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Original Research Article

The Role of Artificial Intelligence in Self-Directed Learning: A Bibliometric Analysis of Recent Trends

Jhuma Das[1], Subrata Khan[1]*, Supriya Khan[2], Elina Mossang[3], Lalit Lalitav Mohakud[4]

[1]Research Scholar (PhD), Department of Education, Jadavpur University, India
[2]Research Scholar (PhD), Department of Education, Visva-Bharati, India
[3]Research Scholar (PhD), Department of Education, Rajiv Gandhi University, India
[4] Associate Professor, Department of Education, Jadavpur University, India

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Abstract: This bibliometric study examines the overall research trends and productivity of Artificial Intelligence in self-directed learning, based on published articles (2005-2025). Initially, we identified 1,801 studies from the Scopus database using the search string ("Artificial Intelligence" OR "AI") AND ("Self-directed Learning" OR "Self-learning"). Finally, we selected 219 articles for analysis after filtering by articles, Conference papers, and reviews within social science, psychology, multidisciplinary, and arts and humanities subjects. Utilizing VOS viewer software, we observed that most studies (38.2%) were in the social science subject area, and China is the dominant contributor, followed by the USA and Germany. Colby College (n = 4 articles) is the leading institution by the number of documents, followed by the University of Oxford and Indiana University Bloomington. Feldmann J., Youngblood N., Wright C.D., Bhaskaran H., and Pernice W. are the most influential authors based on citations. The United Kingdom is the leading country, followed by Germany and South Korea, according to citation counts. The leading source is "Sustainability Switzerland" (n = 7 articles), but the most cited journal in the context of citations is "Nature". The article "All-optical spiking neurosynaptic networks with self-learning capabilities" by Feldmann *et al*., (2019) was highly cited (1072). Ogata H., Flanagan B., Majumdar R., Li H., Hwang G.J., Yang Y., Chen X., Liu Y., Zhang J., and Wang Y. are the most frequently co-cited in artificial intelligence research on self-directed learning. In the co-author analysis, the USA is the most collaborative country, followed by the UK and China. "Artificial Intelligence", "Machine Learning", "Learning Systems", "Self-directed Learning", and "ChatGPT" were the most common co-occurrences among the authors' keywords. The primary theme, based on the author's keywords, is "Artificial Intelligence and Neural Learning for Sustainable Optimisation". This study provides valuable insights into the research landscape of AI in Self-directed Learning. It recommends a thorough review and meta-analysis of related studies to improve generalization.

Keywords: Self-Directed Learning, AI, Self-Learning, Artificial Intelligence, Research Trends.

INTRODUCTION

In recent years, artificial intelligence (AI) has become a transformative force in education, changing traditional learning models and encouraging self-directed learning (SDL) (Gotavade, 2024). SDL enhances student motivation and academic achievement across various educational environments. Research shows that SDL fosters active participation, independence, and self-regulation, all of which are crucial for improving academic performance. This form of learning builds students' intrinsic motivation by empowering them to manage their entire learning journey, thereby increasing engagement and persistence (Kanyopa & Makgalwa, 2024). Wahyudi et al.'s (2024) study confirms that SDL increases students' motivation to learn in specific disciplines. Self-regulated learning strategies, a key aspect of SDL, were found to directly influence academic success, with significant differences

***Corresponding Author:** Subrata Khan
Research Scholar (PhD), Department of Education, Jadavpur University, India

observed among students who use them (Ting-Chia, 2024). SDL has been linked to better academic performance in higher education because it encourages deeper engagement with knowledge and resources (Kanyopa & Makgalwa, 2024). AI improves the personalisation of SDL experiences by adapting educational content and support to meet individual student needs. This revolution is enabled by diverse AI technologies that adjust to students' individual learning styles, preferences, and speeds, promoting a more engaging and effective educational environment. These systems offer immediate feedback and tailored instruction based on students' learning behaviours and emotional states (Rathika *et al*., 2024), and their platforms generate personalised learning trajectories, ensuring that material delivery aligns with individual progress and understanding levels (Taşkın, 2025). Yan *et al*., (2024) stated that AI provides students with learning resources and methodologies (Yan *et al*., 2024), and its technological solutions promote active engagement by giving students collaborative and immersive educational experiences (Gotavade, 2024). Research highlights substantial improvements in academic success and satisfaction through AI-driven, individualised learning solutions (Iman *et al*., 2024; Rathika *et al*., 2024). AI facilitates the elimination of educational disparities, ensuring that every student receives a quality education tailored to their needs (Taşkın, 2025). Although AI offers various benefits for personalizing SDL, issues related to data privacy and algorithmic bias are significant considerations that must be addressed to guarantee ethical application in educational environments.

The role of AI in SDL has attracted significant interest from researchers, leading to a growing body of literature examining its applications, challenges, and effectiveness. Identifying knowledge gaps, key contributors, and future research directions is crucial for understanding trends in this field. Donthu *et al*., (2021) stated that a bibliometric investigation offers a systematic and quantitative method for uncovering emerging trends in articles and journal performance, collaboration patterns, research groups, common research themes, and the internal structure of specific areas within the existing literature. This bibliometric study examines the overall research trends and productivity of AI in SDL, based on published articles from 2005 to 2025.

Literature Reviews and Rationale of the Study

Artificial Intelligence (AI) is increasingly transforming self-directed learning (SDL) by enabling personalized, adaptive, and data-driven learning experiences (Hariyanto *et al*., 2025; Umar & Purwanto, 2025). In AI-supported environments, learners can independently plan, monitor, and evaluate their learning processes, thereby enhancing autonomy and engagement (Umar *et al*., 2025). Wang *et al*., (2024) focused on developing SDL competencies in students using AI-assisted writing methods. The results showed that AI is commonly used for idea development, content modification, proofreading, and rearranging written work. The research indicated that AI enhances all three aspects of SDL: motivation, self-monitoring, and self-management. A meaningful correlation between critical thinking skills, SDL skills, and AI-assisted writing suggests that SDL moderates the relationship between critical thinking and AI use, especially in learners identified by Shen & Teng (2024). Dwina (2024) observed the impact of structured cognitive approaches on writing growth, finding that mind mapping enhances learners' ability to visualise relationships among concepts, thereby improving coherence and overall writing proficiency. Roe & Perkins (2024) elaborate on these results by emphasizing the potential of generative AI tools, such as ChatGPT, in enhancing SDL while warning that despite AI's capacity for personalized support, educators remain critical to the learning process as technology advances.

