RESEARCH HOTSPOTS, TRENDS, AND IMPLICATIONS OF ARTIFICIAL INTELLIGENCE LITERACY BASED ON CITESPACE

XiaoXia Tian[1*], YuFei Zhou[1], Rui Du[2]

[1]*School of Mathematical Sciences, Henan Institute of Science and Technology, Xinxiang 453003, Henan, China.*
[2]*School of Business, Huanghe Science and Technology University, Zhengzhou 450000, Henan, China.*
Corresponding Author: XiaoXia Tian, Email: 15188359878@163.com

Abstract: This study collected 484 core publications from the China National Knowledge Infrastructure (CNKI) and Web of Science (WOS) databases as research samples, focusing on topics related to 'artificial intelligence literacy' and 'intelligence literacy' between 2018 and 2025. Utilizing the CiteSpace 6.3.R4 visualization tool for bibliometric analysis, the findings reveal that: (1) Research activity in the field of artificial intelligence literacy exhibits a significant year-by-year increasing trend. Domestic research primarily concentrates on cultivating intelligence literacy among K-12 students and pre-service teachers, whereas international research shows a greater tendency to explore AI literacy development within university student populations. (2) Through keyword co-occurrence and clustering analysis, this study identifies 'artificial intelligence', 'intelligence literacy' and 'digital literacy' as core research hotspots, uncovering notable differences in research emphasis between the two databases. (3) Burst detection analysis further highlights significant increasing trends for keywords such as 'intelligence literacy', 'core competencies', and 'teachers', providing crucial insights into the field's developmental dynamics. These findings offer valuable empirical support and theoretical insights for advancing AI literacy education globally.
Keywords: Artificial intelligence literacy; Intelligence literacy; CiteSpace; Educational policy; Talent cultivation

1 INTRODUCTION

Amidst the wave of digital transformation, artificial intelligence (AI) literacy, as a vital component of individual cognitive competence, has gained increasing prominence. It plays a crucial role in driving societal innovation, enhancing competitiveness in the global job market, and promoting the achievement of sustainable development goals [1]. Since the State Council of China promulgated the Next Generation Artificial Intelligence Development Plan in 2017 [2], AI has ascended to become a core area of national strategy, underscoring the government's high prioritization of AI technology development. Subsequently, *the Artificial Intelligence Innovation Action Plan for Higher Education Institutions* [3] and *the Education Informatization 2.0 Action Plan* [4], both issued in 2018, further emphasized the importance and urgency of enhancing AI literacy, providing concrete implementation pathways and policy support for its cultivation. By 2023, the release of the *Interim Measures for the Management of Generative Artificial Intelligence Services* [5] and *the Global Artificial Intelligence Governance Initiative* [6] elevated the enhancement of AI literacy to a nationwide imperative, establishing it as a major societal task. This aims to lay a solid foundation for the healthy development of AI technology and the improvement of societal well-being through elevating citizens' AI literacy.
AI literacy encompasses not only the understanding and application skills of AI technology itself but also involves a comprehensive grasp of relevant ethical norms and social responsibilities. It specifically includes multiple dimensions such as data processing, algorithm comprehension, model construction, human-computer interaction, and critical thinking regarding the societal impacts of AI [7]. Konishipioneered a conceptual framework for AI literacy [8]. Long subsequently developed a comprehensive competency framework comprising 17 elements [9]. Zhang et al. proposed a three-dimensional model covering AI knowledge, abilities, and ethics based on the 'Five Big Ideas in AI' [10]. Yang et al., guided by STEM education principles, constructed an AI literacy framework encompassing core concepts, technical practices, interdisciplinary thinking, and ethical attitudes [11]. Wang et al. developed a five-dimensional AI literacy framework—knowledge, skills, awareness, ethics, and thinking—from a historical development perspective [12]. Zheng et al., drawing on Gagné's taxonomy of learning outcomes, proposed a five-dimensional model consisting of intelligent knowledge, ability, thinking, application, and attitude [13]. Cai et al. further emphasize that AI literacy is not merely technical understanding and application ability, but a comprehensive, evolving system of skills and knowledge [14].
However, current research still exhibits limitations. On one hand, existing literature often focuses on theoretical discussions, lacking visual analysis of research dynamics, which makes it difficult to systematically map the developmental trajectory and hotspot trends within the AI literacy research domain. On the other hand, research data predominantly originates from domestic databases, failing to comprehensively encompass global research outputs. This, to some extent, hinders an accurate grasp and holistic understanding of the overall landscape and developmental trends of global AI literacy research.
Addressing these gaps, this study employs CiteSpace to conduct a visual analysis of relevant domestic and international literature from 2018 to 2025. Through CiteSpace's visualization capabilities, it reveals key patterns in AI literacy

research, including keyword co-occurrence networks, research hotspot distributions, and the evolution of research trends. This analysis not only aids in identifying impactful AI domains for education and society but also provides robust data support and decision-making foundations for formulating educational policies, allocating educational resources, and innovating teaching methodologies. It holds significant importance for advancing AI literacy levels globally and cultivating future talent.

2 RESEARCH METHODS

This study selected the China National Knowledge Infrastructure (CNKI) and Web of Science (WOS) core collection databases. Advanced topic searches were conducted using the Chinese search string 'AI Literacy' or 'Intelligence Literacy' for CNKI and the English search string TS=('AI Literacy' OR 'Artificial Intelligence Literacy') for WOS. The search period was set from January 2018 to May 2025.

