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Exploring Emerging Frontiers in Global Assistive Technology Research: A Computational Analysis

Dr. Manendra Singh** * Dr. Syed Shaz Husain**

* Assistant Professor, Department of Library & Information Science, Mizoram University, Aizawl (Mizoram) - 796004, INDIA; Email: manebhu007@gmail.com, manendra@mzu.edu.in
** Assistant Librarian, Maulana Azad Library, Aligarh Muslim University, Aligarh (U.P.) - 202001, INDIA; Email: sshusain@myamu.ac.in; Orcid-id: 0000-0002-9522-2882
# Corresponding author.

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Abstract

Purpose: *This study investigates global research on Assistive Technology (AT) in education from 2005-2024, focusing on emerging trends, research hotspots, prolific authors, journals, and thematic knowledge structures. It aims to reveal research patterns and propose directions for future work.*

Design/methodology/approach: *A mixed-method approach was applied, combining bibliometric, sentiment, and topic modeling techniques. Data (2,652 documents) were retrieved from Scopus and analyzed using Biblioshiny (descriptive analysis), VOSviewer (visualization), TextBlob (sentiment), and BERTopic (topic modeling). The analysis emphasized conceptual and thematic structures of AT research.*

Findings: *The dataset shows contributions from 9,618 scholars, with rapid growth in AT publications from 2020-2024, influenced by technological progress and the pandemic. Bradford's Law identified 34 core journals producing one-third of the output, while Lotka's Law confirmed expected author productivity trends. Collaboration index findings highlight limited global co-authorship. Four major keyword clusters were identified. Sentiment analysis revealed predominantly positive and objective tones, indicating optimism and fact-based reporting in AT research. Topic modeling highlighted 10 promising directions, including AI-enabled multimodal learning, personalized literacy tools, dementia-friendly education, robotics, psychometrics, smart libraries, and AI for emotional learning.*

Practical/implications: *AT research is undergoing technological transformation, with future studies expected to focus on AI, inclusive education, assistive devices, skills training, mobility, and information services.*

Originality/value: *This study uniquely combines bibliometrics, sentiment, and topic modeling to map AT research, offering a replicable framework for analyzing research dynamics across domains.*

Keywords: Education; Assistive technology, Bibliometric, Topic modelling, Sentiment analysis, BERTopic.

1. Introduction

Recently, assistive technology become a subject of debate in special education, as a vital tool that enables students with disabilities to succeed, others argue which fosters dependence, potentially limiting students' ability to perform tasks independently (Edyburn, 2013). Various research examined the role of assistive technology in class rooms regarding its integration for the curriculum assessment. Students with disabilities often struggle with everyday tasks and such challenges may hinder their educational experiences. Denying access to AT may increase their reliance on others, which contradicts their right to lead independent lives (Carlson et al., 2001). In educational settings, AT holds the potential to significantly enhance the learning and academic performance of students with disabilities (Edyburn, 2010). Due to inclusion of these students in mainstream classrooms, they may face challenges in reading, listening, organizing information, or writing works. While inclusive classrooms can help to address some of these issues, new barriers may emerge if students cannot access the general education curriculum.

According to Zilz and Pang (2019), AT could be in the form of "any item, piece of equipment or product system, whether acquired commercially off the shelf, modified, or customized, that is used to increase, maintain, or improve functional capabilities of a child with a disability". In study Lersilp et al (2018) found that most special needs children needed AT, especially for mobility, communications, and as facilitators for education. Assistive technology encompasses a wide range of services and devices. These devices are generally categorized into high-tech and low-tech. High-tech devices, such as adaptive equipment, voice recognition, and word prediction software, are often more complex and costly and usually require user training (Johnson, Davies and Thomas, 2014). In contrast, low-tech tools like talking watches, pencil grips, highlighting tape, eyeglasses, and earplugs are simpler, less expensive, and require minimal training. From the perspective of a special educator, ensuring the well-being and academic inclusion of students with disabilities is a key concern. These students deserve an accessible educational environment where they can actively participate in classroom activities. The concept of the Least Restrictive Environment (LRE), as mandated by IDEA, emphasizes that students with special needs should be educated in settings that are as inclusive as possible (Turnbull, Beegle and Stowe, 2001). To promote acceptance and inclusion of students have disabilities various strategies must be implemented to use AT in classrooms. Assistive technology can help create such inclusive spaces, aligning with the goals of students, parents, and educators alike. Educators, in turn, are continually exploring innovative strategies to facilitate student comprehension and learning. By recognizing not only the limitations posed by disabilities but also the abilities that students with special needs possess, teachers can better appreciate and support the use of assistive technology in educational settings (Edyburn, 2003).

In recent Bibliometric, sentiment and topic modeling are frequently used at different level for systematic analysis and examined the growth, subjectivity of content and thematic overview of any research domain. Bibliometric techniques assess publication trends, citation patterns, research productivity, and collaboration networks, enabling scholars to trace the development of the field (Wang, Zhang and Li, 2021; Garcia, Gutierrez and Ramos, 2018). Several key studies using systemic analysis through bibliometrics provide a foundation for understanding AT's role in education. Alper & Raharinirina (2006) reviewed early AT tools, focusing on their applicability in special education. Dell et al. (2017) examined how modern AT tools integrate with mainstream technology. Bouck & Flanagan (2014) identified trends in AT adoption, emphasizing cognitive and sensory support. Chen et al. (2020) examine the British

Journal of Educational Technology through bibliometric analysis during 1971 to 2018, while Phillips, and Ozogul (2020) conducted a bibliometric review of the current literature in Assistive technology. In study Chen et al. (2019) used the bibliometric technique to study the highest ranking journal “Journal Computers & Education” while Perdima et al. (2022) examine the SCOPUS-indexed journal articles on educational technology in physical education learning using bibliometric tools. These reviews indicate that while various technologies continue to change the landscape of teaching and learning should be adopted in primary or elementary level of education.

Anderson et al. (2015) focused on AI applications and implementation challenges in AT. Recent studies, such as Ginsburg et al. (2017) analyses ethical and policy frameworks, particularly with AI-driven AT solutions. The field of assistive technology in education has evolved from simple tools which are supporting basic to sophisticated learning, AI-driven devices enhancing educational accessibility for diverse learners. These studies conducted to examine the structured understanding of Global AT’s progression, highlighting the focus on inclusivity, technological advancements, and policy challenges. Future research should address ethical concerns and expand accessible AT options to under-resourced settings. Despite the growing body of literature, gaps persist in AT research. Key areas requiring further exploration include: global research growth during 2005-2024, prolific author and source of publication, thematic mapping of AT and future research directions. By employing bibliometric, sentiment and topic modeling approaches, this study aims to bridge these gaps and provide insights into future directions for AT research. The findings will be instrumental in shaping policy frameworks, inclusive education policy and guiding academic discourse. The specific questions guiding the analysis were as follows:

RQ1: What are the global publishing trends in AT research in Education, and who are the most influential authors, institutions, and leading publication sources shaping this field?

RQ2: How is the thematic landscape of global AT research in education structured, as revealed through keyword co-occurrence patterns, and topic modeling analyses?

RQ3: How do abstract sentiment, subjectivity, and polarity relate to citation patterns in published literature?

RQ4: What emerging research directions, thematic gaps, and future priorities can be identified to advance AT applications in education on a global scale?

2. Methodology

A pre-structured research design shown in Figure 1 indicating steps from database selection to find future research direction. The Scopus database selected for data collection through advanced keyword search string. A preliminary analysis on data corpus was then conducted for growth pattern and prolific source and authors, with an emphasis on keyword, sentiment and topic modelling analysis to revels the thematic research patterns. Tools such as Biblioshiny, VOSviewer, TextBlob and BERTopic used for data analysis. This comprehensive analysis method enabled an in-depth examination over the past 20 years of global research in Assistive Technology.