AI has proven effective in autonomous language acquisition. Kang & Sung (2024) found that AI chatbots enhance EFL student's conversational skills, with chatbot activities proving more effective than traditional worksheet exercises. Qiu (2024) noted that ChatGPT serves as a useful conversational partner for oral language practice; however, its limitations mean that traditional training is still necessary to prevent uncritical self-learning. Bosch & Kruger (2024) emphasised the importance of AI chatbots in promoting SDL by providing interactive educational environments. Chandore *et al*., (2024) explored the relationship between AI acceptance and SDL readiness in language learning. Their findings showed that, while students demonstrated above-average SDL readiness, they did not have full autonomy in SDL. Additionally, the study identified a significant correlation between SDL readiness and the adoption and use of AI-assisted language learning tools.

Although AI has the potential to improve SDL, various factors influence its effectiveness. Ouaazki *et al.,* (2024) asserted that while prompt-tuning in generative AI may hinder usability, it could enhance learning outcomes. Esiyok *et al*., (2024) assert that technology-enhanced SDL affects both the intention and actual utilization of AI chatbots, indicating that human differences and learning behaviors are crucial considerations. Mahmud *et al*., (2023) expanded this discussion by analyzing self-learning algorithms, emphasizing their ability to overcome traditional learning challenges while recognizing the risks of errors and data dependencies. Almufarreh & Arshad (2023) examined institutional views on AI and highlighted AI's role in supporting SDL, especially when educational resources are limited, and called for targeted efforts to address implementation challenges. Wu *et al.,* (2024) found that improving teacher support and learning

methods in AI-enhanced environments boosts students' self-efficacy, acceptability, and motivation. Lin (2024) concluded that ChatGPT and other AI tools enhance SDL from goal-setting to assessment, making it a vital resource for adult learners.

The research shows that AI is crucial for enhancing SDL, especially in writing and language development. AI-assisted writing tools boost motivation, self-monitoring, and self-management, while AI chatbots improve language learning and conversational skills. The success of AI in SDL depends on factors such as prompt tuning, technology adoption, and institutional support. Although AI provides significant opportunities for SDL, the findings also highlight the ongoing importance of educators and structured learning methods to maximise its benefits. Therefore, the current study investigates the following research questions:

1. What are the publication trends in the field of Artificial Intelligence in self-directed learning over recent years?
2. Which are the most productive and influential authors, countries, institutions, and journals contributing to research on AI in self-directed learning?
3. What are the most highly cited articles and their major contributions in the domain of AI-supported self-directed learning?
4. What kind of collaborative structure emerges from co-authorship analysis at the country level in the field of Artificial Intelligence in self-directed learning?
5. What kind of intellectual structure emerges from co-citation analysis of authors in research on Artificial Intelligence in self-directed learning?
6. What are the frequently occurring keywords and emerging themes identified through keyword co-occurrence analysis in this field?

METHODOLOGY

This study employs a bibliometric approach using data from the Scopus database, thereby ensuring access to recent, reliable scholarly publications in the field. This method helps track current research trends and identify emerging patterns (Donthu *et al*., 2021; Prahani *et al.,* 2022). Bibliometric analysis is particularly useful for visualizing research patterns and reflecting the shifting interests and focus areas of researchers (Mohakud *et al*., 2024). Scholars have emphasised that bibliometric techniques provide a comprehensive understanding of a research field, including its historical development, structural relationships, patterns of knowledge dissemination, journal impact, and citation dynamics (González-Alcaide, 2021; Zupic & Čater, 2015). In this study, bibliometric analysis is used to examine research progress in the domain of Artificial Intelligence in self-directed learning by analysing publication data from Scopus, one of the largest and most authoritative academic databases. The study uses a systematic process that includes keyword selection, data extraction, and inclusion/exclusion criteria, as detailed later. Bibliometrics, a content analysis method, visualises relationships among publications, authors, and cited works (Zupic & Čater, 2015; Amiruddin *et al*., 2025). While it doesn't replace traditional reviews, bibliometrics provides valuable maps of a research field's structure.

Search String: (“Artificial Intelligence” OR “AI”) AND (“Self-directed Learning” OR “Self-learning”)

