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A Bibliometric Review: Research on Assistive Technology for Special Needs

Marlissa Omar[1], Dayana Farzeeha Ali[2]

[1]Centre for STEM Enculturation, Faculty of Education, Universiti Kebangsaan Malaysia,

[2]School of Education, Faculty of Social Sciences and Humanities, Universiti Teknologi Malaysia

Corresponding Authors Email: marlissa@ukm.edu.my

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Abstract

The use of Assistive Technology (AT) has a vast potential to promote independence for people with disabilities and special needs, and the elderly. AT provides support to people with disabilities to live a fulfilling life and help them in their daily lives. Although there is an increasing trend of the studies in this field, there is a need for a comprehensive bibliometric review conducted to identify the trends of the use of assistive technology for special needs population. Thus, this study is conducted to fulfil this gap. This study aims to conduct a bibliometric analysis based on the Scopus database involving 464 articles from 2000 to 2021. In order to conduct the bibliometric analysis of the articles, VOSviewer software was used to analyze the trends of this research. In the beginning, the researcher conducted a descriptive analysis of the publication number trends, top authors and the leading journals in this field. Then, a summary of the co-authorship based on authors and countries, research trends, citation and keywords analysis and the co-citation analysis based on cited sources were analyzed. This article found that there is an increasing trends of research done especially for Autism Spectrum Disorder. Other than that, the recent research hotspot and research gaps were also identified indicating the future directions of the research in this field.

Keywords: Assistive Technology, Bibliometric Analysis, Disabilities, Special Needs, VOSviewer.

Introduction

Assistive technology (AT) is widely used to help people with disabilities adapt to their daily lives. 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". It is especially important in special needs education where there is an increase in AT's utilisation to support students in an inclusive education setting. Lersilp et al (2018) shows that most special needs children needed AT, especially for mobility, use of buildings, communications, and as facilitators for education.

The utilization of AT has been implemented in many countries. Various studies have identified the effectiveness of AT towards improving and supporting various skills such as literacy (Burne *et al.,* 2010), comprehension (Schiavo *et al.,* 2021), communication (Johnson *et al.,* 2020),

physical abilities (Lin, 2020), daily life skills (Zilz & Pang, 2019) and many more. It is important to recognize the main function of an AT and its benefits to each individual. Even though AT is said to have the ability to promote individuals' skills and their independence, training and support in terms of intervention planning and assessment is needed to ensure the AT chosen can be a powerful tool to them (Almeida & Moreira, 2019). When AT is used efficiently and can improve the functioning of individuals with special needs, it can help them reduce their reliance on their families, therapists, and caregivers. To facilitate learning in individuals with special needs using technology, it is essential to consider how the knowledge should be delivered, its cognitive profiles, behavioural, developmental deficits, and strengths and interests to provide an atmosphere tailored to match their learning style. If the technology is not correctly design, it could create a barrier to the special needs individuals as well as cause discomfort and stress to them (Alves *et al.,* 2020).

Various types of AT have been developed to assists individuals with special needs, such as machine learning application for speech disorder (Mulfari *et al.,* 2021) overground robot-assisted gait for cerebral palsy (Kim *et al.,* 2021), electronic canes for the visually impaired (Dos Santos *et al.,* 2020) and many more. Research trends on AT show an upward trend that indicates increasing interest in AT's development, especially for people with disabilities. Thus, there is a need to study the trend comprehensively in the use of AT for special needs individuals and people with disabilities. Hence, this study has identified some of the previous studies related to assistive technology for special needs and categorized each review paper's information.

The characteristics of some previous review studies in this field are compiled and shown in Tab. 1, highlighting the focus area, year, and the number of reviewed papers in the studies. Salminen (Salminen, 2008) presented a review focusing on the publication of assistive technology for special needs published in the Journal Technology and Disability. A total of 65 papers were identified to be published in this journal. Burne et al (2010) conducted a review of studies related to assistive technology for literacy skills, specifically for young children. Their study involves 110 papers published between 1990 to 2011 that discussed the reason for the use of assistive technology for the promotion of literacy skills. Their review highlighted the types of technology used, the types of disability, and the level of evidence in investigating the outcomes of the assistive technology usage in promoting literacy skills among children in the selected age range. The limitations of the studies were also identified as well as future recommendations on the evidence of the technology used were presented in their studies.