To enhance accuracy, the data sample underwent a meticulous data cleaning process. By manually examining the abstracts and keywords of each article, ineligible publications were excluded, including conference papers, book reviews, newspaper articles, anonymous works, and duplicate publications. After screening, 484 valid publications relevant to the research topic were identified, comprising 269 Chinese articles and 215 English articles. These publications were then exported in plain text format, named 'RefWorks' (WOS) and 'download' (CNKI) files for subsequent analysis.

CiteSpace software (version 6.3.R4) was used to analyze the research sample. Key parameters were configured as follows: Time slicing from 2018 to 2025, with a one-year interval; Node types focused on Author, Institution, and Keyword; Selection criteria (Thresholding) utilized the g-index; Scaling factor (k) was determined based on the number of nodes; Network pruning methods applied were 'Pathfinder Network (PFNET)', 'Pruning Sliced Networks', and 'Pruning the Merged Network' to optimize network visualization. Other parameters retained the software's default settings. Through co-occurrence analysis, burst detection, and keyword timeline clustering analysis, visualization maps were generated, followed by image interpretation and hotspot analysis.

3 VISUALIZATION ANALYSIS OF RESEARCH RESULTS

3.1 Analysis of Publication Volume Trends

Figure 1 illustrates the trend in the number of publications on AI literacy research in the CNKI and WOS databases from January 1, 2018, to May 28, 2025. The data reveals a significant growth trend in publications within this field during this period. Based on growth rates, the timeframe from 2018 to 2025 is divided into two phases. The first phase (2018-2021) exhibited a steady increase in annual publication volume. The second phase (2022-2025) witnessed explosive growth, far exceeding the average publication volume of the first phase. As of the first half of 2025, research in the field of AI literacy continues to show sustained and robust growth.
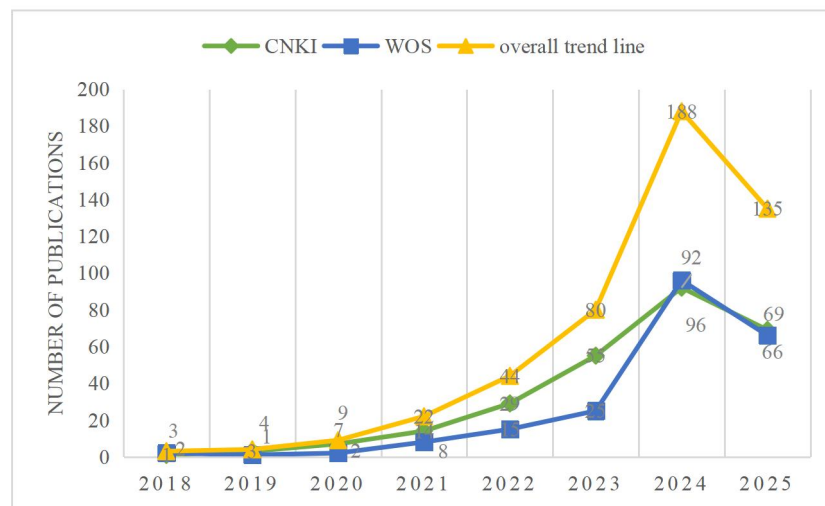

Figure 1 Analysis of Publication Volume in CNKI and WOS Databases
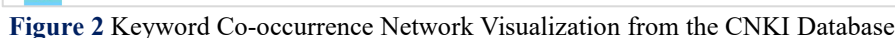*Note: Publication count for 2025 is up to May 2025, not the full year.

3.2 Keyword Co-occurrence Network Analysis

To explore the research themes of AI literacy, this study conducted keyword co-occurrence analysis using CiteSpace. The node type was set to Keyword, with yearly time slicing. The Top N per slice threshold was set to 25, selecting the top 25 most frequently occurring keywords each year. This analysis generated keyword co-occurrence maps. In these maps, node size represents the frequency of keyword occurrence, while the lines connecting nodes and their thickness indicate co-occurrence relationships and the strength of association between keywords. Network density reflects the

closeness of connections between keywords within the research field.

Figure 2 Keyword Co-occurrence Network Visualization from the CNKI Database

Figure 2, based on the CNKI database, comprises 178 nodes and 246 links, with a network density of 0.0156. It reveals the distribution and interconnections of keywords within the domestic AI literacy field. Analysis of high-frequency keywords in CNKI identified 'Artificial Intelligence', 'Intelligence Literacy', 'Pre-service Teachers', 'AI Literacy', and 'Intelligent Education' as having both high frequency and strong centrality, indicating the importance and sustained focus on these themes in domestic AI literacy research.

Furthermore, keywords such as 'Primary and Secondary Students', 'Enhancement Pathways', 'Information Literacy', 'Teachers', 'Digital Intelligence Literacy', and 'Digital Literacy' have gained prominence in recent years. This suggests researchers are broadly focusing on AI applications in elementary education and teacher education, as well as systematic approaches to enhancing students' AI literacy. The wide distribution and cross-linking of keywords indicate that AI literacy is a multi-dimensional research field, involving aspects such as AI competencies, intelligent education, human-machine collaboration, digital literacy, and information literacy. This multi-dimensional perspective facilitates a deeper understanding of AI literacy's connotations and provides diverse strategies for educational practice.

