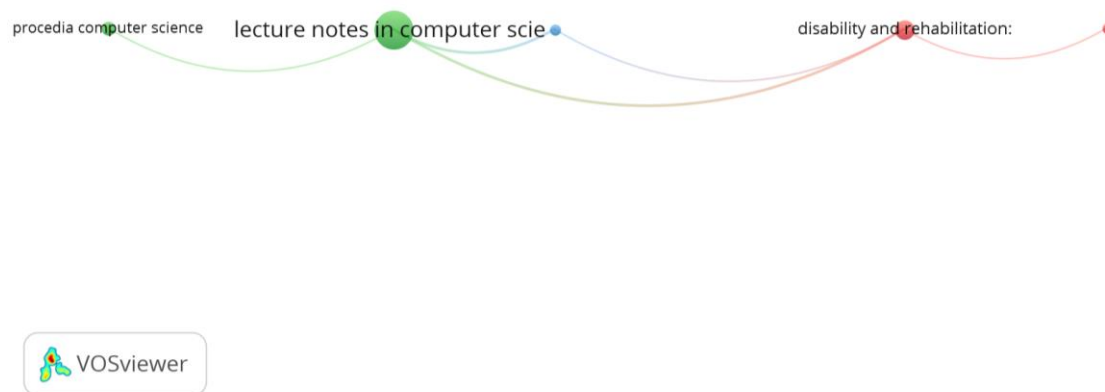


Figure 5. Citation by Source

The bibliometric analysis group sources 22 essential materials into three unique clusters through citation link strength measurement. The Red cluster contains sources from Disability and Rehabilitation and Education and Information Technologies that research assistive technologies while studying educational approaches. The specified sources demonstrate outstanding citation impact because they directly address learning practices and accessibility needs. The research field of computer science and technology applications and artificial intelligence connects with assistive systems and human-computer interaction through Lecture Notes in Computer Science and Procedia Computer Science, which form Cluster 2 (Green). The specialized medical research resource Dyslexia belongs to Cluster 3 (Green), where it delivers research on developmental and cognitive disabilities while examining connections in educational technology and rehabilitation.

The generation of a reliable representation for major resources relied on applying five critical constraints that comprised eight minimum documents per source, along with 130 minimum citations per source, while considering total link strength and selecting impactful sources, and twenty-two bibliometrically approved resources that met these specifications. These constraints enable researchers to find sources that offer extensive field contributions through their high number of cited documents.

Lecture Notes in Computer Science becomes the main entity of output as it has the most documents and the total number of links, according to which it is incorporated into the center of the citation network. Studies on accessibility and developmental disabilities demonstrate that Disability and Rehabilitation and Dyslexia have a significant citation impact, but they also trail Lecture Notes in Computer Science in terms of their prominence. The data of the network show a strong linkage of Lecture Notes in Computer Science and Disability and Rehabilitation with external sources, but the resource on Dyslexia shows only two substantial links of Lecture Notes in Computer Science and Procedia Computer Science. The network topology reveals a highly organized relationship in citations, attributing technology-based innovations in assistive systems to accessibility research, while maintaining cognitive disability-specific research as an independent area.

The citation analysis reveals influential sources that remain most powerful in the research area, despite being relatively few in the primary sources of identification. Studies on assistive technologies and accessibility show multidimensional features due to the high relational nature between the various sources in technology-socialized domains, education, and rehabilitation sciences. The results are fully informative regarding the form of the organization and information flows in various academic disciplines. The interdisciplinary applicability of the field is indicated in articles published in

the journals of different fields related to education, rehabilitation, and computer research. The dominance of technical solutions in neurodiversity education research is an indicator of the central position of Lecture Notes in Computer Science.