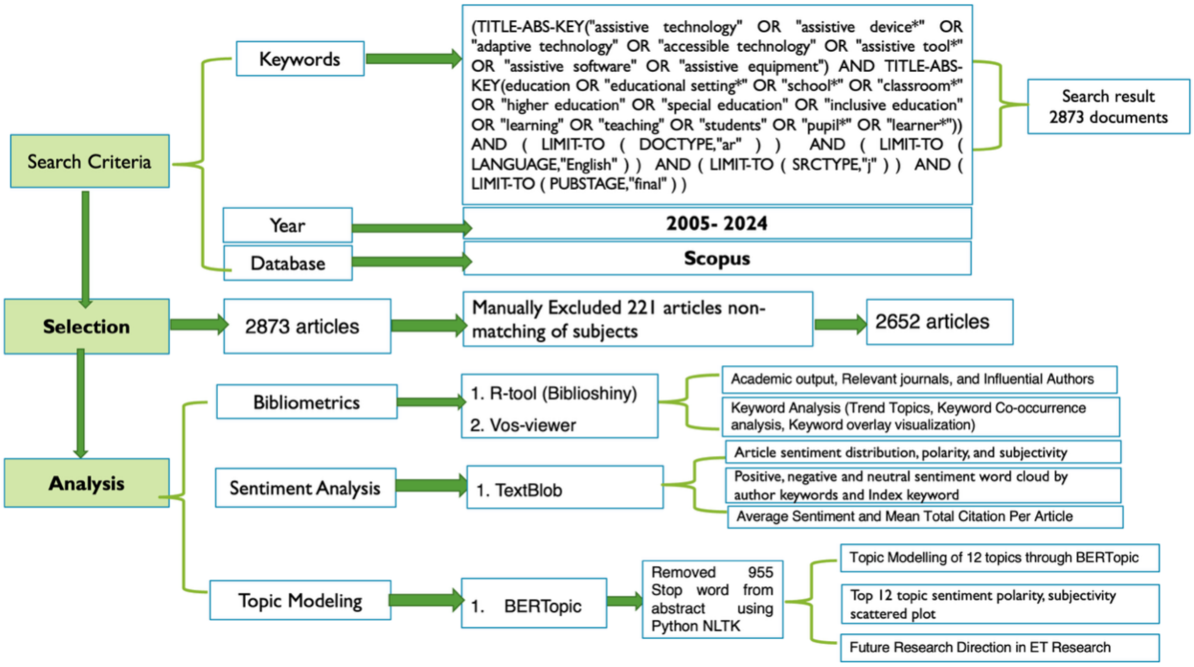

Figure 1: Research flow chart

2.1 Database Selection and Search Keywords Identification

The Scopus, selected for data download on Assistive technology between years 2005 to 2024. It has multi option data filter, which help to efficiently explore and retrieve relevant data with highest precision. A search string was designed to minimize false positives while ensuring academic rigor and relevance to the research topic earlier used by Ramos & Ruiz, (2004). Search string shown in figure 1indicating that all relevant keywords through advance search method used for download of bibliographic details in CSV file. The same search string and limit options were applied to extract data in CSV for sentiment and topic modeling. The data search, executed on August30, 2025, further narrowing the results by focusing on articles published on AT research, a total of 2873 articles were downloaded. The titles and abstracts of downloaded articles were carefully checked, and ultimately, 2652 articles were selected for the analysis.

2.2 Preliminary examination of the selected publications

Table 1 provides a detailed bibliometric overview of AT research output from 2005 to 2024. Over this 20-year time span, 983 distinct journals sources, contributed to a total of 2,652 documents, with an impressive annual growth rate of 14.11%, indicating steady expansion in the field. The average age of documents found is 6.9 years, reflecting a mix of recent and older publications. Each document received about 20.26 citations on average, with a cumulative total of 103,680 references indicating the scholarly depth of research. The dataset shows 10,054 Keywords Plus and 6,307 author keywords, suggesting rich thematic diversity. A total of 9,618 authors contributed, with only 240 single-authored publications out of 255 such documents, highlighting a strong practice of collaboration evidenced by an average of 4.29 co-authors per paper and an international co-authorship pattern of 19.65%. The overall Collaboration Index stands at 3.6, showing the trend toward collective research efforts in this domain.

Table - 1: Preliminary data overview of publications

Description	Results
Time span	2005:2024
Sources (Journals)	983
Documents	2652
Annual Growth Rate %	14.11
Document Average Age	6.9
Average citations per doc	20.26
References	103680
Keywords Plus (ID)	10054
Author's Keywords (DE)	6307
Authors	9618
Authors of single-authored docs	240
Single-authored docs	255
Co-Authors per Doc	4.29
International co-authorships %	19.65
Collaboration Index	3.6

2.3 Keyword co-occurrence, Abstract Sentiment and Topic Modelling Analysis

Keyword co-occurrence analysis is a widely used for bibliometric techniques. It identifies relationships between terms based on their simultaneous appearance within a defined textual unit, such as titles, abstracts, or full texts (Van Eck and Waltman, 2010). This method is useful in uncovering thematic structures, mapping research trends, and revealing conceptual linkages between terms (Cobo et al., 2011). This allow to detect clusters of related keywords, instrumental to locate emerging or dominant areas of study. The sentiment analysis, is a subfield of natural language processing (NLP), increasingly applied in scholarly abstracts to quantify emotional tone and subjectivity. The Text Blob used for the analysis which operates along subjectivity dimension, reflecting the degree of opinion versus fact (0.0 to 1.0) (Liu, 2012). Though still emerging, sentiment analysis of abstracts has revealed patterns in emotional framing, disciplinary tone, and gendered language, offering valuable input for meta-research (Kincaid et al., 2020). The BERTopicis used to detect latent semantic patterns of different topics in literature abstracts. This unsupervised machine learning technique identifies recurring themes by analyzing topic word score (Chen et al., 2022). Implemented via Python in Jupyter Notebook, BERTopic enables thematic clustering based on topic coherence scores, facilitating trend detection and research mapping (Xue, et al., 2020). Together, these methods offer a robust framework for visualizing scholarly landscapes and guiding future research directions for AT.

3. Results

3.1 Research growth, Prolific Journals, and Influential Authors

The figure 2 shows notable trends in yearly publications and mean citations per article from 2005 to 2024. Article output increase from just 33 in 2005 to 59 by 2007, when the mean TC (Total citation) per article peaked at 41.0, indicating high impact during early growth. From 2008 to 2011, output remained stable (56-75 articles) while mean TC declined to 23.2, before reaching to an all-time high of 47.8 in 2012 despite only 82 articles, showing exceptional impact that year. This was followed by a decline in mean TC to 22.6 in 2013.

From 2014 to 2020, publications steadily increased from 109 to 204, but mean TC fluctuated moderately between 17 and 27 The most striking trend is the recent surge in publications from 256 in 2022 to a record 409 in 2024, while mean TC per article plummeted to just 5.7, indicating that despite massive growth in research output, the average impact per article has declined due to fever citation years.

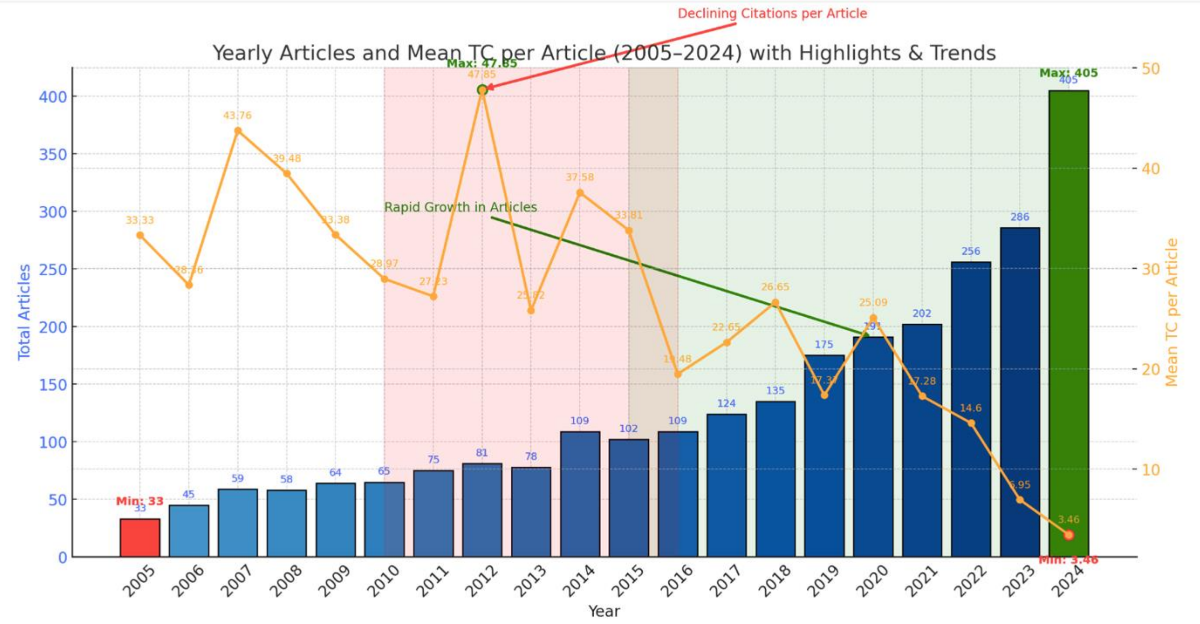

Figure 2: Article per year and mean total citation per article

Bradford's law identifies relevant source that produce articles on a specific topic within a defined research timeframe. This approach allows for the division of journals into a core, or nucleus, of periodicals that focus primarily on the subject, as well as several groups or zones that contain the same number of articles as the nucleus (Bradford, 1934). In Zone 1, a total of 34 journals were identified. The journal "DISABILITY AND REHABILITATION: ASSISTIVE TECHNOLOGY " (N=141, Citation=2654, h index=29) emerged as the leading journal, followed by " ASSISTIVE TECHNOLOGY " (N=94, Citation=1247, h index=20), " IEEE ACCESS " (N=79, Citation=1742, h index=26), " JOURNAL OF SPECIAL EDUCATION TECHNOLOGY " (N=70, Citation=1188, h index=23), and The core zone, representing the highest-ranking academic journals, includes a significant publication rate (N=33.3%) in AT research.