The emergence of new keywords like 'Human-Machine Collaboration' highlights researchers' interest in novel modes of collaboration between AI and humans and the potential impact of this collaboration on future education and work. Concurrently, the rising prominence of 'Enhancement Pathways' and 'Cultivation Pathways' reflects the urgent need among educators and scholars for systematic training frameworks. Increased attention to 'Digital Intelligence Literacy' and 'Information Literacy' emphasizes the technological skills and data processing capabilities required for future talent, crucial for adapting to digital and intelligent work environments. Analysis of keyword centrality reveals research hotspots and potential future directions (see Table 1). 'Intelligent Education' may point towards new approaches integrating pedagogical skills with AI, while the centrality of 'Pre-service Teachers' likely underscores the importance of strengthening AI literacy within teacher training programs.

Figure 3 Keyword Co-occurrence Network Visualization from the WOS Database

Figure 3, based on the WOS database, comprises 188 nodes and 285 links, with a network density of 0.0166,

highlighting research hotspots in the international AI literacy domain. Keywords such as 'artificial intelligence', 'ai literacy', 'artificial intelligence literacy', 'ai education', and 'higher education' exhibit high frequency and centrality, indicating these themes are core research foci. Further analysis shows rising prominence for 'generative ai', 'digital literacy', and 'machine learning', reflecting the educational focus on cultivating students' comprehensive abilities, such as information processing and data analysis skills.

The co-occurrence of keywords 'higher education' and 'ai in education' underscores the pivotal role of higher education institutions in promoting AI literacy education. As future societal leaders and innovators, students' level of AI literacy will directly impact society's adaptability to technology and innovation potential.

Table 1 Top 10 High-Frequency Keywords in AI Literacy Research

Database Type	Rank	Keyword	Frequency	Year	Database Type	Rank	Keyword	Centrality	Year
CNKI	1	Artificial Intelligence	67	2018	CNKI	1	Artificial Intelligence	0.74	2018
	2	Intelligent Literacy	57	2018		2	Intelligent Literacy	0.66	2018
	3	Pre-service Teachers	28	2021		3	Pre-service Teachers	0.22	2021
	4	AI Literacy	21	2022		4	AI Literacy	0.11	2022
	5	Teachers	10	2019		5	AI-based Education / Intelligent Education	0.1	2021
	6	Intelligent Education	8	2021		6	Teachers	0.08	2019
	7	Enhancement Pathways	8	2021		7	Digital Literacy	0.07	2023
	8	Digital Literacy	7	2023		8	Information Literacy	0.07	2020
	9	Information Literacy	6	2020		9	Teacher Competence / Teacher Literacy	0.07	2021
	10	Enhancement Strategies	6	2022		10	Enhancement Pathways	0.05	2021
WOS	1	ai literacy	93	2020	WOS	1	ai literacy	1.17	2020
	2	artificial intelligence	55	2020		2	artificial intelligence	0.41	2020
	3	artificial intelligence literacy	27	2023		3	artificial intelligence literacy	0.35	2023
	4	ai education	16	2022		4	information literacy	0.16	2018
	5	higher education	10	2022		5	ai ethics	0.09	2021
	6	generative ai	9	2024		6	ai education	0.08	2022
	7	digital literacy	8	2022		7	machine learning	0.07	2022
	8	ai ethics	8	2021		8	large language models	0.03	2023
	9	machine learning	7	2022		9	generative ai	0.02	2024
	10	ai in education	7	2021		10	digital literacy	0.02	2022

3.3 Keyword Timeline Clustering Analysis

By setting the Threshold value to 4, this study filtered keywords appearing at least 4 times, generating keyword timeline cluster maps. The CNKI database formed 7 clusters, while the WOS database formed 9 clusters, as shown in Figures 4 and 5. These cluster maps reveal the evolution of keywords over time and display co-occurrence relationships across different dimensions through keywords positioned on the same timeline.

In evaluating clustering effectiveness, the Q-value (Modularity Q) is a key metric, with a critical threshold of 0.3. A Q-value greater than 0.3 indicates a significant cluster structure. In this study, the Q-value for CNKI is 0.6868 and for WOS is 0.538, both exceeding the threshold, signifying highly significant cluster structures for both databases. The S-value (Mean Silhouette) is another metric for clustering effectiveness, with a critical threshold of 0.5. An S-value greater than 0.5 indicates reasonable clustering, while greater than 0.7 indicates convincing clustering. In this study, the S-value for CNKI is 0.9458 and for WOS is 0.9032, both far exceeding the threshold. This suggests significant homogeneity within the clustered groups, rendering the clustering results not only reasonable but also highly credible.

In the CNKI database, the major clusters (labeled by the most central term) are #0 Intelligence Literacy, #1 Artificial Intelligence, #2 Pre-service Teachers, #3 Digital Literacy, #4 Teachers, #5 AI Literacy. In the WOS database, they are

#0 ai literacy, #1 artificial intelligence literacy, #2 artificial intelligence, #3 ai education, #4 early childhood education, #5 generative ai, #6 ai ethics, #7 machine learning, #8 information literacy.