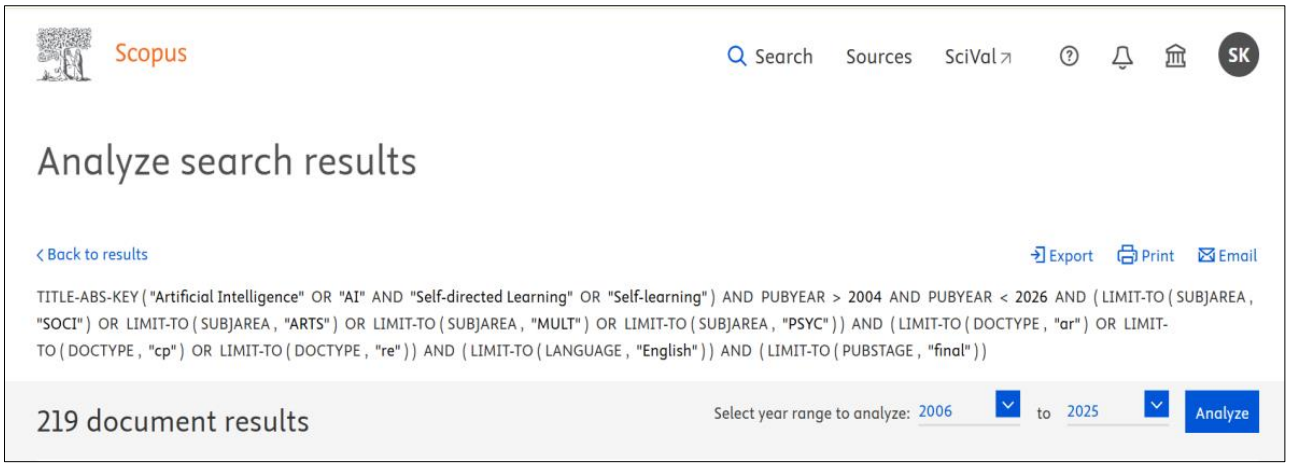

Figure 1: Screenshot of Scopus database search process

Search Strategy and Data Extraction Process

The data extraction and filtration process is shown in Figure 2. The data were retrieved from the Scopus database using a predefined search string related to Artificial Intelligence and self-directed learning, which initially yielded 1,801 documents. A systematic screening process was then applied using inclusion and exclusion criteria. First, a time filter (2005–2025) was implemented, resulting in the exclusion of 136 records, leaving 1,665 documents. Subsequently, subject area filtering was conducted by focusing on Social Sciences, Arts and Humanities, Psychology, and Multidisciplinary

fields, which reduced the dataset to 290 documents, while studies from other domains such as medicine, computer science, and mathematics were excluded. Further refinement, based on document type, included only articles, conference papers, and review papers, resulting in the exclusion of 34 records and 256 documents. Finally, language and publication stage filters were applied, excluding non-English documents and documents in press, removing a total of 37 records. After completing all screening stages, a final dataset of 219 documents was selected for bibliometric analysis and exported for further processing.

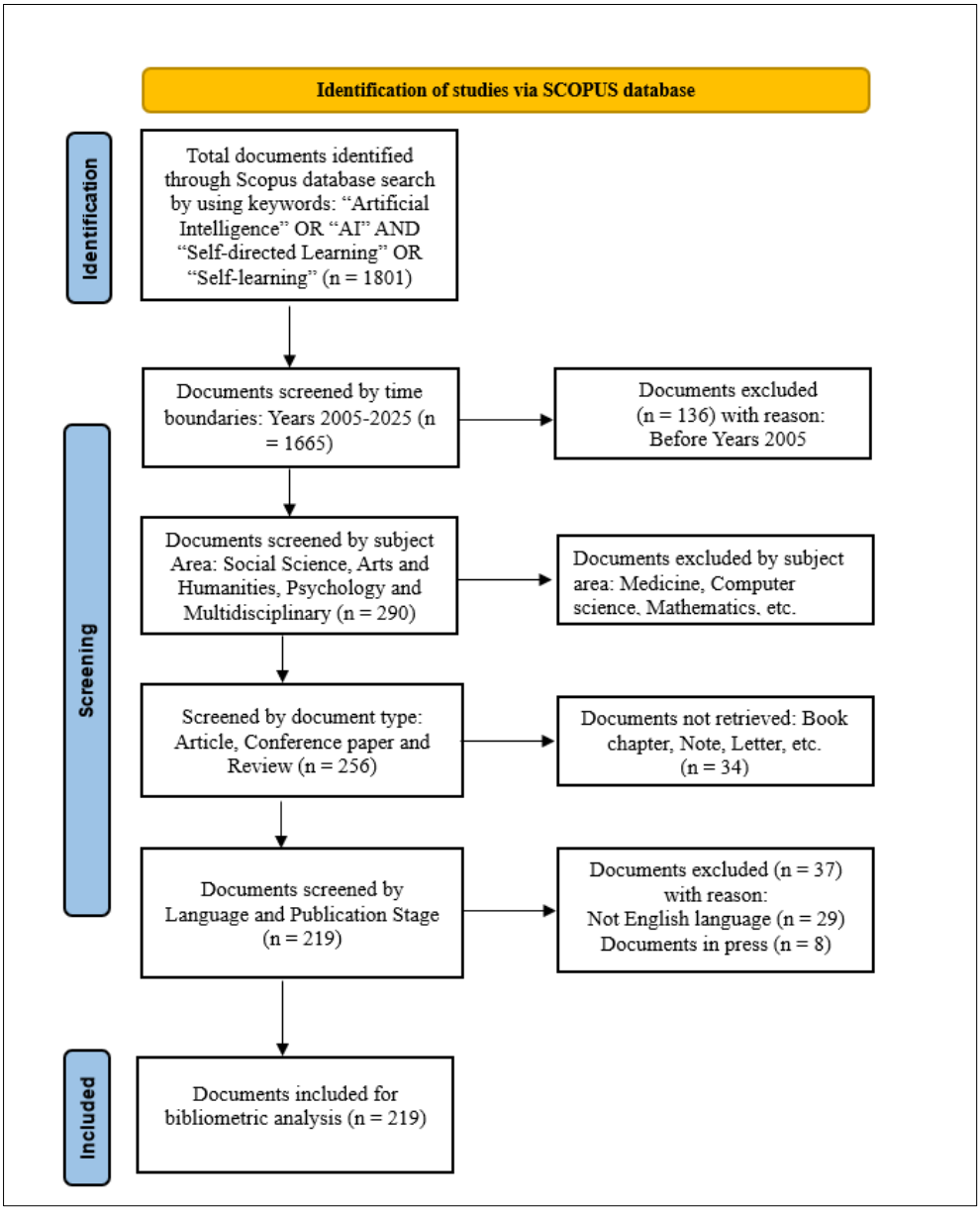

Figure 2: Data extraction and filtration process

Data Analysis

The analysis examined publication trends, leading authors, countries, influential journals, and highly cited documents in AI-supported SDL research. It explored thematic structures via keyword co-occurrence, identifying research clusters and emerging topics. VOSviewer provided visual representations for understanding the research landscape of AI in self-directed learning. The study used bibliometric tools, including VOSviewer and Excel, to analyse data, map scientific knowledge, and examine collaboration patterns, based on data from the Scopus database.

RESULTS

Distribution of Publications by Years

The study first examined the distribution of publications in the Scopus database by year. The findings are shown in Figure 3.