Further analysis indicates that, author Bouck EC leads with the highest h-index (14) and consistent productivity (15 papers, 453 citations), reflecting a strong and sustained research impact. Hemmingsson H. and Lancioni GE also demonstrate with h-index values of 11 and notable citation counts (390 and 311), indicating steady contributions. Wang Y stands out for having the highest total citations (656) despite a lower h-index (7), suggesting his influence concentrated in a few highly cited works. In terms of early-career influence, Zhang Y shows the strongest m-index (1.5) with limited publications (10 papers, 94 citations), while Li J also records a good m-index (0.857). Authors such as O'Reilly MF, Singh NN, and Stasolla F maintain balanced performance with h-index values of 10 and citations in the 248-369 range. Overall, the most notable contributors are Bouck EC for consistent high performance, Wang Y for citation strength, and Zhang Y for strong early-career influence. The Institute productivity indicates that the

University of California (74), University of Toronto (64), University of Washington (64), University of Alberta (58), and University of Pittsburgh (58) dominates in the publication with more than 50 documents. The top five countries including highest United States (1025, Citation=25966) United Kingdome, (234, Citation=5705), Canada (164, Citation=3688), India (164, Citation=3488) and Australia (131, Citation=1331) dominate in the AT research activity. In this list only India as a developing country, finds a place among the top five countries. The study applies Lotka's law (Lotka, 1926), which states that the number of authors producing n articles is proportionate to $1/n^2$ when authors are ranked based on the quantity of papers they have published (Patra and Mishra, 2006). The results showed no statistically significant differences between the statement of law and the findings. Moreover, the analysis suggests that many academics might have treated AT as an alternative topic, evidenced by most authors having published only a single article.

4. Keyword Analysis

Subject keywords are significant to identify core themes and research trends. The key topics are helpful for researchers to understand the primary focus areas in existing literature. The two method trend topics by using Biblioshiny and keyword co-occurrence through VOSviewer utilized for keyword analysis of AT literature.

4.1 Year Wise Trend topic analysis of Abstract terms

This trend topic figure 3 illustrates how research keywords have evolved year by year from 2005 to 2024, highlighting the growing focus on disability studies, assistive technologies, and inclusive education. In the early years (2005-2010), niche foundational terms like “instructional accommodations”, “technical assistance,” “compensatory strategies,” and “exceptional children” (Ok and Rao, 2019) were prevalent but had relatively small frequencies. By around 2010–2013, emerging themes such as “gait speed,” “virtual environment” (Walker and Lindsay, 2005) “intervention phases,” and “occupational performance” (Pinkelman, Roll and Greene, 2006) began to appear, showing an increased interest in therapy and rehabilitation contexts. From 2014-2017, the research expanded to practical applications and conditions like “disabled students,” (Nganji, Brayshaw and Tompsett, 2011) “gross motor,” “technology devices,” “physical disabilities,” “spinal cord,” and “cerebral palsy,” (Pulay and Szabo, 2024) and bubble sizes indicating higher research activity. The trend intensified post-2018, with significant growth in topics such as “hearing impairment,” “visual impairment,” “assistive devices,” “autism spectrum,” “special education,” (Yu et al., 2022) and “future research,” reflecting a strong societal push for inclusivity and accessibility. Notably, terms like “deep learning,” “artificial intelligence,” and “machine learning” (Alsudairy and Eltantawy, 2024) prominently emerged in recent years, suggesting the adoption of advanced technologies to address these challenges. Large bubbles for “sign language,” “assistive technology,” and “significant challenges” found for most recent period (2020-2024) show the mainstreaming of these topics, underlining how the field has evolved from niche educational accommodations to a broad, technology-integrated, multidisciplinary focus on improving the lives of people with disabilities through innovative research and interventions.

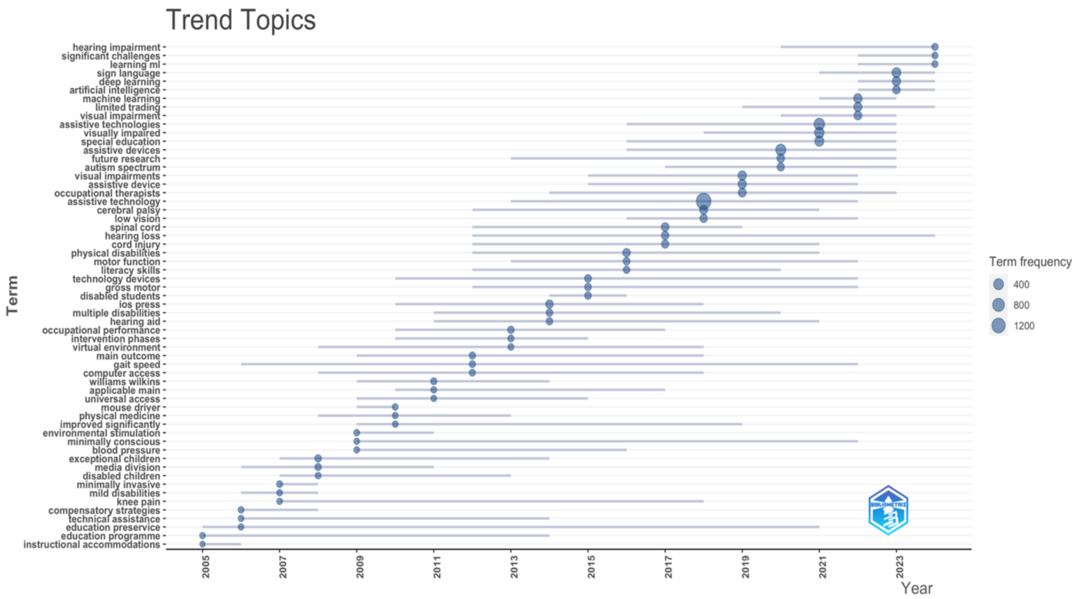

Figure 3: Trend topics of term by year

4.3 Keyword Co-occurrence analysis

The keyword co-occurrence network was constructed using a minimum occurrence threshold of 15 terms. A total of 526 keywords were selected for analysis from the entire set of 10054 keywords. Figure 4 presents the network visualization of keyword co-occurrence, displaying key elements such as visualization scale (1.00), term weights (based on occurrence), and term levels (frame), represented by coloured, and straight lines. The network consists of selected keywords distributed across four distinct clusters, each depicted in a different color.