These clustering results reveal key differences and characteristics in AI literacy research between the databases. The CNKI clusters emphasize a domestic research focus on elementary education, particularly clusters like '#0 Intelligence Literacy,' '#2 Pre-service Teachers,' and '#4 Teachers,' highlighting China's strong emphasis on cultivating intelligence and digital literacy in early education stages. This research is likely closely linked to national educational policies aimed at equipping students with foundational skills essential for future societal challenges.

In contrast, the WOS clusters reveal an international research community focus on higher education and professional development, such as '#0 ai literacy,' '#1 artificial intelligence literacy,' '#5 generative ai,' '#6 ai ethics,' and '#7 machine learning.' These clusters indicate global researchers are striving to build a deep understanding of AI technology and maintain high interest in the latest application progress within subfields like machine learning. The emergence of '#3 ai education' and '#4 early childhood education' further highlights the importance placed on teaching AI knowledge and skills across the educational system.

Synthesizing data from both CNKI and WOS, AI literacy research is gradually expanding globally, covering multiple educational levels from basic to higher education. Researchers are actively exploring methods to effectively integrate AI education at different stages to assess and enhance students' AI literacy, while paying high attention to its potential impact on future career development. Furthermore, educational equity and accessibility have been elevated as important agendas to ensure every student acquires the knowledge and skills necessary to adapt to the digital world.
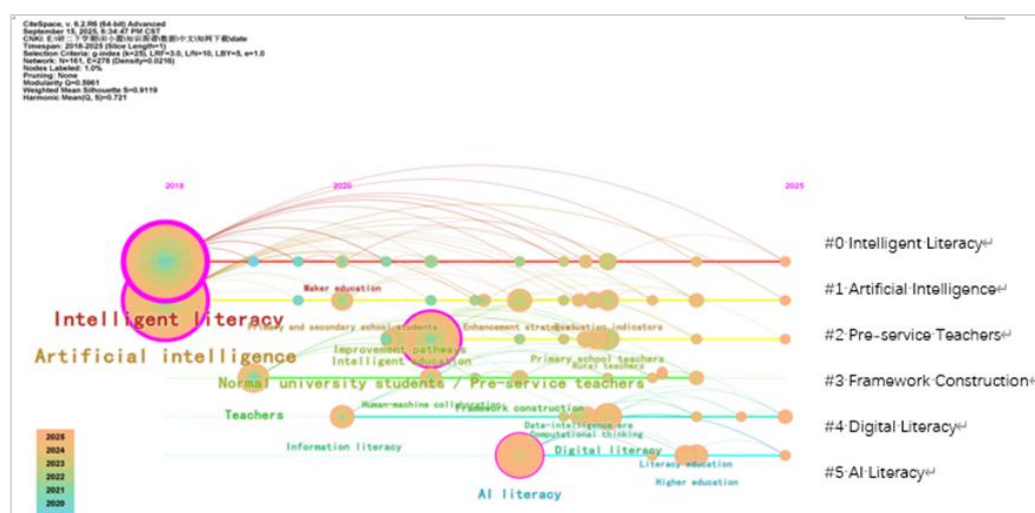

Figure 4 Keyword Co-occurrence Timeline Clustering Visualization (CNKI Database)
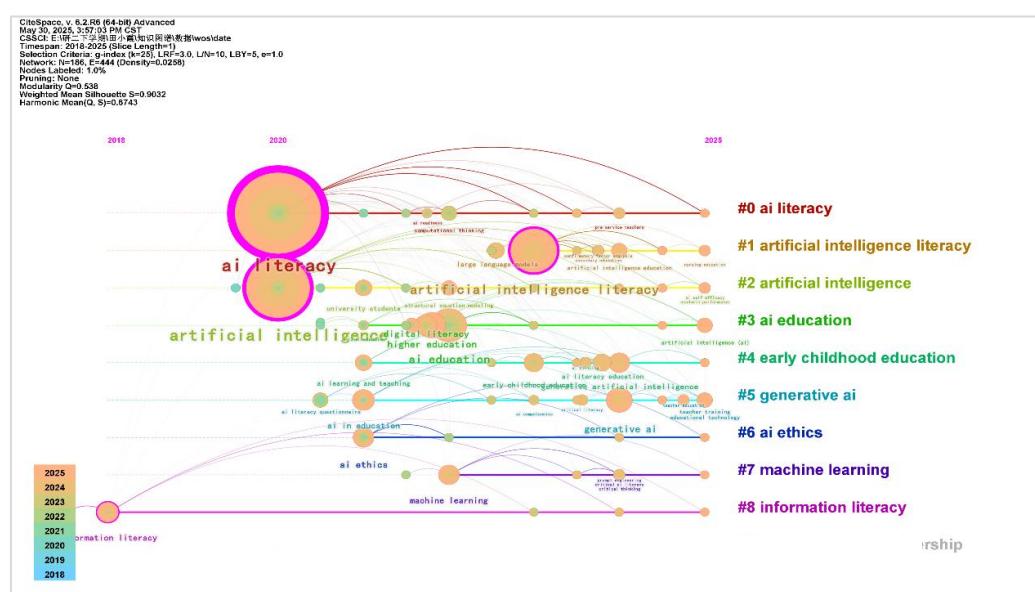

Figure 5 Keyword Co-occurrence Timeline Clustering Visualization (WOS Database)

4 KEYWORD BURST DETECTION ANALYSIS

This study employed CiteSpace to perform burst detection analysis on keywords in the AI literacy field, revealing the frequency, change trends, and growth cycles of keywords. This method not only showcases research hotspots across

different periods but also identifies burst terms characterizing each era. An increase in burst strength reflects a significant rise in the influence of research on related topics during specific periods.