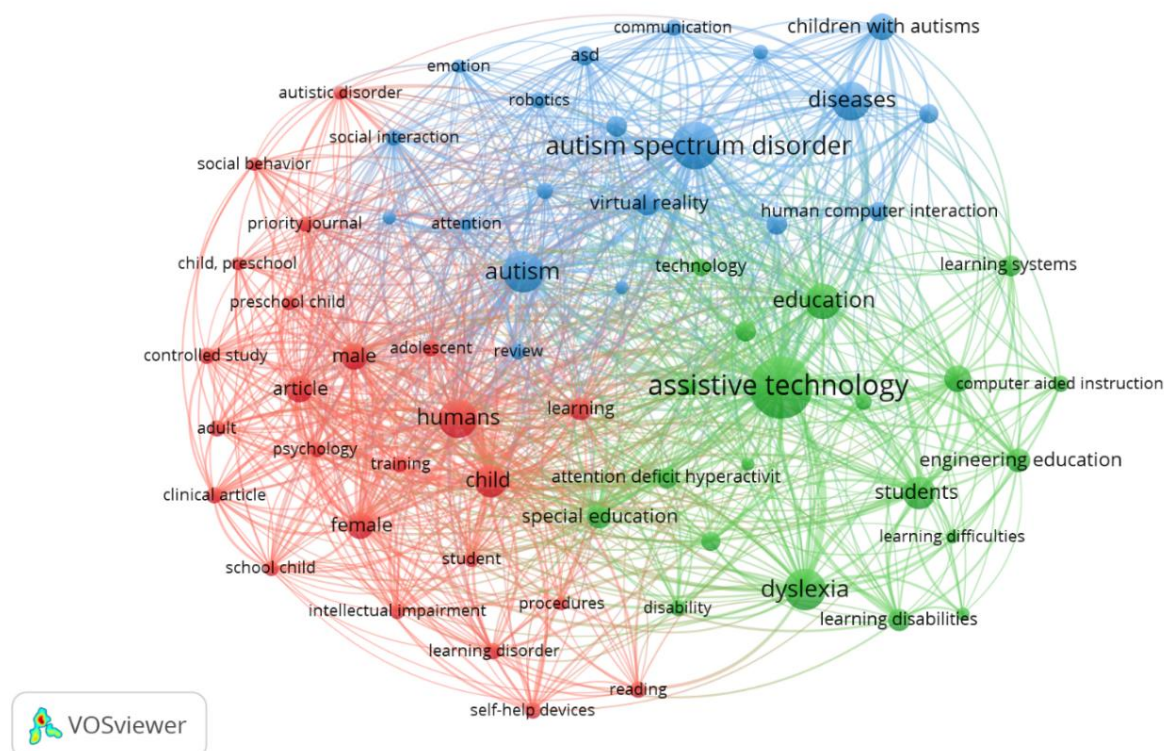


Figure 6. Network Visualization

Bibliometric analysis conducted during this study involves two methods that quantify keyword relationships through co-occurrence mapping and author and country relationships through co-authorship mapping. The data cleaning process utilized a thesaurus file to standardize the data by merging various keywords and abbreviations along with their synonyms. The analysis included only terms that appeared at least nine times, thus keeping vital keyword relationships while removing less significant terms. The research team employed VOSviewer as a scientific tool that performs data mining and mapping of research articles extracted from different databases for their analysis. The graphical interface of this software demonstrated bibliometric data through pictures that showed research connections between keywords and emerging trends. The scientific papers produced Figure 6 through their network visualization. The research-oriented clusters were identified through this process as they contained three unique thematic groups: cognitive and psychological studies within Cluster 1 (Red), educational technology and learning systems in Cluster 2 (Green), and the advanced category of AI-driven and tech-enabled solutions in Cluster 3 (Blue).

The members of Cluster 1 (Red Cluster) dedicate their research to cognitive psychology, along with executive function, memory, and emotion regulation and anxiety management. Near the center of this cluster, researchers analyze ways that neurodivergent individuals handle information, manage their emotions, and deal with uncertain situations. Studies indicate that people with autism spectrum disorder exhibit executive function deficits (Liu et al., 2024), while Kirby (2023) and show how Bayesian methods reveal atypical sensory perception. Studies identify two types of neurological differences which lead to emotional problems, including difficulties with emotion control (Samonte et al., 2024) as well as the inability to handle uncertain situations that creates anxiety symptoms (Lauriello et al., 2024). The cognitive research cluster investigates learning disabilities together with

autism by showing how developmental dyslexia results in working memory issues that affect academic performance (Zingoni et al., 2024). Research confirms how cognitive processes connect with real-life obstacles that neurodivergent people need to overcome. Researcher activity within the red cluster focuses on developing technological support methods that address cognitive and emotional requirements of users (Liu et al., 2024; Lauriello et al., 2024; Samonte et al., 2024; Zingoni et al., 2024).