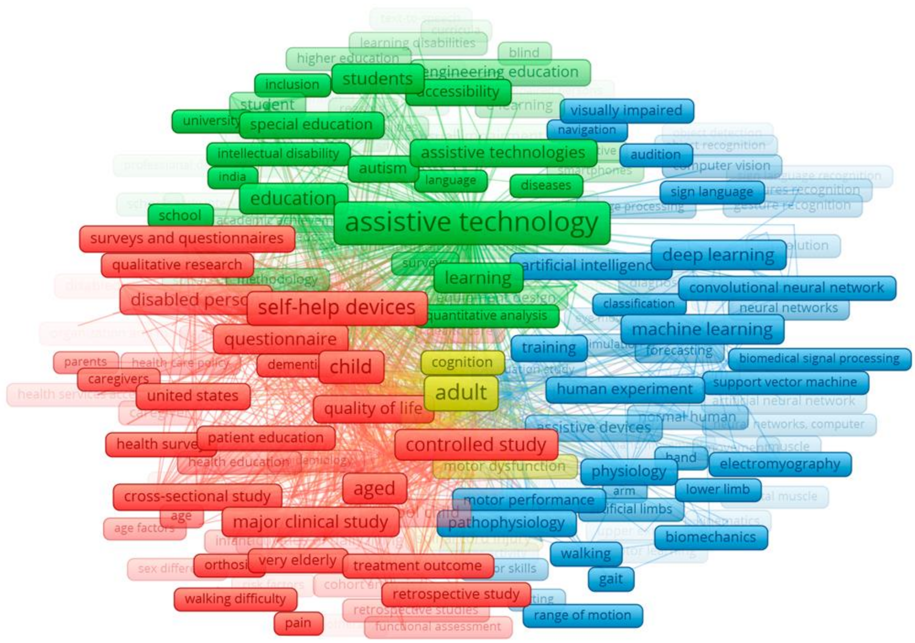

Figure 4: Keyword co-occurrence network

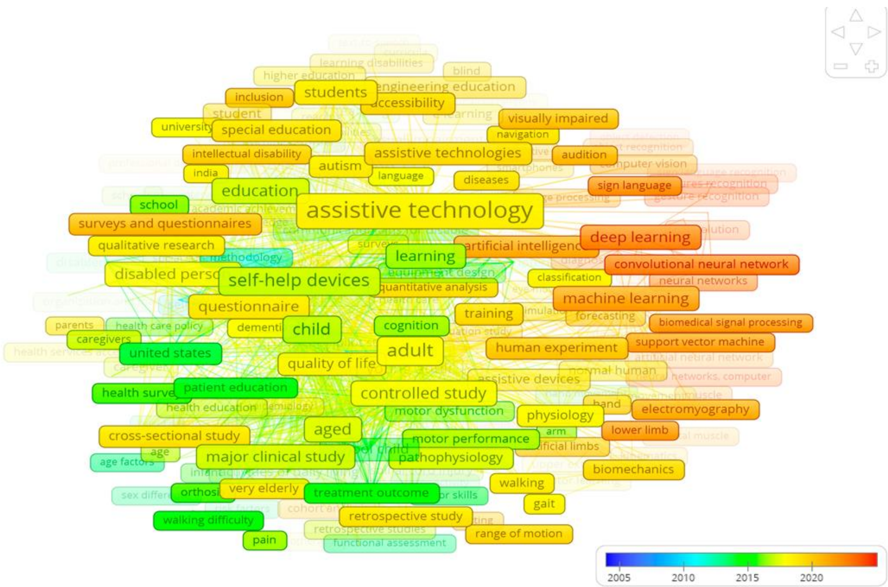

Figure 5: Keyword co-occurrence overlay visualization

Figure 4 illustrates that highest occurrence noticed in cluster 1 (Red) for “self help devices” (N=383). The keyword "self-help devices" enable a "child", "school child", (Al-Zboon and Al-Dababneh, 2023) or "disabled person" (Schaefer-Campion and Johnson, 2015) to overcome "working difficulties" and participate actively in learning. For students with conditions like "dementia", these tools help maintain function and independence, improving overall "quality of life". Effective "patient education" ensures that learners, families, and teachers know how to use these aids, directly influencing "treatment outcome" (Sahin, Kızılaslan and Simşek, 2024). In conclusion these keywords indicate emotional well-being alongside academic progress, showing how AT addresses the full range of needs in inclusive education.

In cluster 2 (green), highest occurrence (N=1173) noted for “assistive technology”. Term "assistive technology" indicates to enhance "special education" (Kurt and Erden, 2024) by providing tools like "communication aid for disabled" students, including "text to speech" and "eye tracking" devices, which improve interaction and learning. Technologies such as "virtual reality" (Carreon, Criss and Mosher, 2024), "mobile application", and "computer interface" make "school learning" more accessible and engaging, especially for students with "autism" or those who are "visual impaired" (Wu, et al., 2024). Integrated "e-learning" platforms support flexible, personalized learning, while strong "social support" systems ensure these tools are effectively used. Together, these terms "technology" solutions bridge gaps in "language", communication, and participation for all learners.

Cluster 3 (blue) “machine learning,” (N=204) noticed as, highest occurrence term. Term "deep learning", "artificial intelligence", and "neural network" models power advanced "forecasting", "image processing", and "computer vision" systems that support reading for people with disabilities (Sadak, et al., 2024). Tools like "robotics", "devices", and "artificial limbs" often rely on "electromyography" signals and "biomechanics" for better control and functionality, improving mobility for "stroke rehabilitation" among patients (Ibrayev, and Amanov, 2024). The innovations in "sign languages" and vision-based interfaces help the "visually impaired" through smart "assistive devices" (Lee and Bae, 2022). These keywords indicate that technologies ensure safe, effective solutions that bridge gaps in daily living, mobility, and independence.

Cluster 4 (yellow) “adult,” (N= 560) depicted as highest occurrence. Keywords "young adult" with "motor dysfunction", "quadriplegia", or "spinal cord" addressing both physical and cognitive challenges (Herajarvi et al., 2020). Terms "brain", "cognition", and impacts of "injuries" indicates the design mechanism of effective tools and therapies for "cognitive defect" and recovery (Khasawneh, 2024). This cluster focused on "psychometry" methods to assess mental functions ensures that interventions meet individual needs, promoting independence and better quality of life for those facing complex neurological and physical conditions.

Figure 5 presents the overlay visualization of keywords with same keyword co-occurrence thresholds for locating hot spot research areas in AT research. Between 2020-2024, "deep learning" and "machine learning" (Shirley, 2023) emerged as key drivers in Assistive Technology research, especially for supporting learners with "intellectual disability" and promoting "inclusion"(Alsultan and Mohammad, 2023). Advanced AI methods like "neural networks", "support vector machine", and "transfer learning" have powered breakthroughs in "gesture recognition", "object detection", and "sign languages", making communication more accessible. In the biomedical domain, tools combining "electromyography", "signal processing", and AI have improved interventions for "lower limb" rehabilitation and "lover limb" prosthetics (Alshamrani, 2024). These innovations enhance students mobility and free them from physical challenges. Overall, integrating "AI" and smart algorithms into assistive systems represents a growing research hotspot focused on smarter, more inclusive solution in future.

5. Sentiment Analysis of Abstract

The sentiment analysis was applied to a corpus of all article abstracts using the TextBlob, a lexicon-based tool which enables the quantification of subjectivity of textual data. Text Blob computes sentiment by assigning subjectivity scores from 0.0 (completely objective) to 1.0 (completely subjective).

5.1 Article sentiment distribution by polarity, and subjectivity

The figure 6 presents two bar charts showing the distribution of articles by polarity and subjectivity. The majority of articles in polarity classified as positive (2,409 articles), followed by negative (234 articles), while only a very small number are neutral (9 articles). This indicates that most of the analyzed content expresses a positive sentiment. Articles by subjectivity include total 2,233 articles with objective sentiment whereas smaller proportions are subjective (419 articles). Together, these charts reveal that the dataset is dominated by positive and objective articles, with very few neutral or highly subjective pieces, suggesting an overall optimistic and fact-based tone in the literature of assistive technology uses in education.