The study selected the top 10 burst keywords ranked by strength, along with their start and end years, as shown in Figures 6 and 7. In the domestic (CNKI) sample, keywords like 'Intelligence Literacy', 'Teacher Education', 'Primary and Secondary Students', and 'University Students' exhibited relatively long burst durations (2-3 years) and remain research hotspots to date. Among the burst keywords in international (WOS) research, 'K-12 ai education' had a longer burst duration, while recent trends (last two years) include 'early childhood education' and 'large language models,' potentially signaling future directions for AI literacy development.

The burst words in domestic research show sustained attention to the role of educators and teaching methods. The long bursts for 'Teachers' and 'University Students' indicate the importance placed on cultivating AI literacy within the educational system. Concurrently, bursts for 'Core Competencies' and 'Teacher Literacy' reflect a focus on building foundational technological competencies, while the burst for 'Influencing Factors' reveals researchers' in-depth exploration of systematically enhancing student AI literacy. The sustained prominence of these keywords suggests the domestic research community is committed to integrating AI technology into the educational system and exploring effective pedagogical models and strategies.

At the international level, the long burst for 'ai education' indicates widespread academic attention globally. The burst for 'computational thinking' might relate to the role of AI technology in information acquisition, processing, and dissemination. The bursts for 'early childhood education' and 'large language models' signal potential future directions for AI literacy education, including innovations in educational models, updates to teaching content, and frameworks for assessing student AI competencies. The rising trend of these keywords may point to the deepening integration of AI technology in education and new understandings of learner competency requirements in this field.
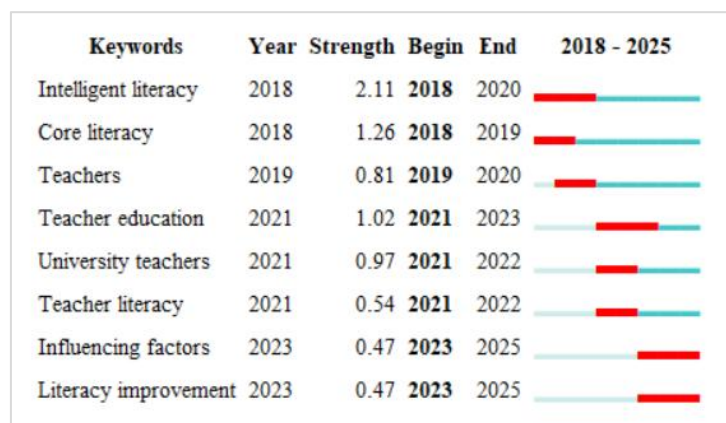
Keywords	Year	Strength	Begin	End	2018 – 2025
Intelligent literacy	2018	2.11	2018	2020	
Core literacy	2018	1.26	2018	2019	
Teachers	2019	0.81	2019	2020	
Teacher education	2021	1.02	2021	2023	
University teachers	2021	0.97	2021	2022	
Teacher literacy	2021	0.54	2021	2022	
Influencing factors	2023	0.47	2023	2025	
Literacy improvement	2023	0.47	2023	2025	

Figure 6 Keyword Burst Detection Map (CNKI Database)

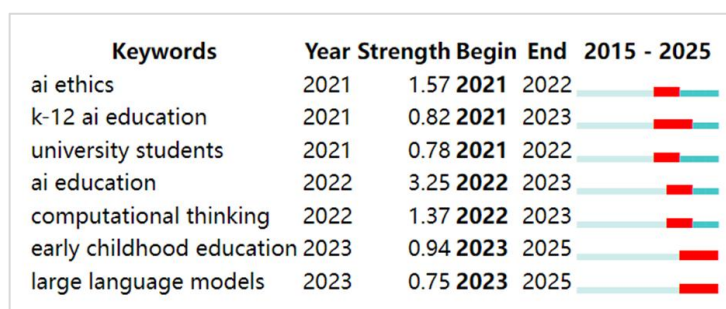| Keywords	Year	Strength	Begin	End	2015 - 2025
ai ethics	2021	1.57	2021	2022	
k-12 ai education	2021	0.82	2021	2023	
university students	2021	0.78	2021	2022	
ai education	2022	3.25	2022	2023	
computational thinking	2022	1.37	2022	2023	
early childhood education	2023	0.94	2023	2025	
large language models	2023	0.75	2023	2025	

Figure 7 Keyword Burst Detection Map (WOS Database)

5 CONCLUSIONS AND IMPLICATIONS

5.1 Conclusions

Leveraging the CiteSpace visualization tool, this study conducted a systematic and comprehensive analysis of 484 core publications on 'Artificial Intelligence Literacy' from the authoritative CNKI and WOS databases between 2018 and 2025. The findings indicate that research in the field of AI literacy not only exhibits a significant year-on-year increasing trend but also reveals pronounced differences in research focus and emphasis between domestic and international contexts. This provides a rich empirical foundation and theoretical insights for further exploring practical pathways in AI literacy education.