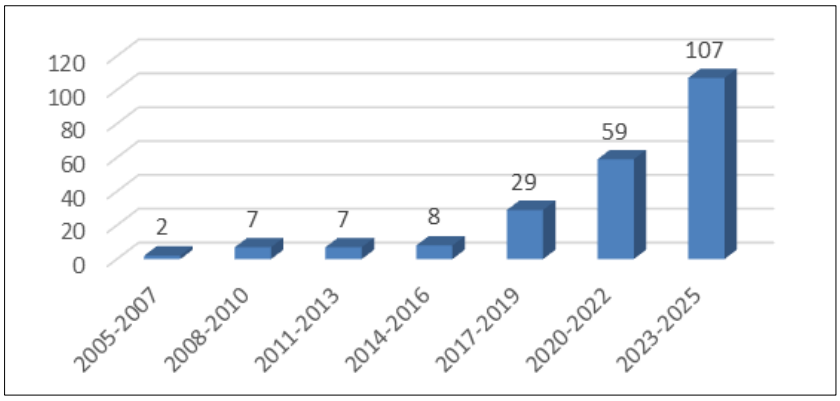

Figure 3: Distribution of Publications by Years

Figure 3: The trend in publication numbers over time shows a steady increase, with significant growth after 2016. From 2005 to 2016, the number of publications remained low, ranging between 2 and 8. However, after 2017, there was a noticeable rise, reaching 29 publications between 2017 and 2019. This growth continued in the following years, with 59 publications recorded between 2020 and 2022. The highest number of publications is observed in the 2023-2025 period, with 107 publications. This pattern suggests a growing research interest in the field, particularly in recent years.

Distribution of Publications by Institutions

The distribution of publications across institutions was also analysed. The top institutions with the most publications are shown in Figure 4.

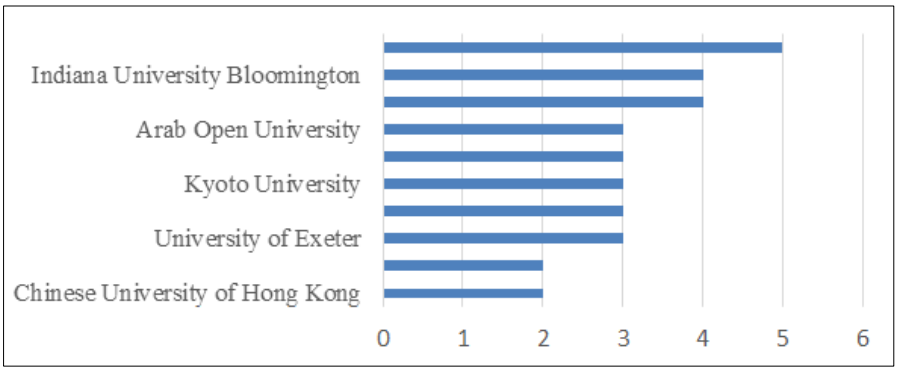

Figure 4: Distribution of Publications by Institutions

Figure 4 shows the leading institutions by the number of documents they contributed. "Colby College" ranks first with 5 documents, followed by "Indiana University Bloomington" and "University of Oxford," each contributing 4 documents. These institutions demonstrate significant research output, underscoring their active role in advancing the field through academic contributions.

Distribution of Publications by Country

The top countries with the most publications, shown in Figure 5, were examined for their distribution in the field.

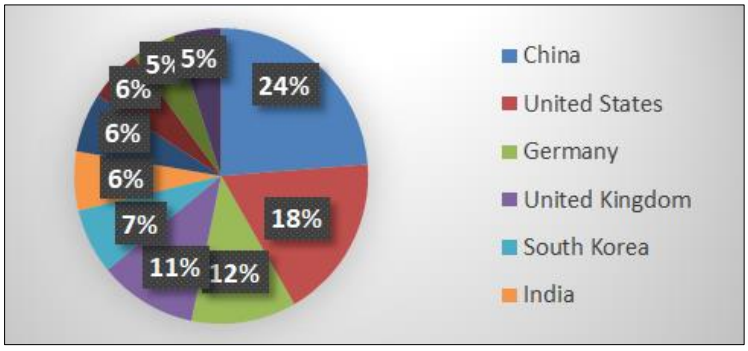

Figure 5: Distribution of Publications by Country

Figure 5 shows the leading countries by their document contributions. China tops the list with 33 documents (24%), followed by the United States with 25 documents (18%). Germany is third with 16 documents (12%), and the United Kingdom is fourth with 15 documents (11%). South Korea is fifth with 10 documents (7%), and India is sixth with 9 documents (6%). These numbers highlight the major research contributions from these countries in the field of AI in Self-directed learning.

Distribution of Publications by Subject Area

The distribution of publications across subject areas was also examined. The top subject areas are displayed in Figure 6.