Another review by DiPietro et al (2019) were done recently in 2019, reviewing the guidelines in designing the assistive technology using the computer and robot-assisted therapies to promote social and intellectual functioning for children with Autism Spectrum Disorder (ASD). Eighteen studies using robot interventions and severe video game interventions have been reported through the review, which primarily indicates a promising result for children with ASD. The gaps of the intervention are identified, which shows the need for further research on the cost-effectiveness of the interventions as well as the use of a higher number of children to test the effectiveness of the interventions is suggested. Other than that, the review also suggested that adults with ASD should also be tested using the intervention to identify its effects on higher functioning autistic individuals. Another review made by Zilz and Pang (2019) illustrated the need for assistive technology in K-12 settings, where seven papers were included in the review comprised of publications between 2010 to 2019. When examining the effects of using assistive technology among school children, it is identified that children with disabilities would benefit the most from assistive technology in K-12 setting while children in

pre-school are too young to benefit from the technology. Spiel *et al* (2019) have provided a critical review regarding the purpose of technology implementation within the special needs community, especially among autistic children, including behaviour analysis, assistive technology, education, social skills, therapy, and well-being. Their review has identified an issue focusing on the lack of design aspects towards special needs children's interest, needs, and desire. This technical limit sets a boundary on what can be achieved by these children as well as creates an isolated feeling among them instead of promoting companionship. Apart from the interesting finding discussed in this study, the researcher provides some insights into the limitations of their review, including adolescents and adults while focusing only on young children. Desideri *et al* (2020) conducted a study identifying the assistive technology that may promote executive functions' improvements among individuals with ASD. The papers identified and involved in this study consist of papers published from 2010 to 2019, with 15 papers included in this study's final review. This study identifies gaps to improve future research in developing an effective application of assistive technology for executive functioning skills in a person with ASD. Through this study, the research provides supports that show positive effects of the interventions towards promoting excutive functioning skills among individuals with ASD. However, recommendations were made by the researcher to involve an older sample for the interventions to widen the possibilities of implementations of assistive technology to improve executive functioning skills.

Bibliometrics is a statistical and quantitative method used to analyze scientific output's academic influence and characteristics (Xia *et al.,* 2021). By means of bibliometrics, researchers can identify particular research topics and thereby gain a greater understanding of the relationships between such research areas. In order to identify the research patterns in assistive technology for special needs and forecast their potential future hotspots, we have used a bibliometric analysis to identify the related information. This is due to bibliometric analysis's excellent achievement in many fields, which provides a more technical and comprehensive yet easy-to-use option to summarize the academic contribution and the development trend of the research field. Previously, there are review studies that have been done towards studying assistive technology for special needs. However, there is a lack of bibliometric analysis done in this field that studies the publications' patterns and trends that can contribute to the future directions of research in this field. To fill this gap, we employed a bibliometric analysis using VOSviewer software in order to thoroughly conduct a bibliometric analysis and review on papers related to assistive technology for special needs published between 2000 to January 2021.

Table 1
Characteristics of previous review studies.

Article	**Focus Area**	**Year**	**No. of Reviewed Paper**
Salminen (2008)	Journal Technology and Disability	2000 - 2005	67
LoPresti et al (2008)	The needs for assistive technology for persons with disabilities	NA	NA
Dicianno et al (2010)	Joystick interface technology for wheelchair, persons with movement disabilities	NA	NA

Burne *et al* (2011)	Assistive technology, literacy skills	1990 - 2011	110
Baxter *et al* (2012)	Communication aids for person with hearing or visual loss	2000 - 2010	65
Schlosser & Koul (2015)	Augmentative Alternative Communications (AAC) intervention for individuals with Autism Spectrum Disorders	NA	48
McNaughton & Light (2015)	Evolution of research in Augmentative and Alternative Communication (AAC)	1985 - 2014	NA
Cruz *et al* (2017)	Using robots for young people with CP and ASD education and rehabilitation	NA	34
Johnston et al (2018)	Innovative computer technology, music-based interventions, autism	NA	NA
Bozgeyikli *et al* (2018)	Design guidelines of VR for individuals with ASD	NA	NA
DiPietro *et al* (2019)	Computer-and robot-assisted therapies for children with ASD, social and intellectual functioning	2015 - 2019	18
Zilz & Pang (2019)	Assistive technology in inclusive settings	2010- 2019	7
Fernandes *et al* (2019)	Assistive technology, spatial orientation and navigation technology	NA	NA
Spiel *et al* (2019)	Behaviour analysis, assistive technologies, education, social skills, therapy and well-being	NA	NA
Syriopoulou-Delli & Gkiolnta (2020)	Robotics, Assistive technology, Children with ASD	2008 - 2018	13
Alves *et al* (2020)	Assistive technology, Applied Behavior Analysis (ABA)	NA	26
Desideri *et al* (2020)	Assistive technology, executive function, ASD	2010 - 2019	15
Tomczak (2021)	Assistive Technology, work environment, digitalization	NA	NA
This study	All area	2000 - 2021	