Firstly, observing the dynamic evolution of academic output, the number of publications focusing on AI literacy has shown continuous growth since 2018, with a particularly sharp increase occurring between 2022 and 2025. This phenomenon not only mirrors the rapid advancement of AI technology itself and its widespread application across industries but also highlights a significant rise in academic attention to AI literacy issues. Prior to 2018, although a

unified consensus on the concept of Artificial Intelligence (AI) had not been reached, it was generally defined as systems capable of simulating human intelligent behavior, encompassing functions like machine learning, problem-solving, and language understanding [15]. During this phase, AI technology showed initial promise but had not yet garnered widespread societal attention. However, 2018 marked a turning point in AI development, witnessing not only deep penetration of AI technology across multiple domains but also its elevation to a core component of national strategic plans in many countries [5, 16]. Therefore, this study selected literature from 2018 onwards as its sample to precisely capture the field's developmental trajectory. By 2022, the rise of generative AI, exemplified by ChatGPT, further accelerated the popularization and practical application of AI concepts [17]. In 2025, the advent of DeepSeek and its broad applicability, high autonomy, and creativity herald revolutionary impacts on the education system. Concurrently, China's rapid development and notable achievements in the global AI arena, securing the second position globally for three consecutive years [18], strongly demonstrate its substantial capabilities in this field. These milestone events collectively spurred the vigorous development of AI literacy research, leading to the explosive growth in publication numbers in recent years.

Secondly, the similarities and differences in domestic and international research foci provide valuable insights for the global promotion of AI literacy education. This study reveals that domestic research primarily concentrates on cultivating intelligence literacy among K-12 students and pre-service teachers, whereas international research leans more towards exploring AI literacy development pathways for university students. This divergence in focus may stem from differences in educational policy orientations, resource allocations, and socio-cultural environments across countries and regions [19]. However, precisely this diversity offers multifaceted research perspectives, facilitating a comprehensive and in-depth understanding of the complexity and diversity of AI literacy education. Domestically, given the critical role of K-12 students and pre-service teachers in future societal development, cultivating their AI literacy holds strategic significance for advancing educational modernization and enhancing national competitiveness. Hence, domestic research focuses on this group, actively exploring AI literacy education models and strategies suited to the national context. In contrast, international research places greater emphasis on university students' AI literacy development, likely due to the unique value of higher education in fostering innovative talent and driving technological progress [20]. By drawing on international advanced experiences, China's AI literacy education system can be further optimized, promoting its global dissemination and practice.

Finally, keyword co-occurrence and clustering analysis reveal the core themes and future development trends in AI literacy research. Through this analysis, this study identified 'Artificial Intelligence,' 'Intelligence Literacy,' and 'Digital Literacy' as core research hotspots, uncovering significant differences in research emphasis between the databases. In domestic research, keywords like 'Artificial Intelligence', 'Intelligence Literacy', 'Pre-service Teachers', 'AI Literacy', and 'Intelligent Education' appear frequently, indicating these topics occupy a central position. In international research, keywords such as 'ai literacy,' 'artificial intelligence,' and 'ai education' are more prominent, reflecting a strong international focus on AI ethics and AI literacy within higher education. Furthermore, burst detection analysis highlighted significant increasing trends for keywords like 'Intelligence Literacy', 'Core Competencies', and 'Teacher Literacy', providing key clues to understanding the field's developmental dynamics. These findings not only help grasp current hotspots in AI literacy research but also offer solid theoretical support for predicting future trends and formulating forward-looking educational policies.

5.2 Implications

In the current era of rapid technological advancement, artificial intelligence, as a key driver of future societal transformation, is becoming increasingly important. The education sector, as the cornerstone of societal progress, faces the urgent task of effectively integrating and promoting AI literacy education. Based on the current domestic and international research landscape, this study delves into the core value and implementation strategies of AI literacy education from six key aspects: strengthening AI literacy education in elementary education; promoting the integration of AI literacy education in higher education; focusing on equity in AI literacy education; enhancing interdisciplinary research and collaboration; addressing the ethical and societal impacts of AI technology; and building a lifelong learning system for AI literacy education. The aim is to provide theoretical support and practical guidance for formulating educational policies, optimizing resource allocation, and innovating teaching methods.

5.2.1 Strengthen AI literacy education in elementary education

Elementary education, as the core stage for constructing individual knowledge frameworks and forming value systems, holds irreplaceable strategic significance for shaping future digital citizens [21]. Domestic academia has widely demonstrated that cultivating AI literacy among K-12 students and pre-service teachers is a key element in building national global competitiveness [22]. In light of this, educational administrative bodies and schools should keenly grasp the pulse of the times and strengthen AI literacy education at the elementary education level.