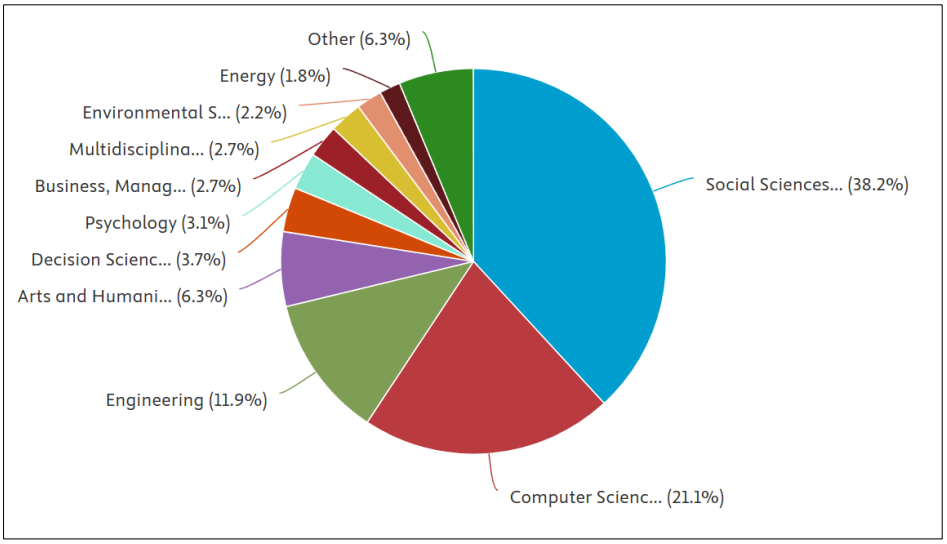

Figure 6: Distribution of Publications by Subject Area

A total of 219 research articles were retrieved from the Scopus database and visually represented in Figure 6 to analyze the academic disciplines covered in this research domain. The data indicates that Social Sciences lead with 196 documents (38.2%), followed by Computer Science with 108 documents (21.1%). Engineering ranks third with 62 documents (11.9%), while Arts and Humanities rank fourth with 32 documents (6.3%). These findings emphasize the dominance of Social Sciences and Computer Science in this field, reflecting the diverse research interests across various academic disciplines.

Table 1: Most Leading, Influential, and Impactful Authors, Institutions, and Countries on AI in Self-directed Learning

Rank	TC	Author	TP	TC	Institutions	TP	TC	Country	TP
1	1072	Feldmann J.	1	1072	University of Exeter, United Kingdom	1	1567	United Kingdom	15
2	1072	Youngblood N.	1	1072	University of Oxford, United Kingdom	1	1260	Germany	16
3	1072	Wright C.D.	1	1072	University of Münster, Germany	1	357	South Korea	10
4	1072	Bhaskaran H.	1	180	Kosin University, South Korea	1	308	United States	25
5	1072	Pernice W.H.P.	1	180	Chonnam National University, South Korea	1	223	China	33
6	214	Romano M.	2	180	Gachon University, South Korea	1	203	Sweden	3
7	214	Kapelan Z.	2	180	Inje University, South Korea	1	200	India	9
8	214	Savić D.A.	2	180	Kyungpook National University, South Korea	1	196	Australia	6
9	180	Han E.R.	1	180	Korea University, South Korea	1	121	Switzerland	2
10	180	Yeo S.	1	153	Chalmers University of Technology, Sweden	1	120	Italy	7

Table 1 shows the citation distribution among authors, institutions, and countries. Feldmann J., Youngblood N., Wright C.D., Bhaskaran H., and Pernice W. have the highest citation count, each with 1,072 citations, highlighting their significant research contributions. In terms of publication productivity, Romano and Kapelan are the most active authors with two publications. Similarly, the University of Exeter (United Kingdom), University of Oxford (United Kingdom), and University of Münster (Germany) each

have 1,072 citations, indicating their strong academic influence. At the country level, the United Kingdom leads with 1,567 citations, followed by Germany with 1,260 citations, and India ranks seventh with 200 citations. Based on publication count, China is the most productive country with 33 publications. This data emphasises the global scope of academic research, with key institutions and researchers driving influential studies across regions. These figures highlight the research impact of various contributors within this field.

Table 2: Name of the Top Journals with No. of Documents and Citations

Name of the Journals	Documents	Citations
Nature	1	1072
BMC Medical Education	4	256
Journal of Water Resources Planning and Management	2	214
AI and Society	2	154
Artificial Intelligence Review	1	142
Proceedings of The National Academy of Sciences of The United States of America	1	120
Sustainability (Switzerland)	7	106
Proceedings of NAACL-HLT 2016	1	103
Zeitschrift Fur Soziologie	1	97
Computers and Education: Artificial Intelligence	4	82
University of Illinois Law Review	1	80
Education and Information Technologies	2	70
Library Hi Tech	2	65
International Journal of Data and Network Science	1	64

Table 2 shows the leading journals by citation impact. “Nature” has the highest citation count with 1,072 citations, followed by “BMC Medical Education” with 256 citations. The “Journal of Water Resources Planning and Management” has 214 citations, while “AI and Society” have 154 citations. “Artificial Intelligence Review” has received 142 citations, demonstrating the varying levels of research influence among these journals. Regarding publication productivity, Sustainability (Switzerland) is the most productive journal in this AI and self-directed learning domain, with seven publications.

Table 3: Most Influential and Impactful Articles on AI in Self-directed Learning

Title	Authors	Sources	Citations
“All-optical spiking neurosynaptic networks with self-learning capabilities”	Feldmann *et al*., (2019)	Nature	1072
“Medical education trends for future physicians in the era of advanced technology and artificial intelligence: An integrative review”	Han *et al*., (2019)	BMC Medical Education	180
“Automated detection of pipe bursts and other events in water distribution systems”	Romano e*t al*., (2014)	Journal of Water Resources Planning and Management	174
“Artificial intelligence, transparency, and public decision-making: Why explanations are key when trying to produce perceived legitimacy”	De fine licht (2020)	AI and Society	153
“Reinforcement learning in robotic applications: a comprehensive survey”	Singh *et al.*, (2022)	Artificial Intelligence Review	142
“A self-learning algorithm for biased molecular dynamics”	Tribello *et al*., (2010)	Proceedings of the National Academy of Sciences of the United States of America	120
“Text readability assessment for second language learners”	Xia *et al*., (2016)	Proceedings of NAACL-HLT 2016	103
“Artificial Communication? The Production of Contingency by Algorithms”	Esposito E. (2017)	Zeitschrift fur Soziologie	97
“Artificial intelligence & collusion: When computers inhibit competition”	Ezrachi and Stucke (2017)	University of Illinois Law Review	80
“Analysis of the effect of an artificial intelligence chatbot educational program on non-face-to-face classes: a quasi-experimental study”	Han *et al*., (2022)	BMC Medical Education	74
“The impact of ChatGPT on blended learning: Current trends and future research directions”	Alshahrani A. (2023)	International Journal of Data and Network Science	64

Table 3 displays the most cited research articles and their academic impact. "All-optical spiking neurosynaptic networks with self-learning capabilities" by Feldmann *et al*., (2019), published in Nature, has received 1,072 citations, showing its significant influence. "Medical education trends for future physicians in the era of advanced technology and artificial intelligence: An integrative review" by Han *et al*., (2019) in BMC Medical Education has earned 180 citations, indicating its contribution to medical education research. "Automated detection of pipe bursts and other events in water distribution systems" by Romano *et al*., (2014), published in the Journal of Water Resources planning and Management, has garnered 174 citations, reflecting its impact on water management research.