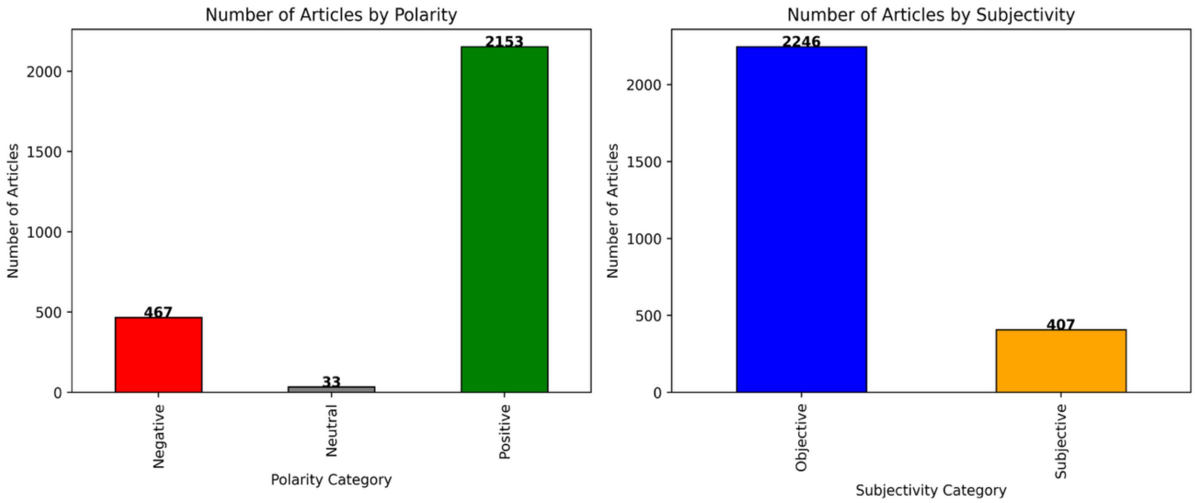

Figure 6: Articles by polarity and subjectivity

The figure 7 shows the scattered plot of Polarity vs. Subjectivity that visualizes sentiment characteristics of a dataset. The x-axis (Polarity) ranges from –0.3 to +0.5, where negative values indicate negative sentiment, values near zero indicate neutrality, and positive values suggest positive sentiment. The y-axis (Subjectivity) ranges from 0 (objective, fact-based) to 1 (subjective, opinion-based). Each point represents an individual text or document. The dense clustering of points is centered around polarity values between –0.1 and +0.2 and subjectivity values between 0.3 and 0.6**,** suggesting that most of the content is neutral to slightly positive in tone, with a balanced mix of objectivity and subjectivity. Few outliers extend toward stronger positive polarity (≈0.4) or more subjective expressions (>0.7), while very negative polarity values (< –0.2) are relatively rare. Overall, the plot shows that the dataset is dominated by moderately positive and moderately subjective content, with limited extreme sentiments.

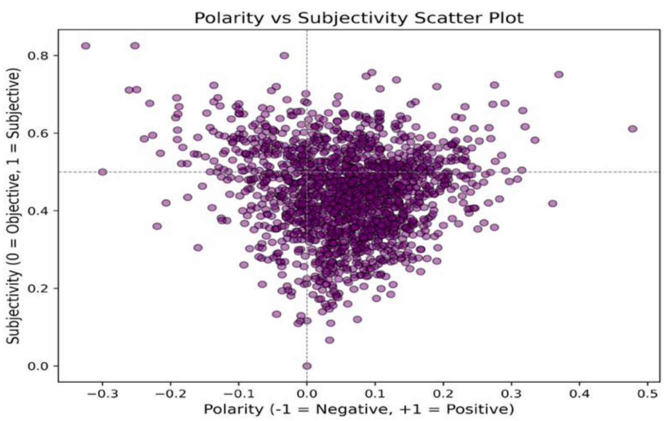

Figure7. Polarity and subjectivity scattered plot

The figures 8 present word clouds of author keywords and figure 9 index keywords which are categorized by sentiment analysis into positive, negative, and neutral contexts, offering a comparative view of how research themes are framed in scholarly discourse. The author keywords shows thematic and conceptual view with positive terms such as "assistive technology," "machine learning," "education," and "sign language" highlighting innovation, negative terms like "disability," "device," "rehabilitation," and "teacher" reflecting barriers, and neutral terms such as "adaptive," "health," "community," and "wellbeing" pointing to broader domains. The index keywords focus more on methodological and descriptive aspects including positive sentiment terms such as "self-help," "neural network," and "rehabilitation" which indicates applied innovations. The negative sentiment terms like "human," "system," "student," and "female" indicate challenges around human technology interactions, and neutral terms including "study," "article," "clinical," "child," and "computer" reflect educational practices focused on study designs, populations, and disciplinary contexts. The both keyword set highlights recurring themes of "technology," "learning," "system," and "human/disability". Further all keyword demonstrating how sentiment analysis based on author and index keywords provides complementary insights into the opportunities, limitations, and contexts shaping research on assistive technologies, disability, and education.

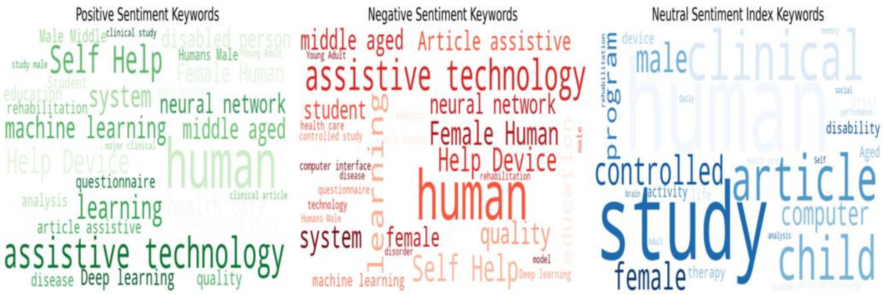

Figure 8: Positive, negative and neutral sentiment word cloud by author keywords

Figure 9: Positive, negative and neutral sentiment word cloud by Index keywords

5.2 Average sentiment score and Mean Total Citation per article by year

The chart in figure 10 reveals an inverse relationship between Average Compound Sentiment Score and Mean Total Citations per Article (Mean TC per Art) over the years 2005-2024. While sentiment steadily improves rising from 0.52 in 2006 to a peak of 0.73 in 2023 citation impact per article declines from 47.9 in 2012 to just 3.5 in 2024. This suggests that although research abstracts have become increasingly positive in tone, they are garnering fewer citations over time. Notably, in early years like 2007-2008, high citation averages (43.8 and 39.5) coincide with moderate sentiment scores (0.63 and 0.60), whereas in recent years, higher sentiment (above 0.69) contrasts with low citation rates (below 15). This divergence may reflect growing publication volume, shorter citation windows for newer papers, or a shift toward more optimistic but less citable writing in assistive technology.

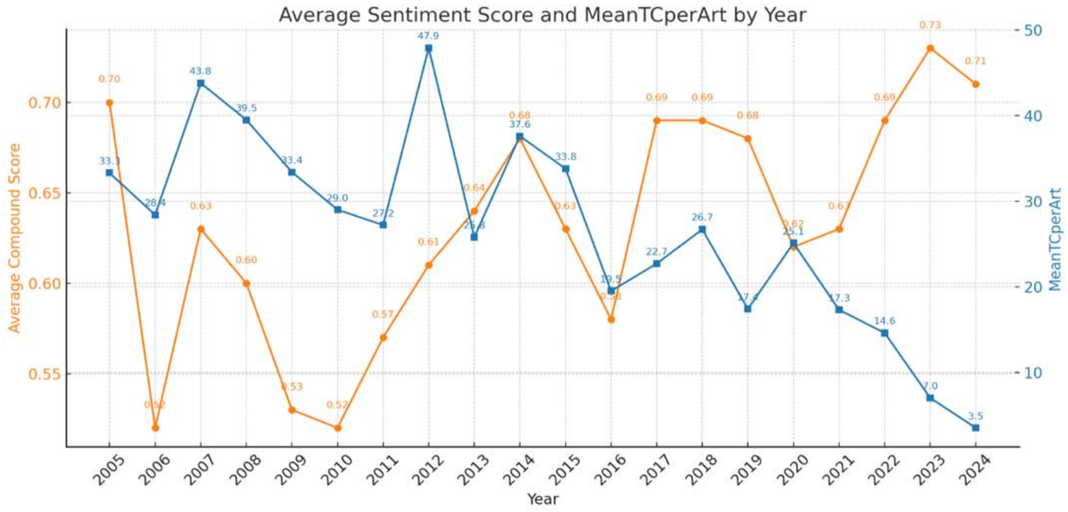

Figure 10: Average sentiment score and Mean Total Citation per article by year

6. Topic Modelling

BERTopic modeling was performed using topic coherence scores to determine the optimal number of topics. The process began with text preprocessing and word segmentation using the BERTopic Python package. To refine the abstracts, 955 relevant stop words removed from the abstract dataset using python NLTK (Natural language Toolkit). Figure 11represents topic word scores in different colour with most frequent 10 terms for each topic using Latent Dirichlet Allocation (LDA) generated by BERTopic.