Firstly, AI literacy education should be organically integrated into the elementary education curriculum system. This can be achieved by establishing specialized modules such as introductory AI courses, fundamental programming instruction, and data analysis skills training, aiming to spark students' interest and curiosity about AI technology and build their initial AI awareness framework. Such curriculum design must adhere to the principle of balancing theory and practice. It should not only impart foundational theoretical knowledge but also utilize advanced pedagogical models like project-based learning and inquiry-based learning, enabling students to deepen their understanding and mastery of AI technology through hands-on experience. Secondly, diverse practical activities should be carefully planned and

implemented. Examples include AI innovation competitions, robotics workshops, and seminars analyzing AI application cases. These activities promote students' deeper comprehension of AI principles through practical operation and help them acquire basic AI skills, covering problem-solving strategies, logical reasoning, and initial applications of machine learning. Crucially, ethical dimensions must be organically integrated throughout the educational process. Students should be guided to deeply contemplate the social responsibilities and ethical boundaries of AI technology, striving to cultivate them as digital citizens possessing both professional competence and ethical responsibility. This includes, but is not limited to, fostering awareness of personal privacy protection, educating about preventing algorithmic bias, and advocating for fairness in AI technology application. This lays a solid and comprehensive foundation for students to assume leading roles in the future digital society.

5.2.2 Promote the integration of higher education and AI literacy education

Higher education, as the core hub for knowledge innovation and high-level talent cultivation, holds immeasurable strategic value for driving the in-depth development of AI literacy education [20]. Simultaneously, AI, with its capabilities in powerful data processing, multimodal knowledge output, and efficient content generation, injects new ideas and momentum into talent cultivation in higher education. International research experience shows that higher education institutions, by integrating interdisciplinary resources, optimizing curriculum systems, and strengthening practice-oriented teaching strategies, can significantly enhance students' all-round AI literacy [23]. Based on this, Chinese universities should actively promote the integration of higher education and AI literacy education.

Firstly, actively explore and implement an 'AI + X' interdisciplinary education model. This involves deeply integrating AI technology into traditional disciplinary teaching, such as in cross-disciplinary fields like 'AI + Medicine,' 'AI + Law,' and 'AI + Finance,' aiming to cultivate versatile talents possessing both deep disciplinary expertise and proficiency in AI technology. This model seeks to break down traditional disciplinary boundaries, fostering cross-fertilization and integrated innovation of knowledge systems. Secondly, build new industry-academia collaboration platforms. Actively facilitate student participation in real-world AI project practices. Through project-driven pedagogy, this significantly enhances their innovative thinking and practical operational skills. It helps students apply theoretical knowledge to solve complex real-world problems while deepening their understanding of the current application status and future trends of AI technology across industries. Thirdly, strengthen faculty development. Proactively recruit and cultivate full-time teachers with AI disciplinary backgrounds to provide solid teaching and research support for AI literacy education. Teachers should possess profound AI theoretical knowledge and rich practical experience to guide students in deeply exploring the internal logic and broad applications of AI technology. This will drive the sustained high-quality development of AI literacy education and foster the cultivation of high-caliber innovative talent.

5.2.3 Focus on equity in AI literacy education

The 2023 Global Education Monitoring Report by UNESCO, Technology in Education: A Tool on Whose Terms? [24], highlights that globally, disparities persist in the ownership and benefits derived from technology. Technology has not yet truly fulfilled its potential in achieving educational equity and justice. Educational equity has always been a core concern for nations and people. Faced with rapid technological development and widespread penetration, while ensuring equal educational opportunities and fair resource distribution, emphasis must also be placed on digital education equity to eliminate the digital divide. This requires educational policymakers, when making decisions related to information technology, to start from the specific national context, the current situation and needs of learners, and the most disadvantaged groups. They must ensure the dividends of IT development are equally enjoyed by all, making technology a sustainable development enabler for everyone. Therefore, governments and all sectors of society should collaborate to ensure equitable access to AI literacy education mechanisms.

Firstly, formulate and optimize relevant policy frameworks. Strengthen financial support for schools in rural and remote areas, committed to building and improving digital infrastructure systems, encompassing computer labs, high-speed internet facilities, etc. This aims to effectively reduce the significant disparities in educational hardware between urban and rural areas and across regions, narrowing gaps in digital access and digital literacy. Secondly, focus on the diversified and differentiated development of educational resources. Design and develop a range of AI educational resources tailored to different age groups and diverse learning needs. These include, but are not limited to, interactive online courses, virtual simulation labs, and intelligent teaching materials. Leverage the broad connectivity of internet technology to achieve widespread dissemination and sharing of high-quality educational content, promoting balanced allocation of educational resources. Finally, deeply attend to the educational rights and needs of special student groups, particularly students with disabilities and those from economically disadvantaged backgrounds. By developing accessible learning platforms, implementing precise learning support strategies, and providing targeted grants and scholarship programs, tailor personalized learning pathways and assistive tools for them. Ensure these groups can equally participate in and benefit from high-quality AI literacy education, thereby promoting the comprehensive popularization and deep equitable development of AI literacy education.

5.2.4 Strengthen interdisciplinary research and collaboration

AI literacy education constitutes a highly complex and multi-disciplinary system. Its knowledge domain broadly encompasses academic fields such as computer science, education, psychology, and ethics [25]. Given this system's comprehensiveness and frontier nature, future research urgently needs to strengthen interdisciplinary collaboration mechanisms. This is essential to break down traditional disciplinary barriers and foster deep interaction, fusion, and collaborative innovation among different fields of knowledge.

Firstly, build interdisciplinary research communities. Focus on deeply exploring the essential characteristics of AI literacy, investigating effective cultivation strategies, and constructing a scientifically rigorous evaluation framework.