Result of Co-Citation Network Analysis with Authors

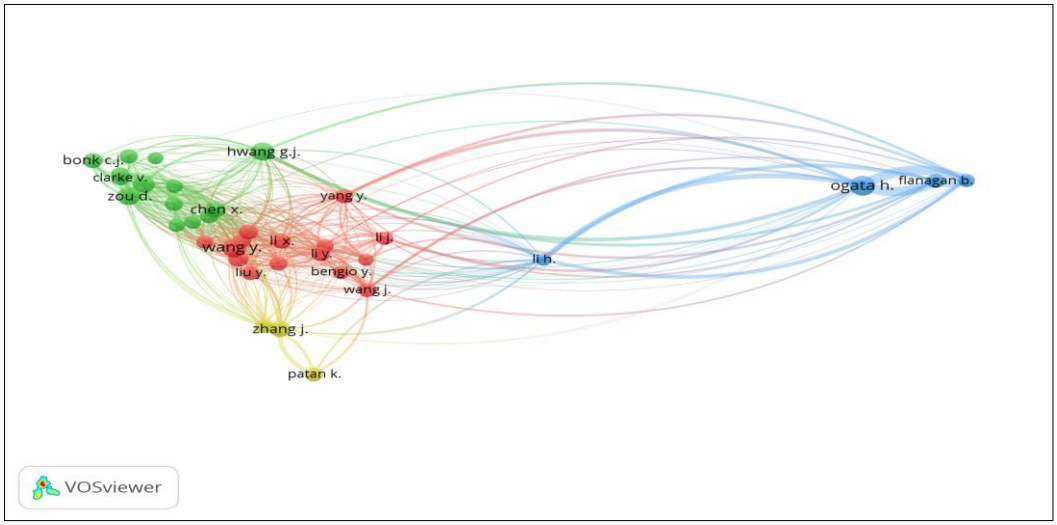

Fig. 7: Map of Clustered Network Authors Based on Co-citation Data

Figure 7 shows the results of a co-citation analysis with a minimum of 15 author citations. The analysis reveals four distinct coloured clusters, with authors who receive many citations grouped together. The authors at the centre of the figure are cited across various fields and have detailed connections to multiple clusters. Among these clusters, the red, green, and blue are the largest and most prominent. Figure 7 found that the publications by Ogata H., Flanagan B., Majumdar R., Li H., Hwang G.J., Yang Y., Chen X., Liu Y., Zhang J., and Wang Y. have been co-cited most frequently in artificial intelligence research on self-directed learning.

Result of Co-Author Network Analysis with Countries

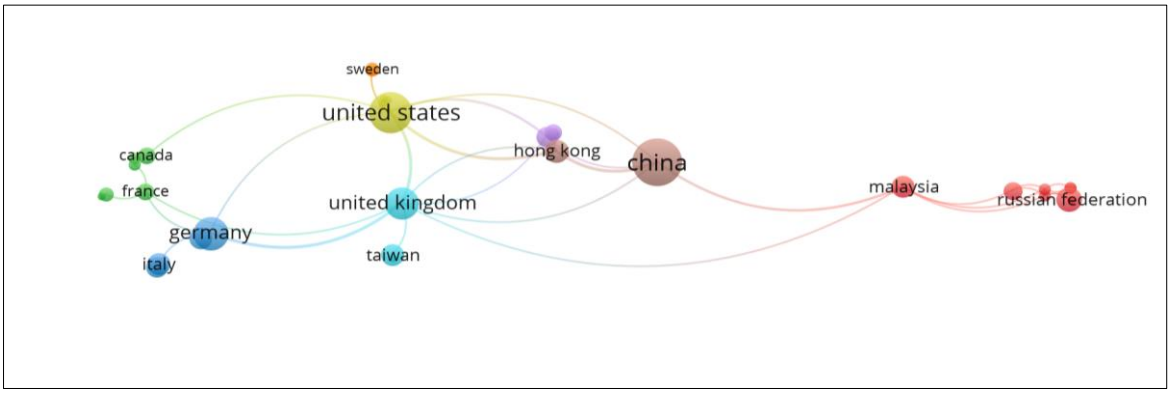

Fig. 8: Collaborative Research Networks between Countries and Territories.

Figure 8 shows a co-author analysis of international research collaborations among countries. It focuses on collaborations between countries. Each circular shape represents a country, with larger circles indicating higher research productivity. Lines connecting country names indicate collaboration between those two countries, and the proximity of countries on the figure reflects the strength and breadth of their research connections. The analysis of co-authors' countries revealed that the USA worked with 16 countries, the UK with 12 countries, and China and Hong Kong with 8 countries. Australia followed the list (7 links), Germany (7 links), Malaysia (6 links) and others.