Note: Not Applicable (NA) is used to indicate that the articles do not state the time span of the review conducted and the number of papers included in the review.

In this review studies, we explored the recent hotspots and its future prospects with VOSviewer software, a free bibliometric measurements mapping tool. VOSviewer is a software developed by (Van Eck and Waltman, 2019). The finding of our research will provide insights and let other researchers to better grasp the trends and status of research in the field of assistive technology for special needs individuals as well as give information to new researcher in this field to help them find their directions in their research.
The sections of this paper are organized as follow:

Section II: Data sources and methodology
Section III: Analysis of the trends
Section IV: Citation and keywords analysis
Section V: Co-citation analysis
Section 6: Conclusion of the research

Ii. Data Sources and Methodology

A. Data Sources

In this study, the data used is retrieved from the Scopus database on January 21, 2021. The Scopus database is chosen in this study due to the high number of publications in this field compared to other databases. Compared to the other database, such as the Web of Science (WOS) database, there is quite a considerable difference in the number of publications. Thus, even though WOS outperforms the other database in terms of its journal collection, the Scopus database is chosen to provide more relevant findings related to this field.
In this research, to identify the articles related to this field, we have used a specific keyword to ensure the retrieved articles' accuracy. The keywords used is as follow: “Assistive Technology” AND “Special Need” or “Autism”. The search was then followed by applying strategies as shown in Fig. 1 as follow: Year = “2000 – 2021”; Document Type = “Conference”, “Articles”; Publication Stage = “Final”; Language = “English”, which is done by exploring the refine results function in the Scopus database. The initial search results show a total of 590 publication. After applying the strategies, a total of 464 publications is identified to be included in this study.

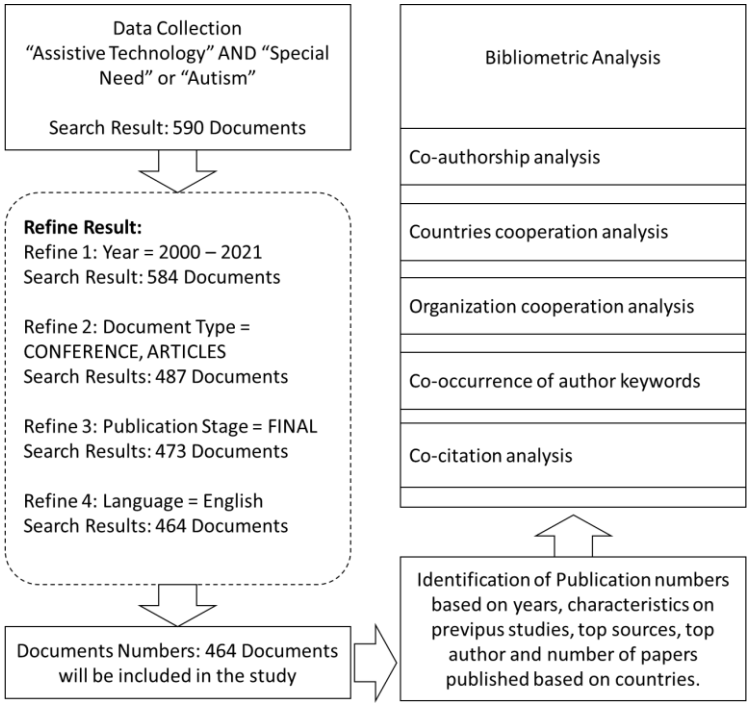


Figure 1: Research design of bibliometric analysis on assistive technology for special needs

B. Data Analysis

VOSviewer software version 1.6.16 was used to analyze the data obtained from the Scopus database to identify and summarise the authors and countries' co-authorship analysis, the keywords analysis, and co-citation analysis of authors, organizations and countries. Overlay visualization map and density visualization map were presented based on the analysis using the software to show the research trends in this field.