This will provide solid and systematic theoretical support for educational practice. Secondly, promote interdisciplinary teaching models. Initiatives such as offering interdisciplinary elective course modules and organizing regular interdisciplinary academic seminars can enrich the application scenarios of AI in teaching, deepen its integration with pedagogy, and enable students to grasp fundamental AI theories while gaining profound insights into their practical applications in other academic domains. Finally, strengthen international academic exchange and cooperation. Drawing on international advanced experiences while adapting them to the national educational context is an effective pathway for continuously enriching and optimizing the theoretical system and practical models of AI literacy education, thereby driving high-quality development in this field. In this process, attention must be paid to localized innovation, ensuring the effective translation and integration of international experiences to build an AI literacy education system aligned with China's national conditions.

5.2.5 Address the ethical and societal impacts of AI technology

Education is not merely the transmission of skills; it is also the shaping of values. AI technology possesses unique advantages but also brings negative consequences stemming from these advantages, a key one being ethical risks. Examples include academic integrity crises caused by rapid data generation and cybersecurity issues arising from 'black box' technology. Therefore, in promoting AI literacy education, the ethical and societal impacts of AI technology must be given paramount importance.

Firstly, employ diversified teaching methods such as in-depth case studies, ethics seminars, scenario simulations, and role-playing to stimulate students' critical thinking and moral reasoning abilities. This equips them with the capacity to rationally and comprehensively evaluate the dual nature of AI technology, avoiding both blind deification and irrational fear. Secondly, the education system should strengthen education for students on personal privacy protection, data security management, and identifying algorithmic biases. The aim is to guide students in constructing a scientifically sound framework for technological ethics, growing into AI users who are both technically proficient and deeply versed in ethical norms. This process concerns not only knowledge transmission but also the cultivation of a sense of civic responsibility for the future society. Finally, encourage students to actively participate in social practice projects, transforming their acquired AI knowledge into solutions for real societal problems. Examples include using AI to optimize public services, advance environmental protection, or enhance healthcare efficiency. Such practical activities not only deepen students' understanding of the social responsibilities associated with AI technology but also hone their sense of social responsibility and mission through practice. More importantly, by tackling real-world problems, students' practical abilities and innovative thinking will be significantly enhanced, laying a solid foundation for their diverse career development. Emphasizing the combination of ethics education and practical application is an indispensable pathway for cultivating AI-era talent with high ethical standards and a strong sense of social responsibility.

5.2.6 Build a lifelong learning system for AI literacy education

As AI technology continuously innovates and its application boundaries persistently expand, individuals face unprecedented challenges: the need to constantly update their knowledge structures and skill sets to adapt to the rapid changes in the social environment. In this context, constructing a systematic and continuous AI literacy education system is particularly crucial.

Firstly, the design of this framework should be based on a diverse, multi-layered learning ecosystem. Integrate various learning resources and platforms, including online courses, micro-courses, and MOOCs (Massive Open Online Courses), aiming to provide flexible, diverse, and content-rich educational opportunities for learners across a wide age range and professional backgrounds, meeting their personalized learning needs. Secondly, to further motivate individuals to engage in continuous learning and effectively assess their learning outcomes, establishing a comprehensive and flexible learning achievement recognition and transfer mechanism is essential. This mechanism should encompass multiple recognition pathways such as certification, credit accumulation, and degree conferral. It should also establish a system for the mutual recognition and transfer of learning achievements across different educational stages and career development trajectories. This ensures learners can navigate freely through diverse learning and development paths, achieving seamless connection and upgrading of knowledge and skills. Finally, building a lifelong learning system for AI literacy education is a systemic project requiring deep collaboration and joint participation from governments, enterprises, and all sectors of society. At the government level, relevant policies and regulations should be introduced to provide guidance and support for the popularization and deepening of AI literacy education. Enterprises should leverage their industry advantages to assist learners in skill enhancement and career transition through concrete measures like providing internship and training bases and employment guidance services. All sectors of society should actively participate in the research, development, and sharing of educational resources, jointly fostering an open, inclusive, and positive learning atmosphere and cultural environment, contributing wisdom and strength to the construction of the lifelong learning system.

In summary, AI literacy education, as a key strategy for addressing future societal challenges, is becoming increasingly prominent. Through implementing measures such as strengthening AI literacy in elementary education, promoting deep integration of AI education in higher education, focusing on educational equity, enhancing interdisciplinary research and collaboration, addressing the ethical and societal impacts of AI, and building a lifelong learning system for AI literacy, the goal is to construct a comprehensive, multi-layered AI literacy education ecosystem. Through multi-party cooperation and joint efforts, this will effectively propel AI literacy education towards greater depth and breadth, laying a solid foundation for cultivating high-quality, versatile talent adapted to future societal needs and contributing to societal progress and sustainable development.

Through analyzing the research hotspots, trends, and implications in the field of AI literacy, this study provides robust

data support and a decision-making basis for formulating educational policies, allocating educational resources, and innovating teaching methods. Future research should continue to monitor the development dynamics of AI literacy, constantly explore new educational models and evaluation mechanisms, and promote the popularization and enhancement of AI literacy education. Simultaneously, exchanges and cooperation with the international community should be strengthened to jointly address the challenges and opportunities brought by AI technology, contributing wisdom and strength to building a community with a shared future for mankind.

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