Educational technology combined with learning systems comprises Cluster 2 (Green Cluster) to study the effects of technology on education and digital learning approaches for inclusive education. Researchers within this cluster concentrate on online learning accessibility through examinations of how students with disabilities fared during remote study because of the COVID-19 crisis. The research conducted in Italy demonstrated how special education systems navigated online instruction after pandemics through an analysis of their achieved milestones along with their educational challenges (Tholkapiyan et al., 2025). Personnel from the VRAllexia Project provided distance education assistance to rural students with complex needs and ASD when schools closed (Zingoni et al., 2024), thus demonstrating how e-learning remains vital for inclusive educational settings. A mobile app created by Samonte et al. (2024) enables students with autism to engage with physical education classes while traditional schools make use of educational technologies in their activities. Research indicates that effective models help schools determine proper technological tools for students with ADHD (Morciano et al., 2024). (Zingoni et al. 2024) establish that children with dyslexia shy away from maximizing accessible technical aids since current educational tools fall short of meeting technical specifications along with teacher requirements and system standards. The deployment of digital educational technologies should prioritize usability and accessibility when combined with suitable trainer education.

The Blue Cluster branch studies the utilization of modern AI systems and technical solutions that employ artificial intelligence (AI) alongside virtual or augmented reality and robotic technology in research related to neurodiversity. Research focuses on creating intelligent support systems powered by artificial intelligence whose machine learning functionality helps screen for autism during infancy (Olabisi Oluwakemi Adeleye et al., 2024; Wei et al., 2024). AI-based adaptive learning systems built by Tholkapiyan et al., (2025) show the possible ways smart educational tools boost neurodivergent students' learning process (Tholkapiyan et al., 2025). The cluster of research investigates how immersive technology enables better social results and student learning. The research by Samonte et al. (2024) has shown that virtual reality interventions assist autistic children in developing conversation abilities, thus validating technology-based interactive systems. The cluster's critical component involves robotics, and recent research determines that socially assistive robots demonstrate effectiveness in autism therapy according to Zingoni et al., (2024). Research from Morciano et al. (2024) through systematic reviews verifies how AI-powered robotic interventions produce positive transformations in special education intervention approaches. The research connects neurodiversity studies to practical applications through the co-occurring keywords AI, machine learning, robotics, VR, and AR through citations of Morciano et al., (2024); Samonte et al., (2024); Tholkapiyan et al., (2025); Wei et al., (2024); Zingoni et al., (2024), Tholkapiyan et al. (2025), Samonte et al. (2024), Zingoni et al. (2024), and Morciano et al. (2024).

The bibliometric analysis proves three key areas of research. Cluster 1 red examines cognitive and psychological research on executive functional weaknesses, memory dysregulation, and emotional regulation problems faced by neurodivergent individuals. The green cluster in Cluster 2 examines educational technology through inclusive learning approaches together with assistive tools and digital educational interventions. The blue research cluster tests advanced AI technology, along with technological applications using AI screening tools, virtual platforms, and robotic systems to intervene with students. The current evidence confirms that growing support systems are designed

to offer personalized and data-driven support to neurodivergent individuals by substituting traditional interventions with the AI-enhanced learning platforms. The three most important word groups, which include cognitive/psychological (red), educational technology (green), and AI-based solutions (blue) are balanced in terms of theoretical, practical, and technical side. Such groupings convey the guarantee of the multidimensional developmental field in neuroscience, pedagogy, and engineering.

The bibliometric analysis establishes the presence of three major directions that research follows. The cluster of red focuses on cognitive and psychological aspects by addressing executive functioning, as well as the impact of perception and memory on learning processes and emotional control. The green cluster by educational technology component demonstrates that inclusive education can be implemented using the assistance of online interventions and assistive devices that can work in virtual learning settings. The blue cluster presents artificial intelligence services and technological interventions that encompass virtual reality, robots, and intelligent systems, leading to enhanced learning and therapy. The neurodiversity study has emerged from conventional educational and psychological contexts, applying technology-driven methods that implement adaptive learning models with real-time intervention mechanisms, alongside AI and immersive technologies.

Future research should focus on upgrading these technologies to achieve greater accessibility and efficiency. Adoption of more sophisticated technology systems of data analytics will develop individualized support services to neuro divergent individuals to improve their independence during their studies, health care services and day to day life activities. The use of bibliometric mapping accelerates neurodiversity research by adopting a novel approach that leverages technology to develop effective support systems.