Iii. Analysis of the Trends in Research Field

A. Trends of Publication

This section analyzes the trends of publications in the field of assistive technology for special needs based on the number of publications. Fig. 2 shows the statistics of the number of publications in each year from 2000 to 2021. The figure indicates an increase in the number of publications starting from 2009, where technologies are rapidly growing towards the end of the 20th century. By 2019, the number of publications had reached the highest number, where a total of 52 articles were published in that year. If we compare the number of publications from 2000 to 2019, there is a considerable increase in recent years, which have shown the increased interest in this field of research among researchers.

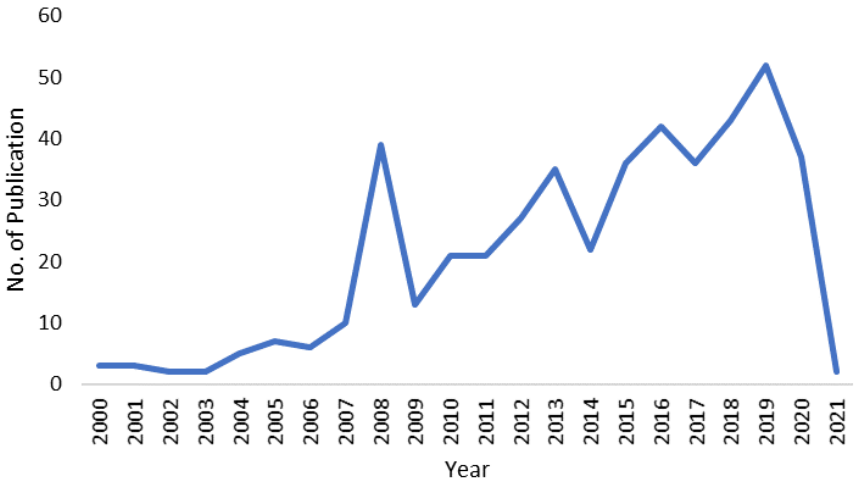


Figure 2. Publication numbers based on years.

According to Fig. 2, while the publication reached its highest number in 2019, the number of publications started to rapidly increase, starting from 2015 where half of the articles published in this field are within 2015 until recently. This finding indicates a growing interest in research in AT for special needs in recent years. According to the Scopus database statistics, there are 98 sources with publications related to assistive technology for special needs starting from 2015 until recently. Tab. 2 shows the top 10 sources contributing the highest number of publications in this field within the year range included in this review.

Table 2
Top 10 sources on Assistive Technology for special needs based on Scopus database.

No.	Journal	No. of Publication
1	Lecture Notes in Computer Science Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics	64
2	ACM International Conference Proceeding Series	24
3	Conference on Human Factors in Computing Systems Proceedings	17
4	Advances in Intelligent Systems and Computing	11
5	Assistive Technology	8
6	Assistive Technology Research Series	8
7	Journal of Autism and Developmental Disorders	8
8	Journal of Special Education Technology	6
9	Journal of Vocational Rehabilitation	6
10	Studies in Health Technology and Informatics	6

Table 3
Top 10 authors based on Scopus database.

No.	Authors	No. of Publication
1	Hayes	17
2	Dautenhahn	14
3	Robins	14
4	Lahiri	11
5	Sarkar	8
6	Schlosser	7
7	Warren	7
8	Boyd	6
9	Gomez	6
10	Boyd	5

Based on Tab. 2, Lecture Notes in Computer Science Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics, ACM International Conference Proceeding Series, Conference on Human Factors in Computing Systems Proceedings are the sources that contribute the most to this field of research with a total of 105 published papers. Tab. 3 shows the top 10 authors with the highest numbers of published papers in this field where the authors with the most published papers (Hayes, G.R.) is from the United States, and both the second and third authors with most published papers in this field are from the United Kingdom.

The findings from Tab. 3 are parallel with Fig. 2, which shown the numbers of papers published in each country per year. According to Fig. 3, the United States and the United Kingdom are the most prominent countries with high numbers of publications compared to other countries. The United States, to be specific, shown an increasing trend of publications starting from 2009 until recent years. The fig indicates that the United States, United Kingdom, Spain, India, Italy, Brazil, Canada, Malaysia, and Portugal were the highest contributors to assistive technology for special needs. It is worth noting that among the top eight countries listed, only two countries are from Asian countries, which is Malaysia and India, where the other countries are from Europe, North America and South America. These findings have shown that developed countries such as the United States, the United Kingdom and Spain are the most prominent countries in research and studies in this field. However, some developing countries such as India, Brazil and Malaysia are showing up an increase in the numbers of publications, and India is significantly advancing by following behind Spain in the fourth place.