Co-Occurrence Analysis with Author Keywords (Co-words) and Thematic Clusters

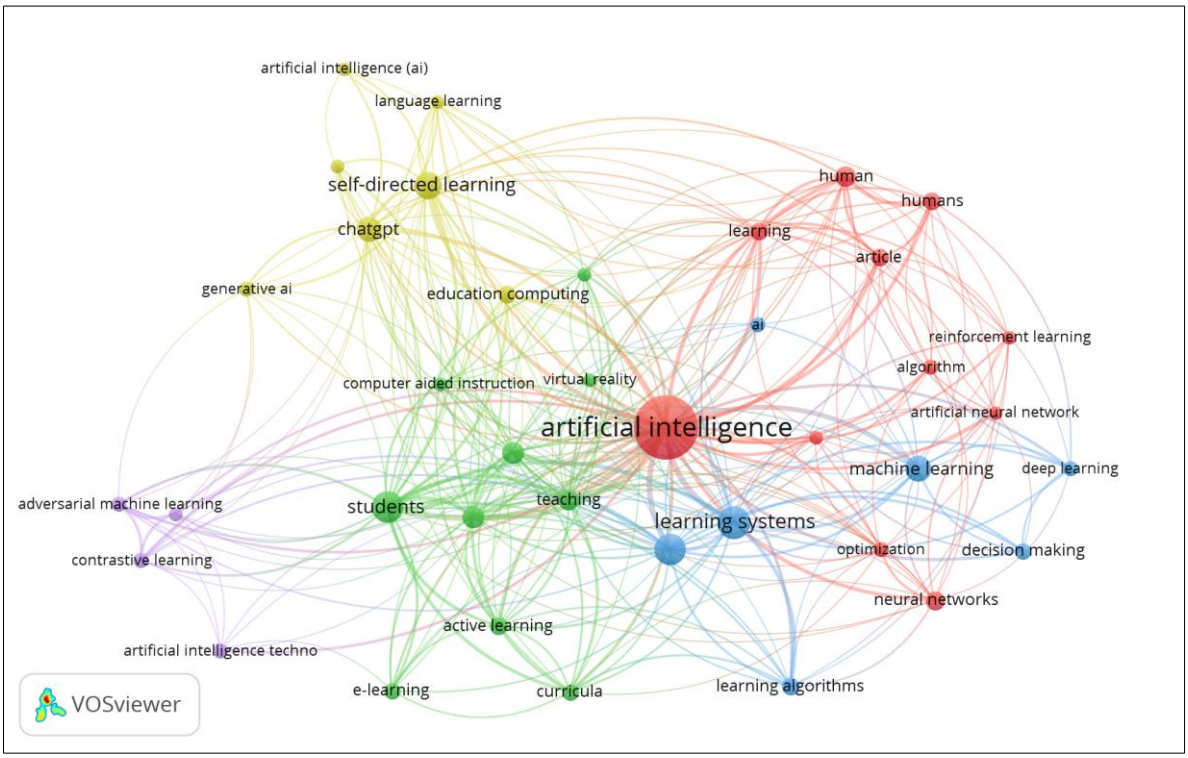

Figure 8: Network of Author's Keywords

Figure 9 presents an overlay visualisation of 33 keywords from the author, created with VOSviewer software. This network highlights the most frequently used and trending keywords. Larger circles indicate topics discussed more often, while yellow markers show the most popular subjects. Artificial intelligence, machine learning, ChatGPT, and Self-directed learning are identified as the most frequently used keywords. ChatGPT, chatbots, generative AI, and virtual reality are the most recent trending keywords in this research area, followed by collaborative learning, self-learning, and artificial intelligence. Consequently, future researchers can incorporate these keywords into their studies.

Table 4: Thematic Cluster based on Authors' Keywords

Cluster	Themes	Keyword	Occurrences	Total Link Strength
Cluster-1 (Red)	Artificial Intelligence and Neural Learning for Sustainable Optimisation	Algorithm	7	16
		Article	10	42
		Artificial Intelligence	131	313
		Artificial Neural Network	6	22
		Human	13	55
		Humans	11	41
		Learning	11	52
		Neural Networks	12	30
		Optimization	7	24
		Reinforcement Learning	6	18
		Sustainability	6	20
Cluster-2 (Green)	Virtual Reality and Active Learning in Higher Education	Active Learning	10	46
		Computer-Aided Instruction	6	28
		Curricula	9	49
		E-Learning	9	25
		Education	15	65
		Engineering Education	16	83
		Higher Education	6	30
		Students	31	140
		Teaching	14	70

Cluster	Themes	Keyword	Occurrences	Total Link Strength
		Virtual Reality	6	12
Cluster-3 (Blue)	Self-Learning and Intelligent Decision Making	AI	8	12
		Decision Making	9	25
		Deep Learning	8	25
		Learning Algorithms	10	39
		Learning Systems	33	118
		Machine Learning	21	53
		Self-Learning	32	86
Cluster-4 (Yellow)	AI-Driven Language Learning and Self-Directed Education	Artificial Intelligence	6	10
		Chatbots	6	17
		ChatGPT	20	53
		Education Computing	10	44
		Generative AI	7	18
		Language Learning	6	22
		Self-Directed Learning	24	63
Cluster-5 (Purple)	Advanced and Secure AI Learning Technologies	Adversarial Machine Learning	8	30
		Artificial Intelligence Technologies	7	13
		Contrastive Learning	8	33
		Federated Learning	6	26

Five main themes summarise the field's key topics in artificial intelligence in self-directed learning from 2005 to 2025. First, there is a general interest in "Artificial Intelligence and Neural Learning for Sustainable Optimisation" contexts, indicated by frequently co-occurring words such as Artificial Intelligence, Algorithm, Human, Learning, Artificial Neural Network, Optimisation, and Sustainability (red cluster). A second theme centres on "Virtual Reality and Active Learning in Higher Education, "including Active Learning, Curricula, E-Learning, Virtual Reality, Computer-Aided Instruction, Education, Teaching, and Higher Education (green cluster). Third, cluster three examines "Self-Learning and Intelligent Decision Making," with keywords such as Learning Systems, Decision Making, Learning Algorithms, Deep Learning, AI, Machine Learning, and Self-Learning (blue cluster). A fourth theme focuses on "AI-Driven Language Learning and Self-Directed Education, "encompassing Artificial Intelligence (AI), Chatbots, ChatGPT, Education Computing, Self-Directed Learning, Generative AI, and Language Learning (yellow cluster). Fifth, cluster five highlights "Advanced and Secure AI Learning Technologies, "including Artificial Intelligence Technologies, Adversarial Machine Learning, Federated Learning, and Contrastive Learning (purple cluster). In Figure 9, Artificial Intelligence, Learning Systems, Decision Making, Self-directed Learning, Machine Learning, ChatGPT, and Virtual Reality are positioned at the centre of the map. These are the most frequently used keywords and have been studied alongside other clusters.