VOSviewer generates three mapping interfaces that appear above Figure 6 (network visualization), Figure 7 (overlay visualization), and Figure 8 (density visualization).

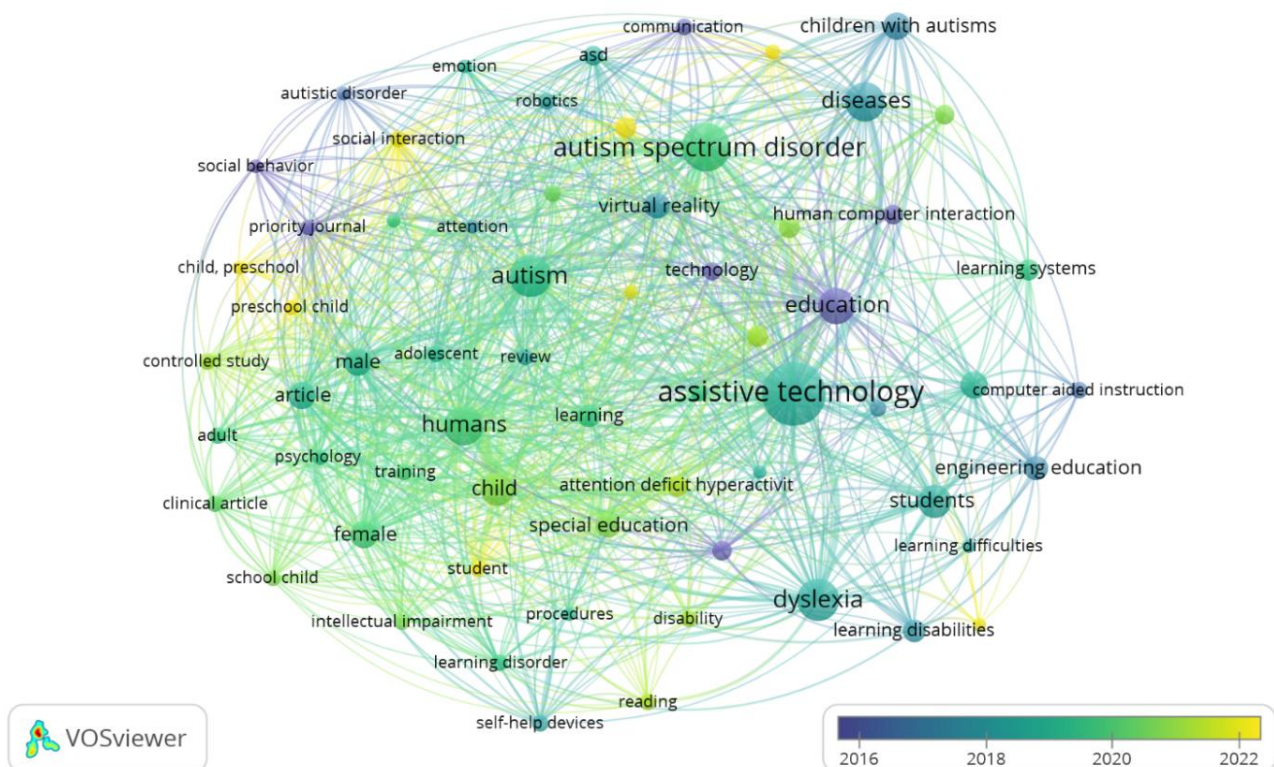


Figure 7. Overlay Visualization

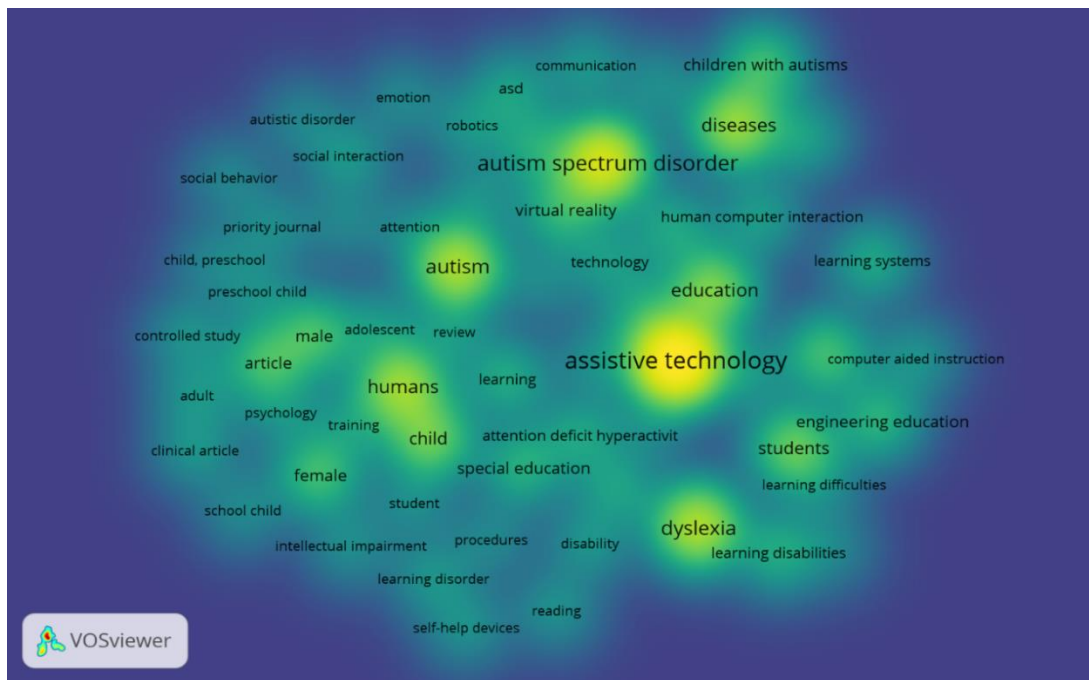


Figure 8. Density Visualization

The bibliographic coupling analysis in Figure 9 employs countries as its analytical unit. The study required at least five documents from each country as a necessary condition in conducting the analysis. The research evaluation revealed twenty major contributing countries, which were grouped into different network clusters. It is assumed that countries such as the U.S., U.K., and Italy enjoy good policy frameworks and funding of research in inclusive technology, as they have been leading in terms of their prominence. At the same time, an increasing number of Indian, Malaysian, and Saudi Arabian investments demonstrate global diversification of the field of investigations.

The data reveals that the top publishing countries are shown in Table 2. The United States leads the world with published articles, followed by the United Kingdom in second place, Italy in third, and then France and Ireland.

Table 2. Top 10 Countries with the Highest Number of Publications

Country	Documents	Citations
United States	73	2109
United Kingdom	33	586
Italy	22	429
France	6	387
Ireland	6	343
India	32	280
Malaysia	16	114
Australia	5	111