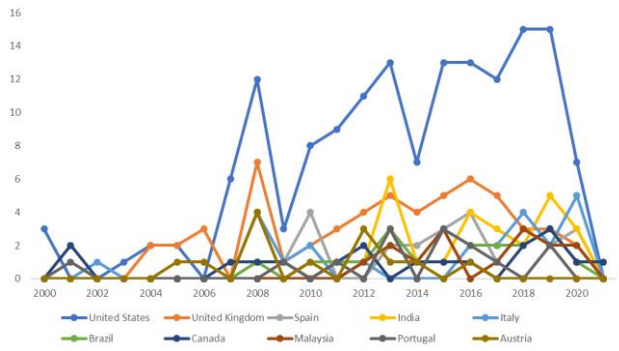


Figure 3. Number of papers published in each country per year

B. Co-Authorship Analysis

Using VOSviewer, the function of the co-authorship was utilized to identify the authors' patterns and the link between countries in this field. Based on the documents included in this study published by 1401 authors, the analyzed result is shown in Fig. 3. When the data retrieved is analyzed statistically, 95.7% of the total authors have a total number of at least two publications (n = 1341/1401), 2.07% of the authors have a total number of at three publications (29/1401), 1.07% authors have a total of four publications (n = 15/1401), and 1.14% authors have a total number of five or more number of publications in the field of assistive technology for special needs. During the co-authorship analysis to identify the patterns of authors using VOSviewer, a threshold value of two is used to identify the prominent authors who have published in this field. From 1401 authors identified from the data, only 187 authors meet the threshold. However, from the 187 authors who meet the threshold, only 32 authors were related to other network authors and analyzed.

Based on Fig. 4, we can observe a total of five clusters based on five different colored clusters. The color of the node indicates the clusters each author belongs to and the size of the node indicates the number of their publications. The lines between authors shows the link and relationships between the authors. Based on the result, the strongest cluster which is colored in orange comprises of “Boyd”, “Cramer”, “Escobedo”, “Hayes”, “Hirano”, “Marcu”, “Monibi”, :Nguyen”, “Rangel”, “Tentori” and “Yeganyan”. The second strongest cluster colored in green comprises of “Abdo”, “Boyd”, “Day”, “Hayes”, “Johnson”, “Linstead”, “Pass”, and “Wasserman”. Based on the analysis, the top researcher in this network are “Hayes” (n = 17; citations = 570; TLS = 47), “Dautenhahn” (n = 14; citations = 913; TLS = 37), “Robins” (n=13; citations = 869; TLS = 37), “Sarkar” (n = 8; citations = 183; TLS = 26), “Warren” (n = 7; citations = 176; TLS = 24), “Lahiri” (n = 11; citation = 199; TLS = 23), “Distante” (n = 4; citation = 17; TLS = 22), “Leo” (n = 4; citation = 17; TLS = 22), “Keshav” (n = 5; citation = 60; TLS = 21) and “Vahabzadeh” (n = 5; citation = 60; TLS = 21). Among all the authors included in the findings, Dautenhahn, Kerstin is the most influential authors with 913 total citations whereas Hayes, Gillian R. is the most influential author in terms of link strength.

The co-authorship analysis based on the link between countries was also conducted, as shown in Fig. 4. The minimum threshold of a country is set at three. From 72 countries identified, only 37 met the threshold. However, from the 37 countries that met the threshold, only 32 countries were linked to each other in the network. As shown in Fig. 5, eight clusters were identified through the analysis where the cluster with the highest numbers of countries includes countries as follows: Canada; Israel; Mexico; Saudi Arabia; South Africa; United States. Countries that are most influential in the research in this field are identified based on the result in Tab. 4. The top 10 countries identified are United Kingdom, United States, Spain, Italy, Netherland, Austria, India, Albania, Japan and Portugal. The density visualization map based on the countries link is shown in Fig. 6. Based on the analysis, the United Kingdom is the most influential in link strength, while the United States is the most influential country with the highest citation (n = 2647).