DISCUSSION

The study identifies AI research trends in self-directed learning, using publication and citation records to outline future potential. The findings revealed that the number of publications has increased rapidly and attracted greater research interest over the last ten years (2015-2025). Fernando *et al*., (2025) contradict this finding, stating that the high concentration occurred in the period from 2020 to 2025. The first publications in this field emerged in 1985 (Holtz, K. 1985). Artificial intelligence (AI) significantly enhances self-directed learning (SDL) by providing personalized, adaptive, and real-time support, which is crucial for fostering learner autonomy and improving educational outcomes (Xu & Zheng, 2025; Umar & Purwanto, 2025). AI tools such as intelligent tutoring systems, chatbots, and adaptive learning platforms enable learners to manage their learning processes more effectively by offering tailored feedback and individualized learning paths (Navas Bonilla *et al*., 2025). The findings revealed that Feldmann J., Youngblood N., Wright C.D., Bhaskaran H., and Pernice W. are the most productive authors in AI and self-directed learning research, indicating a sustained and impactful presence. The University of Exeter, the University of Oxford, and the University of Münster are the most prominent universities in terms of citations. This finding emphasises the exciting evolution of the field, its widespread appeal, and the influence of these publications. Authors from China make the largest contribution, followed by the United States, Germany, and the United Kingdom, which also dominate this field, publishing the articles. This finding aligns with that of Navas Bonilla et al. (2025) and Xue *et al*., (2025). Conversely, Fernando *et al*., (2025) contradict this finding, stating that the USA makes the largest contribution to research on AI and self-paced learning. Moreover, the co-author analysis of international research collaborations among countries revealed that the USA worked with 16 countries, followed by the UK, China, and Hong Kong. It suggests that international collaborations are associated with substantial research

and development budgets, prestigious universities, a culture of innovation, and a diverse academic community. The study's co-citation analysis with the author revealed that the publications by Ogata H., Flanagan B., Majumdar R., Li H., Hwang G.J., Yang Y., Chen X., Liu Y., Zhang J., and Wang Y. have been co-cited most frequently in artificial intelligence research on self-directed learning.

Furthermore, based on their document contributions, "Colby College" is the most impactful institution, followed by "Indiana University Bloomington" and "University of Oxford." These institutions enhance the global significance of AI research in self-directed learning, empowering institutions from diverse regions to shape the future of this field, thereby fostering innovation, collaboration, and knowledge exchange worldwide. However, the results revealed that the source “Sustainability” has the most productive journal, followed by “BMC Medical Education” and “Computers and Education: Artificial Intelligence”, which published the most articles. The study also revealed that, based on citation impact, “Nature” has the highest citation count, followed by “BMC Medical Education”. These sources are essential for sharing impactful research, fostering knowledge exchange, and shaping the future of AI in self-directed learning. Co-occurrence analysis is crucial for extracting insights from studies, enabling researchers to identify prevailing themes and concepts (Stockwell *et al*., 2009). The findings revealed that "Artificial intelligence", “Learning Systems”, “Self-directed Learning”, “Higher education”, and “ChatGPT” are the most frequently used keywords. Fernando *et al*., (2025) study revealed that “learning”, “self-paced, “AI”, and “teaching” are the most frequently used keywords in this field. Similarly, Navas Bonilla *et al*., (2025) study also revealed that “artificial intelligence”, “self-directed learning”, and “students” are the most frequently used keywords.

Moreover, the findings also revealed five thematic clusters in AI in Self-directed Learning, providing valuable insights into the field. From the perspective of Artificial Intelligence in SDL, this study has some limitations. The data were collected only from the Scopus database, so some relevant studies from other databases might not be included. Although many important keywords related to AI and SDL were used, a few relevant terms may have been missed, potentially affecting the study's coverage. However, the selected keywords and categories still provide a good overall picture of the research trends and complexity in this field.

CONCLUSION

This study presents a comprehensive bibliometric analysis of the scientific literature on the role of Artificial Intelligence (AI) in self-directed learning (SDL), with a particular focus on recent research trends, influential authors, contributing countries, and thematic developments. The findings reveal substantial, continuous growth in publications, especially in the post-pandemic period, reflecting the increasing significance of AI in fostering learner autonomy and transforming contemporary educational practices. A considerable proportion of contributions originates from countries such as China, the USA, and Germany, indicating active global engagement and growing international collaboration in this emerging research domain. While developed nations continue to dominate the research output, developing countries are gradually expanding their contributions, thereby enhancing the diversity and inclusivity of scholarly discourse. The analysis further reveals that research outputs are published in high-impact journals and by reputable institutions, emphasising the field's academic significance and broader scope. Keyword co-occurrence analysis highlights major themes centred on Artificial Intelligence, machine learning, ChatGPT, and self-directed learning as the most frequently used keywords. ChatGPT, chatbots, generative AI, and virtual reality are the latest trending keywords in this research area, all contributing to improving self-directed learning processes. Moreover, thematic clustering uncovers several interconnected research domains, offering a structured view of the AI-supported SDL intellectual landscape. These thematic insights provide valuable guidance for future researchers in determining research directions and filling existing gaps. The study also emphasises the interdisciplinary nature of this field, combining perspectives from education, psychology, and computer science to address the complex dynamics of self-directed learning in AI-enabled environments. However, the findings reveal that much of the existing research is framed within self-regulated learning (SRL) rather than purely self-directed learning, highlighting the need for clearer conceptual distinctions and theoretical progress. Moreover, there are still a few empirical, longitudinal studies examining the long-term effectiveness of AI in fostering genuine learner autonomy. Future research should incorporate multiple databases to achieve broader global coverage and improve the robustness of bibliometric results. There is also a requirement for more longitudinal and experimental studies to evaluate the real-world impact of AI on self-directed learning outcomes. Additionally, future investigations should focus on critical issues such as ethical concerns, data privacy, algorithmic bias, and the digital divide, which heavily influence the fair implementation of AI in education. Exploring context-specific challenges across regions and educational systems will deepen understanding of how AI can best support self-directed learning in diverse environments. In conclusion, although AI shows great potential to improve self-directed learning through personalised, adaptive, and data-driven methods, the field is still in its early stages and requires ongoing research to fully understand its educational impact.

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