6.1 Topic word score

The keyword distribution across the first twelve visualized topics demonstrates the diverse and interconnected thematic orientations within the literature. Topics such as teachers, technology, and special education (Topic 1), reading, comprehension, and dyslexia (Topic 2), and adaptive learning and e-learning (Topic 12) foreground educational dimensions, highlighting both pedagogical practices and digital interventions for learners with disabilities. The term dementia and telehealth (Topic 3), cerebral palsy and child mobility (Topic 5), hearing loss and speech aids (Topic 6), and motor function and gait rehabilitation (Topic 9), reflecting the medical and rehabilitative focus of educational research for students with disabilities. The technological strand emerges prominently in visual impairment and object detection (Topic 4), clinical diagnosis and AI-based classification (Topic 10), and sign language and gesture recognition (Topic 11), emphasizing computational tools that enhance accessibility and clinical efficiency. Meanwhile, libraries and accessibility services (Topic 7) and autism spectrum interventions (Topic 8) bridge educational, social, and technological perspectives by promoting inclusion and communication support. Collectively, these topics reveal a research landscape that is both multidimensional and integrative, balancing technical innovations with educational and social inclusion, shows scholarly engagement with disability, technology, and learning.

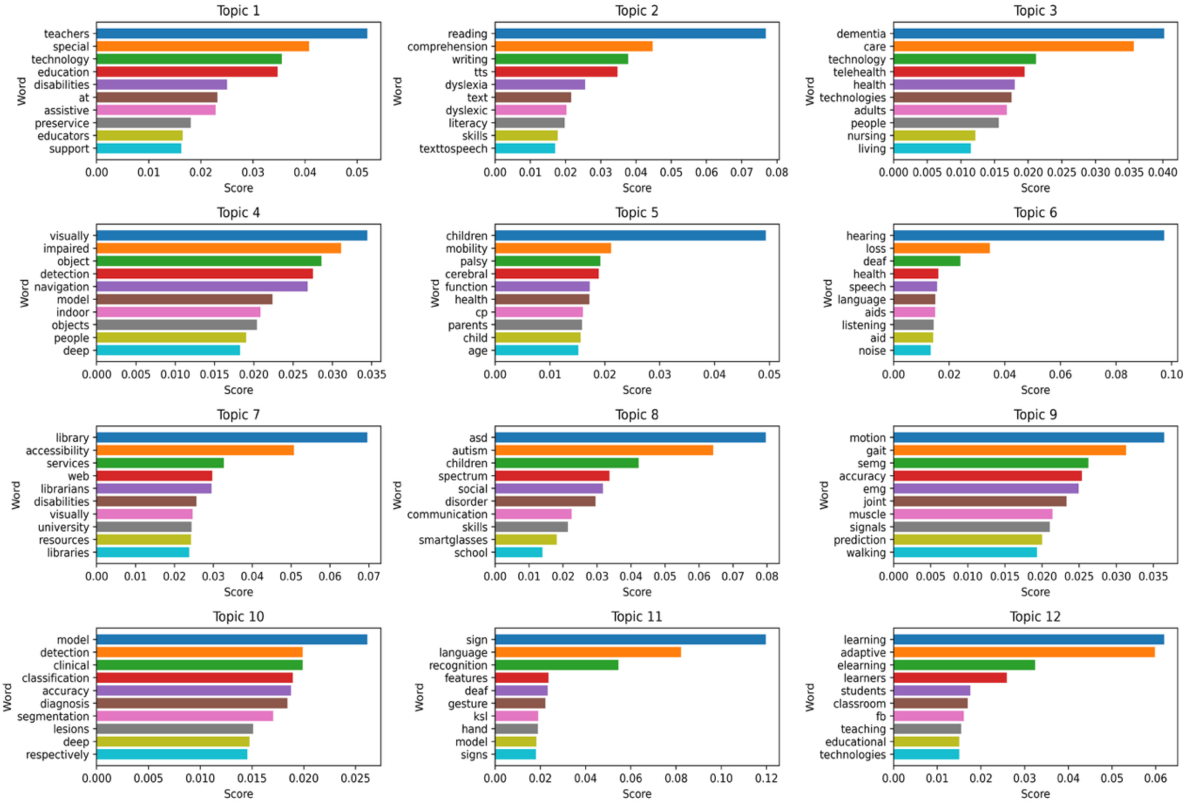

Figure 11: Topic word score 12 relevant topics

6.2 Topic with sentiment score and scattered plot for sentiment distribution

The figure 12 and 13 together illustrate the distribution and characteristics of sentiment by polarity and subjectivity across the first 12 topics, highlighting both thematic prominence and evaluation within the literature. The bar chart shows that positive sentiment dominates among most topics, particularly in Topic 0 ("technology, teachers, disabilities"), which accounts for the highest number of documents (765 positive, 282 neutral, 51 negative), under scoring its centrality in research. The Topic 1 ("visual, visually, accessibility") and Topic 2 ("control, motion, gait") also indicates the positive sentiment, whereas themes of Topic 6 ("hearing, loss, deaf") Topic 7 ("visually, impaired, object") and Topic 8 ("dementia, care, technology") dominates with relatively higher number of negative sentiment, reflecting discussions of unresolved challenges and barriers. The scatter plot shows the mapping topics against polarity (x-axis) and subjectivity (y-axis). The most number of dots in cluster around mildly positive polarity (0 to 0.3) and medium subjectivity (0.3 to 0.7), indicating the research discourse from generally optimistic to experience-driven perspectives. Topic 11 ("model, detection, clinical") and Topic 9 ("sign, language, recognition") are relatively more concentrated, suggesting objective or evidence-based discussions, while health- and disability-related themes such as Topic 8 ("dementia, care, technology"), Topic 6 ("hearing, loss, deaf"), and Topic 5 ("asd, autism, children") show greater subjectivity, and diverse viewpoints. Overall, the analysis demonstrates that technology-related topics are framed largely in positive and forward-looking terms, health and impairment-focused topics indicating nuanced sentiment.