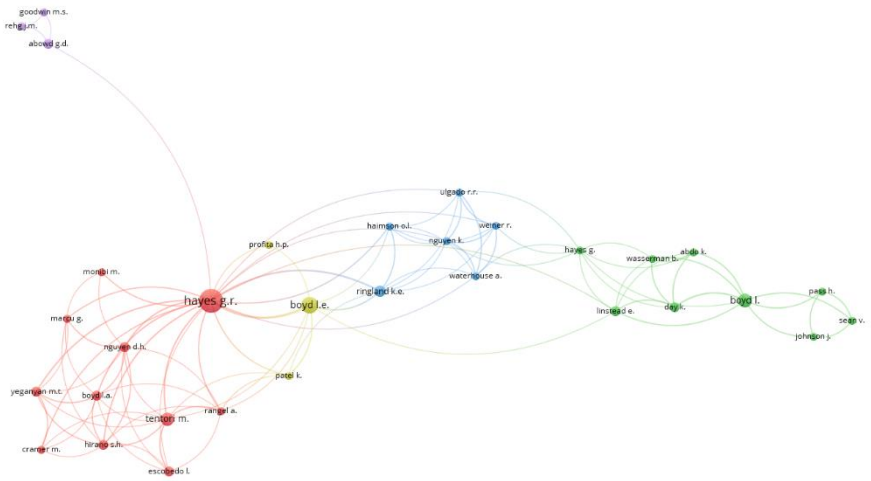


Figure 4: Overlay visualization of co-authorship based on author link

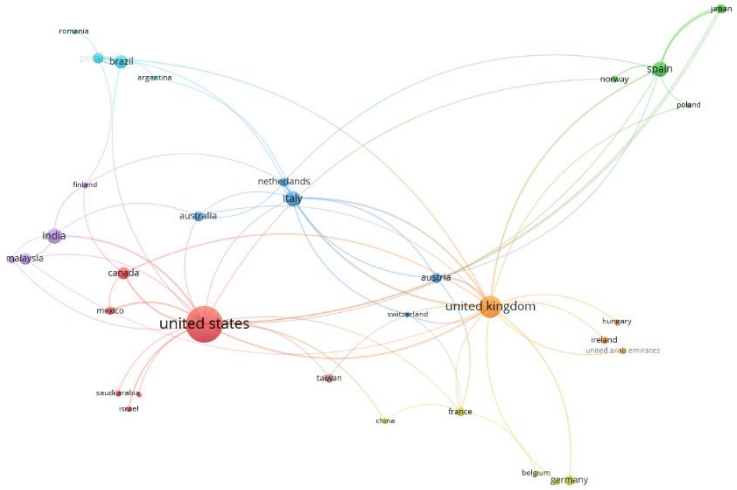


Figure 5: Overlay visualization of co-authorship based on countries link

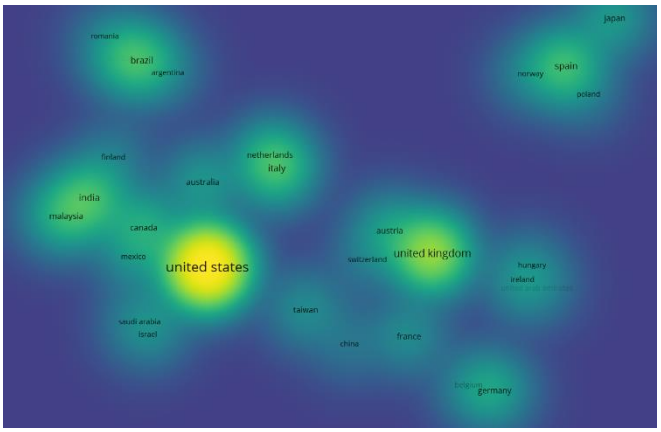


Figure 6: Density visualization map based on countries link

Table 4
Top 10 most influential countries in assistive technology for special needs field.