Brazil	8	105
Saudi Arabia	11	101

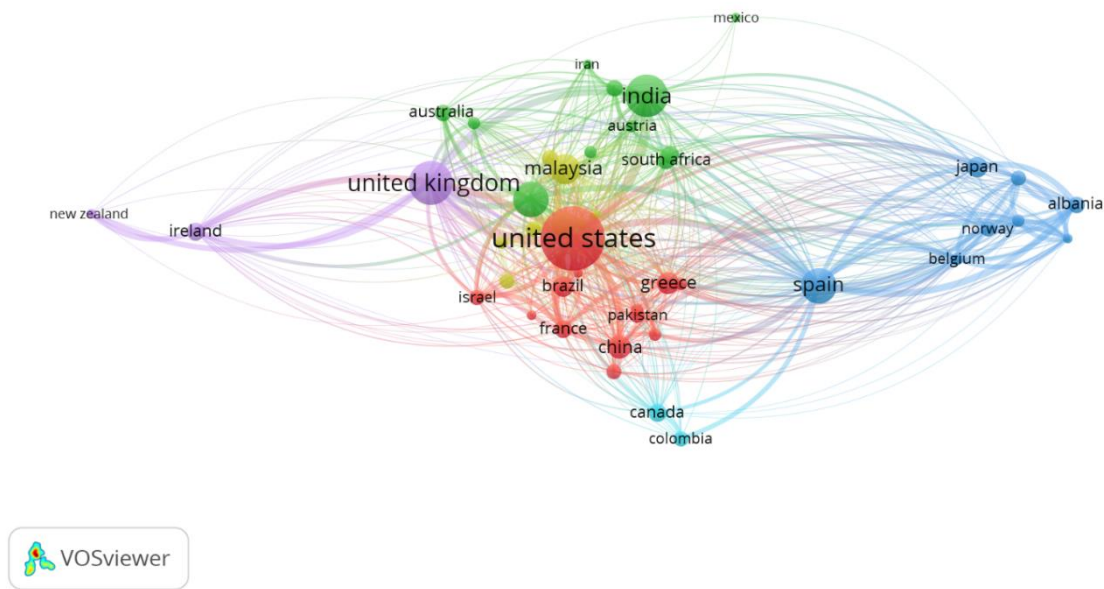


Figure 9. Country Analysis

5. Discussion

Academic interest in neurodiverse educational populations increases as researchers study educational environments that accept all students while implementing technology-based tools (Basha et al., 2025b). Bibliometric research explores three significant themes, which include how TEL frameworks function as well as adaptive student support methods and policy changes in education (Shen & Ho, 2020). Research investigations demonstrate that combining assistive technologies with suitable teaching methods leads to better educational achievements for students who possess neurological differences. The emerging digital accessibility issues, together with institutional challenges, continue to exist and need focused solutions (Clouder et al., 2020). Research about neurodiversity combined with higher education accessibility has witnessed a continuous increase in scholarly contributions. The time-series investigation carried out by Zsofia J. et al., (2023) proves that neurodivergent students achieve better graduation outcomes while undergoing challenges in conventional educational settings (Zsofia J. et al., 2023). UDL frameworks, along with institutional policy reforms, represent fundamental approaches to address the mentioned challenges, according to Hamilton & Petty, (2023). Research outcomes indicate that specific learning approaches with AI-powered adaptive systems deliver great benefits to neurodivergent students, according to findings from Thomas (2020).

Research based on bibliometrics reveals that the combination of TEL adoption and improved academic results shows a direct relationship for neurodivergent students in education. Students receive benefits from technology-based educational approaches that include personal learning systems and AI-driven tutors and cognitive load optimization strategies, according to Konu Kadirhanogullari & Ozay Kose (2023). The widespread adoption of these technologies remains limited due to digital accessibility gaps and socioeconomic barriers (Rollnik-Sadowska & Grabińska, 2024). The educational environment now focuses on wearable and IoT-based assistive technologies, which

play essential roles in neurodiverse learning systems. Time-based sensory feedback systems demonstrated how they enhanced students with sensory processing issues by improving their cognitive focus and mental concentration (Sims et al., 2023). A mixed-reality integration enables immersive educational concepts that satisfy various learning types, according to Bheemaiah (2020). The tools improve student learning success and enable independent study and more engagement from neurodivergent students (Spaeth & Pearson, 2023).

Academic research needs to dedicate its efforts toward solving fundamental neurodiversity barriers that exist within universities. Institutional policies must implement inclusive education strategies through accessibility improvement and establishment of an innovative and accepting environment (Murnaka et al., 2021). TEL methodology improvements through artificial intelligence and machine learning implementation will establish equal academic prospects for students who differ neurologically (Nasution & Batubara, 2024). The continuous development of neurodiversity research within education brings increasing successes and sustained obstacles to address. Additional research between different disciplines, together with government-led initiatives, will help develop permanent solutions that effectively serve neurodivergent students.

6. Conclusion

Global educational institutions are now showing a rising interest in neurodiversity due to their enhanced adoption of technology-enhanced learning (TEL). Modern technology advances through digital intervention, intelligent systems, and assistive tools, providing extensive support systems to neurodiverse students. Such tools acquire greater importance in creating fair educational settings as educational administrators and policymakers understand their potential benefits better.

A book-related analysis examined the research patterns regarding neurodiversity and TEL from 2010 through 2025 based on Scopus database results visualized by VOSviewer. The research yielded valuable findings but was limited by its reliance on the Scopus database, which excluded relevant material published in Web of Science and SpringerLink. An expanded approach for future research should combine several research databases to gain a better understanding of worldwide academic activities.

Among scholarly literature studies, the interest in neurodiversity and TEL in the academic world dramatically increased between 2019 and 2024, reaching its highest point in 2024. The research shows considerable expansion because educational institutions now recognize the necessity of individualized technology-based learning methods. Educational institutions face ongoing barriers in making TEL tools accessible to all students and financially practical for schools and universities to implement without barriers. The resolution of these problems demands cooperation between representatives from education, technology, policy-making bodies, and disability support groups.