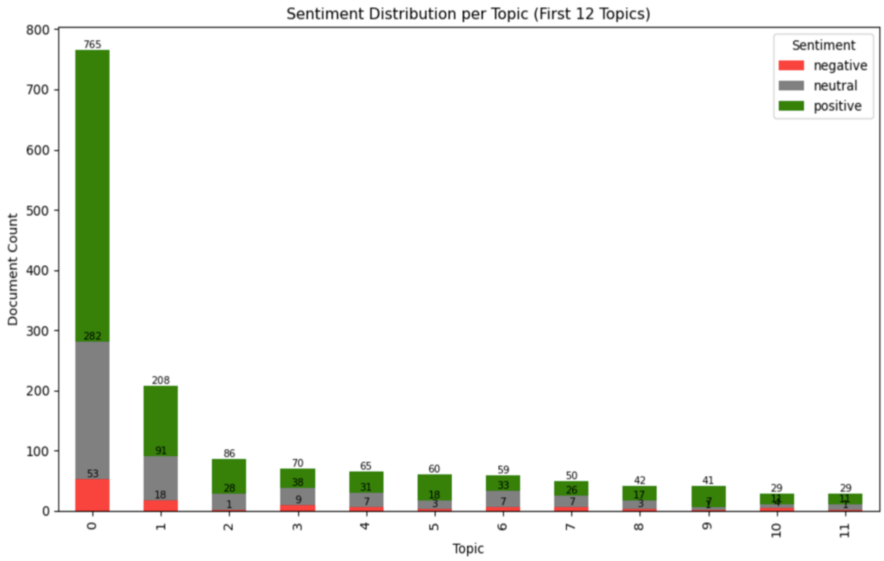

Figure 12: Topics with sentiments score

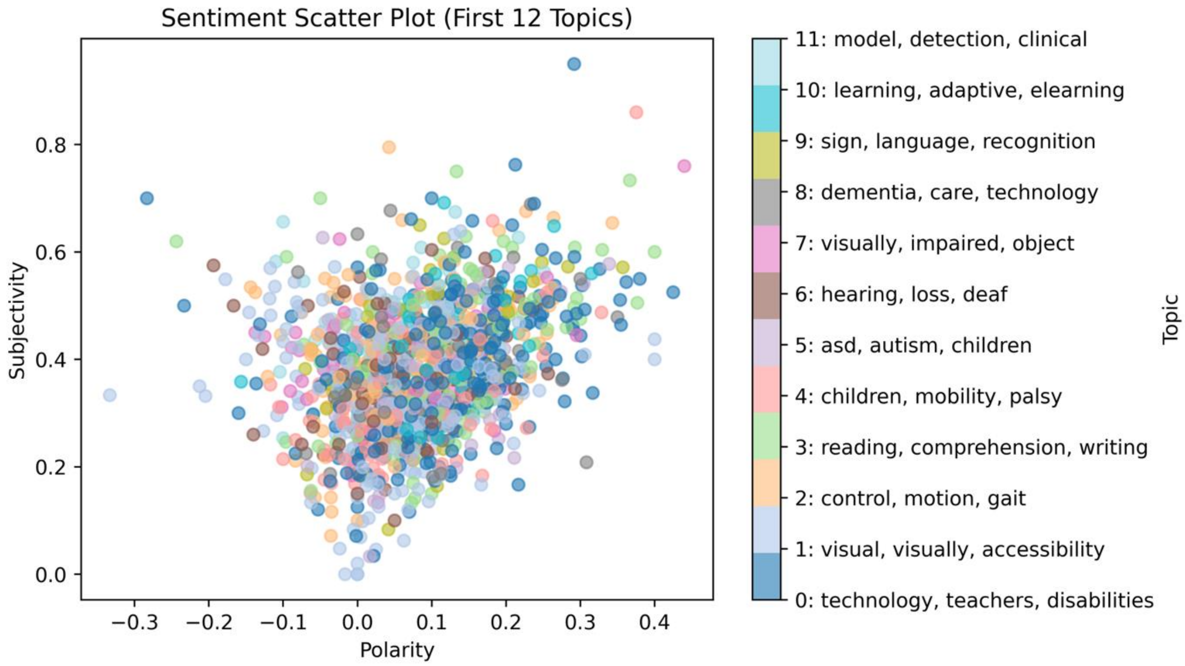

Figure 13: Topics sentiment scattered plot by polarity and subjectivity

7. Future Research Directions

Based on the integrated analysis of the keyword co-occurrence, and topic modelling total ten most prioritize future research directions have been identified. First, self-help devices require deeper exploration in educational and therapeutic contexts, particularly for miner students with dementia, to improve their quality of life. Second, work on assistive technologies such as communication aids, text-to-speech, and eye-tracking tools should focus on enhancing inclusivity in special education to overcome digital divide. Third, the role of artificial intelligence and machine learning, including deep learning, neural networks, and robotics, should be expanded for gesture recognition, computer vision, and smart learning to improve rehabilitation of students. Fourth, research on adult learners, particularly those with cognitive deficits, should emphasize tailored interventions for mental recovery. Fifth, the integration of AI-driven e-learning platforms with personalized feedback mechanisms should be prioritized to promote inclusion and learner engagement across disabilities. Sixth, block chain-enabled secure systems for learner authentication must be investigated to address trust, transparency, and academic integrity in digital education. Seventh, immersive technologies such as VR, AR, and metaverse environments should be assessed for their pedagogical value, accessibility, and impact on disabled students engagement. Eighth, emotion-aware and multimodal systems should be developed to respond adaptively to learners' affective states, especially for disorder interventions, ensuring empathetic learning environments. Ninth, research in federated learning offers privacy-preserving, multi-institutional collaborations in AT research, and its adoption could expand large-scale, inclusive analytics. Finally, research should intensify around IoT-enabled digital twins and smart classroom infrastructure to monitor learning environments, support adaptive interventions, and ensure sustainable and accessible educational ecosystems for maximum utilization and impact of existing education system. Collectively, these directions highlight a forward-looking research agenda that balances technological innovation with social inclusion, addressing challenges across self-help, rehabilitation, pedagogy, and policy to create transformative educational futures. These directions reflect a convergence of AI, rehabilitation science, education, and user-centric design, aiming to build a smarter, more inclusive future for assistive technology uses in the education.

8. Conclusions, Implications and Limitations

This study offers a detailed analysis on Global AT research and its future research direction using advance text mining tools, covering publication trends, authorship patterns, keyword and sentiment analysis, and thematic evolution, from 2005 to 2024. Research growth in linear direction begin from 33 publications to 405 during analysis period. The publication growth pattern shows rapid expansion between year 2021-2024 due to technological advancements and Covid-19 impact both on teaching and learning. The Bradford Law indicates that 34 journals dominates in core zone responsible for the 1/3 of the total publication in AT were Lotka law indicates no variation among actual distribution of author and theoretical model. Author Bouck EC dominates with number of citations and publications among all the authors. The University of California among institute and United States among countries dominates in AT research. The trend topics highlighting the research focus on Assistive devices, special education, disabled students, virtual learning, use of AI and Sign languages. Total four cluster found through keyword analysis and hot spot research areas between 2020-2024 noted as deep learning, machine learning, AI methods, smart algorithm, transfer learning, inclusion, object detection, etc. The sentiment analysis shows that dataset is dominated by positive and objective articles, with very few neutral or highly subjective pieces, suggesting an overall optimistic and fact-based tone in the literature of assistive technology uses in education. The topic modeling using BERTopic found 12 main topic word score. Based on the keywords and topic modeling analysis 10 future research areas have been identified from AI powered multimodal platform to robot assisted learning.

The study has significant implications for policymakers, academic researchers, and industry stakeholders. Policymakers can leverage insights to design advance ATtools that support overall education and mental development of students. Researchers can explore interdisciplinary approaches to AI, education technique, and digital innovations to improve learning efficiency among students. For industry stakeholders, the findings emphasize the need to invest in AT research, smart study tools, and future learning platform. Furthermore, the study underscores the importance of public awareness and community participation in fostering education development at both urban and rural areas students. Study has certain limitations like analysis is based on existing literature and bibliometric techniques and text mining tools, which may not capture all the literature or even the interdisciplinary research. Additionally, data sources are limited to published research, excluding insights from industry reports, government policies, and market-driven innovations. The study focuses on global, limiting the presentation of all literature which may not cover the findings on other regional contexts. Future research should incorporate real-world case studies, empirical assessments, and policy evaluations to provide a more comprehensive understanding of AT research at global and regional level.

References

1. Al-Zboon, E., & Al-Dababneh, K.A. (2023). Using assistive technology in a curriculum for preschool children with developmental disabilities in Jordan. *Education, 51*(1), 3-13.
2. Alper, S., & Raharinirina, S. (2006). Assistive technology for individuals with disabilities: A review and synthesis of the literature. *Journal of Special Education Technology, 21*(2), 47-64.
3. Alshamrani, K.A. (2024). Assistive technology services for adults with disabilities in state-federal vocational rehabilitation programs. *Disability and Rehabilitation: Assistive Technology, 19*(4), 1382-1391, doi: 10.1080/17483107.2023.2181413.
4. Alsudairy, N.A., & Eltantawy, M.M. (2024). Special education teachers' perceptions of using artificial intelligence in educating students with disabilities. Journal of Intellectual Disability – Diagnosis and Treatment, 12(2), 92-102, doi: 10.6000/2292-2598.2024.12.02.5.
5. Alsultan, O.K.T., & Mohammad, M.T. (2023). A deep learning-based assistive system for the visually impaired using YOLO-V7. *Revue d' Intelligence Artificielle, 37*(4), 901-906, doi: 10.18280/ria.370409.
6. Anderson, C., Smith, R., & Taylor, J. (2015). Barriers to integrating assistive technology into inclusive education: Perspectives of teachers. *Technology and Disability, 27*(2), 63-72.
7. Bouck, E.C., & Flanagan, S. (2014). Technological advances in special education. *Advances in Special Education, 27*, 209-235.
8. Bradford, S.C. (1934). Sources of information on specific subjects. Engineering, 137, 85-86.
9. Carlson, D., Ehrlich, N.J., Berland, B.J., & Bailey, N. (2001). Assistive technology survey results: Continued benefits and needs reported by Americans with disabilities. *Research Exchange, 7*(1). (Presented at RESNA Annual Meeting, Reno, NV).
10. Carreon, A., Criss, C., & Mosher, M. (2024). Classroom virtual reality for students with disabilities: A preliminary guide to available virtual content. *Journal of Special Education Technology, 39*(1), 143-150, doi: 10.1177/01626434231170593.
11. Chen, X., Xie, H., Cheng, G., & Li, Z. (2022). A decade of Sentic computing: Topic modeling and bibliometric analysis. *Cognitive Computation, 14*, 24-47, doi: 10.1007/s12559-021-09845-y.
12. Chen, X., Yu, G., Cheng, G., & Hao, T. (2019). Research topics, author profiles, and collaboration networks in the top-ranked journal on educational technology over the past 40 years: A bibliometric analysis. *Journal of Computers in Education, 6*, 563-585, doi: 10.1007/s40692-019-00149-1.