	Countries	Documents	Citations	TLS
1	United Kingdom	58	1418	36
2	United States	153	2647	30
3	Spain	28	187	15
4	Italy	26	219	14
5	Netherlands	10	203	14
6	Austria	13	178	11
7	India	26	224	10
8	Albania	4	25	8
9	Japan	9	60	8
10	Portugal	14	106	8

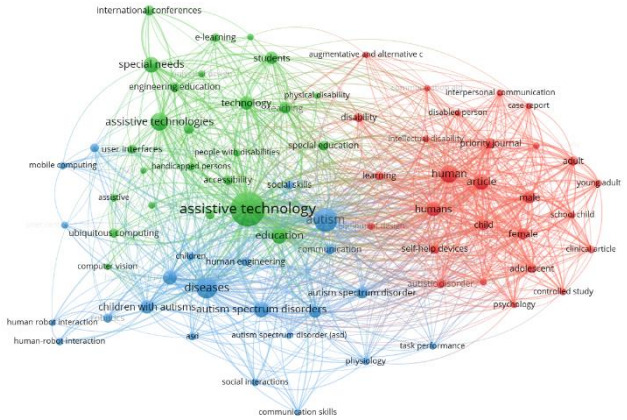
IV. Citation and Keywords Analysis

Citation analysis for documents were conducted to identify the most cited papers in this research area. After applying the analysis procedures using VOSviewer software, a total of five clusters were identified as shown in Fig. 7. From a total of 16 papers included after applying the procedures, the most cited papers were Ploog *et al.* (2013) followed by Moore *et al.* (2005). Tab. 5 shows the most cited papers in this research area based on the analysis. Based on the top 10 most cited papers in this research area, it can be seen that it is dominated by R. V. Burke (n = 3) and T. Gentry (n = 3).

FIGURE 7: Citation analysis of documents

TABLE 4
Top 10 most cited papers in this research area.

	Authors	Citations
1	Ploog *et al* (2013)	1418
2	Moore *et al* (2005)	2647
3	Shane *et al* (2012)	112
4	Odom *et al* (2015)	77
5	Burke *et al* (2010)	76
6	Gentry *et al* (2010)	59
7	Burke *et al* (2013)	44
8	Gentry *et al* (2015)	41
9	Gentry *et al* (2012)	35
10	Boyd *et al* (2016)	31



Keywords are the most important words that describe your research which consists of nouns. The researcher often uses keywords to retrieve articles related to their studies due to their ability to show more results when compared to using phrases. This study has identified a total of 3178 keywords. By using VOSviewer, the analysis of the co-occurrence of keywords were conducted. For this analysis, the minimum threshold applied was set at 11, and a total of 60 keywords were identified to meet the threshold value.

As shown in Fig. 8, the keywords are classified based on colours indicating differences in the cluster. There are a total of three clusters identified through the analysis. According to Fig. 8, the most frequently used keywords in assistive technology for the unique needs field are assistive technology, diseases and autism.

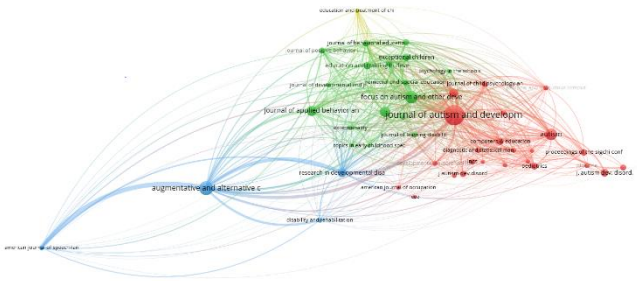


Figure 8. Overlay visualization of co-keywords

Based on the colour of the clusters, the red colours represent the keywords such as adult, article, adolescent, augmentative and alternative communications, autistic disorder, case report, child, clinical article, communication aid, controlled study, disability, disabled person, equipment design, female, human, intellectual disability, intellectual impairment, interpersonal communications, learning, male, priority journal, psychology, schoolchild, self help device and young adult. Cluster two in green colour represents keywords such as accessibility, artificial intelligence, assistive technology, augmented reality, computer vision, design, e-learning, education, educational technology, engineering education, handicapped person, people with disabilities, physical disabilities, quality of life, special education, special needs, students, teaching, technology, ubiquitous computing, universal design and user interface. Among the keywords in this cluster, assistive technology is the largest node indicating the keywords with the highest co-occurrence. Next, in blue colour, the keywords in this cluster include ASD, autism, children with autism, communication skills, diseases, human-computer interaction, human engineering, human-robot interaction, mobile applications, mobile computing, physiology,

robotics, social interactions, social skills, task performance, user-centred design and virtual reality.

Among all the keywords, the keywords assistive technology and autism show the strongest strength. Tab. 5 shows the information of total link strength for the top 10 keywords with the highest occurrences. Link value represents the connection of re-occurrences between two different keywords where a bigger value shows a stronger connection. Based on Tab. 5, the new research hotspot can be identified, focusing on diseases and Autism Spectrum Disorders.