This research study responded to four major research inquiries:

1. What are the key trends in technology for neurodiversity education research from 2010 to 2025?

High-quality research demonstrates growing attention to AI-based supportive technology, adjustable learning techniques, and wearable devices that help neurodivergent students enhance executive abilities while fostering their cognitive performance. Revised studies about virtual reality and augmented reality, as well as other immersive technologies, have proven their effectiveness in developing inclusive learning environments.

2. Which authors, together with their journals and institutions, produce most of this field's leading research?

The analysis recognized Vanderbilt University and Harvard University as seminal research establishments that created significant contributions about assistive technology and inclusive pedagogy. The journals *Disability and Rehabilitation* and *Lecture Notes in Computer Science* contribute essential knowledge about neurodiversity and TEL because of their interdisciplinary approach in academic research.

3. What are the prevalent themes along with keywords throughout research about technology-neurodiversity education?

The study offered three fundamental clusters, which were (1) studies of the cognitive psychology and (2) studies of educational technology and inclusive learning solutions with (3) studies of AI applications and implement assistive technologies. New areas of study have emerged, focusing on the modalities of adaptation learning, real-time commenting technologies, and inclusive teaching strategies.

4. What is the effectiveness of technology-enhanced education systems in reducing issues of educational equality among the neurodiverse students?

TEL is an effective technology that significantly decreases the learning barriers that confront neurodiverse learners. This is because the application of digital interventions involving the AI-based adaptive learning systems can eliminate the complications of education and increase learning opportunities that facilitate student academic success. The realization of actual equity is achieved through policies that focus on making inclusive technology available to every student at the point of use, ensuring that costs are affordable to users regardless of their financial status.

7. limitations

This study has several limitations that should be mentioned in concluding the results. First, only Scopus database was used, which, although it was broad enough, may not have reflected useful publications that could be registered in other databases such as Web of Science, SpringerLink, or ERIC (Arruda et al., 2022). This restriction may indicate a partial view of global research activity. Also, since only publications written in English were taken into account, the role of other languages, especially those representing countries with active neurodiversity and inclusive education research, could be neglected. Data collection was carried out in the early months of 2025, so some of the latest studies of the year may not have been indexed yet, and their contribution may be underestimated. Additionally, it did not include preprints or in-press articles; only those close to publication were included. Finally, the investigation relied on VOSviewer to map the bibliometric data. However, despite its power, the program can miss significant interdisciplinary connections or new emerging themes that are not yet represented in citation patterns or keyword co-occurrences. The additional sources of data, such as the data in foreign languages, as well as the use of other bibliometric tools, should be considered in future studies to enrich the comprehension of the field (Konu Ozay, 2023).

8. Suggestion

The bibliometric review demonstrates quick growth in research about neurodiversity and TEL, although key aspects still need further investigation. The researchers should examine the impact of TEL interventions on the short-term and long-term development of students, including their readiness to participate in the labor market and their subsequent social integration skills. The implementation of AI-driven educational tools requires thorough ethical evaluation to stop discrimination against students from various learning populations (Basha et al., 2025).

The integration of TEL to serve neurodiverse learners has improved, but many hurdles remain to achieve complete accessibility and cost-effective, productive solutions. Research and policymaking with technology development, together with educational staff and researchers, must work to create

a disability-friendly learning structure which strengthens neurodiverse students (Nasution & Batubara, 2024). The future strength of neurodiversity education depends on using innovation alongside evidence-based policy to accomplish interdisciplinary research that enables all learners to succeed.

Declarations

Author Contributions. Valentine Muriira: original manuscript preparation; Venoth Nallissamy: literature review, conceptualization. Valentine Muriira, Shem Mwalw'a: methodology, data analysis. Valentine Muriira, Henry Kamundi: review editing and writing. All authors have read and approved the publication of the final version of the article.

Conflicts of Interest. The authors declare no conflict of interest.

Funding. The authors would like to thank INTI International University for its continuous support of academic research and publication funding.

Ethical Approval. This study did not involve human participants or animals and thus did not require ethical approval.

Data Availability Statement. Data is available upon request.

Acknowledgments. The authors would like to acknowledge the institutional support provided by INTI International University Malaysia.

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