13. Chen, X., Zou, D., & Xie, H. (2020). Fifty years of British Journal of Educational Technology: A topic modeling based bibliometric perspective. *British Journal of Educational Technology, 51*(3), 692-708, doi: 10.1111/bjet.12907.
14. Cobo, M.J., López-Herrera, A.G., Herrera-Viedma, E., & Herrera, F. (2011). Science mapping software tools: Review, analysis, and cooperative study among tools. *Journal of the American Society for Information Science and Technology, 62*(7), 1382-1402, doi: 10.1002/asi.21525.
15. Dell, A.G., Newton, D.A., & Petroff, J.G. (2017). Assistive Technology in the Classroom: Enhancing the School Experiences of Students with Disabilities, 3rd ed., Pearson.
16. Edyburn, D.L. (2004). 2003 in review: A synthesis of the special education technology literature. *Journal of Special Education Technology, 19*(4), 57-80, doi: 10.1177/016264340401900404.
17. Edyburn, D.L. (2010). Would you recognize universal design for learning if you saw it? Ten propositions for new directions for the second decade of UDL. *Learning Disability Quarterly, 33*(1), 33-41.
18. Edyburn, D.L. (2013). Critical issues in advancing the special education technology evidence base. *Exceptional Children, 80*(1), 7-24.
19. Garcia, I., Gutierrez, V., & Ramos, F. (2018). Global trends in assistive technology research: A bibliometric analysis. *Technology and Disability, 30*(1-2), 49-60.
20. Ginsburg, H.P., Lee, J.S., & Boyd, J.S. (2017). The impact of digital equity in assistive technology: Policy, ethics, and classroom application. *Journal of Special Education Technology, 32*(3), 134-145.
21. Herajarvi, N.U. et al. (2020). Predictors of completion of upper secondary education of young adults with severe physical and multiple disabilities in Finland. *European Journal of Special Needs Education, 35*(3), 318-332, doi: 10.1080/08856257.2019.1665230.
22. Ibrayev, S., & Amanov, B. (2024). Enhancing orthopedics and sports medicine with lower limb exoskeleton control in rehabilitation using deep learning-based electromyography signal classification. *Retos, 61*, 616-625, doi: 10.47197/retos.v61.109799.
23. Johnson, G.M., Davies, S.C., & Thomas, B.A. (2014). Assistive technology implementation in inclusive classrooms: Perspectives of teachers and administrators. *Australian Journal of Special Education, 38*(1), 50-64.
24. Khasawneh, M.A.S. (2024). Assessing cognitive flexibility in adaptive learning technologies for special education. *Journal of Infrastructure, Policy and Development, 8*(12), 5172, doi: 10.24294/jipd.v8i12.5172.
25. Kincaid, S., Michalska, S., Heller, D.S., & Funston, G. (2020). Linguistic positivity in scientific writing: A large-scale text analysis of published papers in the life sciences. *PLOS Biology, 18*(8), e3000800, doi: 10.1371/journal.pbio.3000800.
26. Kurt, A., & Erden, M.K. (2024). Investigation of the opinions of pre-service special education teachers on the use of assistive technologies in special education. *Education and Information Technologies, 29*(1), 51-76, doi: 10.1007/s10639-023-12278-3.
27. Lee, M., & Bae, J. (2022). Real-time gesture recognition in the view of repeating characteristics of sign languages. *IEEE Transactions on Industrial Informatics, 18*(12), 8818-8828, doi: 10.1109/TII.2022.3152214.
28. Lersilp, S., Putthinoi, S., & Chakpitak, N. (2018). The need of assistive technology for students with disabilities in different educational levels. *Occupational Therapy International,* Article 8619613, doi: 10.1155/2018/8619613.

29. Liu, B. (2012). Sentiment Analysis and Opinion Mining, Morgan & Claypool, doi: 10.2200/S00416ED1V01Y201204HLT016.
30. Lotka, A.J. (1926). The frequency distribution of scientific productivity. *Journal of the Washington Academy of Sciences, 16*(12), 317-324.
31. Nganji, J.T., Brayshaw, M., & Tompsett, B. (2011). Ontology-based e-learning personalisation for disabled students in higher education. *ITALICS, 10*(1), 1-11, doi: 10.11120/ital.2011.10010001.
32. Ok, M.W., & Rao, K. (2019). Digital tools for the inclusive classroom: Google Chrome as assistive and instructional technology. *Journal of Special Education Technology, 34*(3), 204-211, doi: 10.1177/0162643419841546.
33. Patra, S.K., & Mishra, S. (2006). Bibliometric study of bioinformatics literature. *Scientometrics, 67*, 477-489, doi: 10.1007/s11192-006-0114-2.
34. Perdima, F.E., Suwarni, S., & Gazali, N. (2022). Educational technology in physical education learning: A bibliometric analysis using Scopus database. *Journal of Sports Science, 11*(14), 1-16, doi: 10.6018/sportk.517091.
35. Phillips, T., & Ozogul, G. (2020). Learning analytics research in relation to educational technology: Capturing learning analytics contributions with bibliometric analysis. *TechTrends, 64*(6), 878-886, doi: 10.1007/s11528-020-00519-y.
36. Pinkelman, A., Roll, M., & Greene, D. (2016). Use of a modified Canadian occupational performance measure for assistive technology outcomes in postsecondary education. *Occupational Therapy in Health Care, 30*(4), 388-401, doi: 10.1080/07380577.2016.1227893.
37. Pulay, MÁ., & Szabó, ÉF. (2024). Developing visual perceptual skills with assistive technology supported application for children with cerebral palsy. *Acta Polytechnica Hungarica, 21*(3), 25-38, doi: 10.12700/APH.21.3.2024.3.3.
38. Ramos-Rodríguez, A-R., & Ruíz-Navarro, J. (2004). Changes in the intellectual structure of strategic management research: A bibliometric study of the Strategic Management Journal, 1980-2000. *Strategic Management Journal, 25*, 981-1004, doi: 10.1002/smj.397.
39. Sadak, H.M. et al. (2024). Braille code classifications tool based on computer vision for visual impaired. *International Journal of Electrical and Computer Engineering, 14*(6), 6992-7000, doi: 10.11591/ijece.v14i6.pp6992-7000.
40. Sahin, F., Kızılaslan, A., & Şimşek, Ö. (2024). Factors influencing the acceptance of assistive technology by teacher candidates in the context of inclusive education and special needs students. *Education and Information Technologies, 29*(10), 12263-12288, doi: 10.1007/s10639-023-12383-3.
41. Shirley, C.P. et al. (2023). Machine learning and sensor-based multi-robot system with voice recognition for assisting the visually impaired. *Journal of Machine Computing, 3*(3), 206-215, doi: 10.53759/7669/jmc202303019.
42. Turnbull, H.R., Beegle, G., & Stowe, M.J. (2001). The core concepts of disability policy affecting families who have children with disabilities. *Journal of Disability Policy Studies, 12*(3), 133-143, doi: 10.1177/104420730101200302.
43. van Eck, N.J., & Waltman, L. (2010). Software survey: VOSviewer, a computer program for bibliometric mapping. *Scientometrics, 84*(2), 523-538, doi: 10.1007/s11192-009-0146-3.
44. Walker, B.N., & Lindsay, J. (2005). Using virtual environments to prototype auditory navigation displays. *Assistive Technology, 17*(1), 72-81, doi: 10.1080/10400435.2005.10132097.

45. Wang, Y., Zhang, H., & Li, F. (2021). Mapping the landscape of assistive technology research using bibliometric techniques. *International Journal of Disability, Development and Education, 68*(6), 721-738, doi: 10.1080/1034912X.2019.1699648.
46. Wu, X. et al. (2024). Channel selection for stereo-electroencephalography (SEEG)-based invasive brain–computer interfaces using deep learning methods. *IEEE Transactions on Neural Systems and Rehabilitation Engineering, 32*, 800-811, doi: 10.1109/TNSRE.2024.3364752.
47. Xue, J. et al. (2020). Public discourse and sentiment during the COVID-19 pandemic: Using Latent Dirichlet Allocation for topic modeling on Twitter. *PLOS ONE*, *15*(9), e0239441, doi: 10.1371/journal.pone.0239441.
48. Yu, S. et al. (2022). Factors influencing utilisation of assistive devices by the elderly in China: A community-based cross-sectional study. *Public Health*, *213*, 12-18, doi: 10.1016/j.puhe.2022.09.002.
49. Zilz, D.A., & Pang, Y. (2019). Assistive technology for students with disabilities in K–12 schools: A review of selected literature. *Assistive Technology Outcomes and Benefits, 13*(1), 1-12.

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