Table 5

Top 10 most influential countries in assistive technology for special needs field.

	Keywords	Cluster	Links	Occurrences	TLS	APY
1	Assistive technology	2	74	339	1482	2014
2	Autism	3	72	155	963	2014
3	Human	1	63	82	739	2014
4	Diseases	3	65	121	650	2015
5	Article	1	58	65	606	2013
6	Male	1	49	38	434	2014
7	Education	2	65	63	415	2013
8	Female	1	50	30	356	2014
9	Autism Spectrum Disorders	3	62	61	334	2016
10	Child	1	48	28	305	2013

V. Co-Citation Analysis

Based on a threshold value of 15, we performed a co-citation analysis based on cited sources. Out of the 7237 sources, 47 meet the threshold. This procedure formed a total of four distinct clusters with TLS = 16922. Based on the result, the most cited sources were Journal of Autism and Developmental Disorder with TLS = 5085 and 353 citations, followed by Augmentative and Alternative Communication with TLS = 3778 and 170 citations. The other journals with high TLS are Focus on Autism and Other Developmental Disabilities (TLS = 2557), Research in Developmental Disabilities (TLS = 1812), Autism (TLS = 1787), Research in Autism Spectrum Disorders (TLS = 1778) and Journal of Applied Behaviour Analysis (TLS = 1761). As shown in Fig. 9, three out of five top cited sources in this field are related to Autism which indicates a high interest in the implementation of assistive technology for Autism Spectrum Disorder.

FIGURE 9. Overlay visualization of co-citation analysis based on cited sources

Conclusion

Using the data retrieved from the Scopus database involving papers published between 2000 and 2021 with the aid of VOSviewer, a software tool for constructing and visualizing bibliometric networks, this paper presents a comprehensive bibliometric analysis based on 464 papers in the field of assistive technology for special needs individuals. Based on the findings presented in this paper, it can be seen that the number of publications in this field is increasing in recent years. The publications started from 3 papers in 2000 to their highest number of publications in 2019 with 52 publications.

Next, it is found that the United States and the United Kingdom is the most prominent countries with the highest publications and citations in this field which shows the correlation between the technology advancement of the country with interest in the research related to assistive technology. This is due to the use of various types of advanced technology such as augmented reality, virtual reality, and robotics to develop an assistive technology that can be accessed primarily in a developed country. However, developing Asian countries like India, which are also famous for their technological advancement, were slowly joining the top countries in this field at the fourth place, indicating an increasing interest in assistive technology research in the country. Nevertheless, it is safe to say that this research area primarily involved in developed countries.

Additionally, "Use of Computer-Assisted Technologies (CAT) to Enhance Social, Communicative, and Language Development in Children with Autism Spectrum Disorders" published by the Journal of Autism and Developmental Disorders is the most cited paper among all the documents included in this study, followed by "Collaborative Virtual Environment Technology for People with Autism" published by Focus on Autism and Other Developmental Disabilities. It is also identified that emerging research keywords were "disease" and "autism spectrum disorders". This shows that more research in this field was conducted related to these keywords recently, and it has become a hot topic among researcher.

Apart from that, research gaps were also identified through this research which indicates a lack of studies implementing assistive technology among adolescent and adults. Most studies identifying the effectiveness of assistive technology focuses on young children, and there should be more interventions conducted to study the effects on adults specifically. This research also found a need for more Asian countries to increase their participation in this research field as the findings show a lack of Asian countries among the top countries identified. Differences in cultures and lifestyle between European, American and Asian might contribute to the differences in the designing aspects of assistive technology. Thus, making it crucial for researchers to study the application and implementation respective to their origin. With the advancement of technology worldwide, there is a massive potential for developing assistive technology that can support the unique needs community to undertake tasks or functions that they would otherwise be incapable of achieving.

To further study the trends and future directions in this research area, using more databases to retrieve the publication data involved in the analysis will give a more comprehensive view and insights to future researcher. In this paper, VOSviewer was used as software to analyze the data obtained. However, the finding's quality could further be enhanced by using other visualization tools such as CiteSpace to provide a better perspective on various aspects of this research area. Other than that, using different keywords, can also further enhance the quality of the data obtained in the future. In the future, a study on the effectiveness of the implementation of different types of assistive technology among people from different age range should be conducted to provide a clear perspective on its effectiveness in a more comprehensive manner.

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