

Knowledge Graph Analysis of Educational Collaboration Research Based on CiteSpace

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Abstract: Based on the relevant articles from Chinese core journals and CSSCI source journals in the CNKI China Academic Journals Full-text Database from 1994 to 2024, this study utilizes CiteSpace for visual analysis of the knowledge graph structure of educational collaboration research in China. The visualization includes the distribution of publication years, authors, institutions, cooperation networks, and keywords in educational collaboration research. The results show that educational collaboration research in China has a long history with rich achievements, exhibiting a trend of continuous growth. Research institutions mainly consist of universities, vocational colleges, and research institutes, with insufficiently close collaboration among them. Key research topics include collaborative development, collaborative innovation, vocational education, higher education, ideological and political education, collaborative cultivation, Beijing-Tianjin-Hebei collaboration, and collaborative governance. The focus of research has shifted from general educational collaboration to regional educational collaboration, with an emphasis on higher education, vocational education, innovation and entrepreneurship education, teacher education, and continuing education collaboration. Future research should concentrate on theoretical and practical studies of educational collaboration mechanisms, teacher education collaboration, and educational collaboration evaluation.

Keywords: Educational Collaboration; CiteSpace; Knowledge graph; China

1. Introduction

Education collaboration is an essential foundation for promoting structural reform in educational governance, and coordinating various forms of collaboration is key to comprehensively enhancing the overall quality and efficiency of education. By investigating the mechanisms and models of educational collaboration, deepening communication and cooperation among collaboration entities, and better leveraging the strengths of all parties, new momentum will be injected into the development of the education system, propelling the education sector to new heights. Building upon this premise, this paper aims to utilize literature from the CNKI database on educational collaboration research as the basis for analysis, employing the information visualization software CiteSpace as the research tool. It seeks to analyze the current trends in educational collaboration research in China, construct a knowledge graph of educational collaboration research, delineate research hotspots and frontiers, discern evolutionary patterns, and explore the developmental trends of research, thus providing valuable insights for further exploration into educational collaboration.

2. Data Source and Research Methodology

2.1 Data Source

To ensure comprehensive accuracy and high interpretability of the original data, this paper selected Chinese core journals and CSSCI source journals from the CNKI China Academic Journals Full-text Database as the sample data source. The search terms *education collaboration*, *educational cooperation*, and *educational coordination* were chosen, with title as the search approach. The search period spanned from 1994 to 2024, resulting in a total of 478 documents retrieved. After excluding 72 documents consisting of conference notices, achievement introductions, book reviews, and other

irrelevant items, the study obtained 406 valid sample documents.

2.2 Research Methodology

This paper comprehensively employs the analysis software provided by the CNKI database and CiteSpace software to analyze the sample documents. Firstly, using the analysis software provided by the CNKI database, the annual distribution of the sample documents is initially analyzed, and trends in annual publication are depicted through graphical analysis. Secondly, Using CiteSpace to conduct corresponding data mining and quantitative analysis on the sample literature data, we extract the knowledge foundation of educational collaboration research in China, grasp the latest developments and frontier hotspots in this field, and subsequently discuss the directions for future research deepening.

3. Statistics and Analysis

3.1 Analysis of Publication Time Distribution

Research on educational collaboration in China has a relatively early history, with the first relevant literature appearing in 1994. From the perspective of development stages, Chinese research on educational collaboration has gone through two stages: the initial stage (1994–2011) and the development stage (2012 to present). During the initial stage, a total of 53 documents were published, with an average annual publication rate of 2.9 documents. The quantity of educational collaboration research publications was relatively low during this period, with annual publication numbers remaining relatively stable despite fluctuations. Although there was a gradual increase in the number of publications over the years, the overall research output was limited, indicating that educational collaboration research was in its infancy. In the development stage, a total of 353 documents were published, with an average annual publication rate of 27 documents. During this period, a large number of research outcomes on educational collaboration emerged, leading to a rapid increase in publication numbers. While there were occasional decreases in publication numbers in certain years, along with some fluctuations, the overall research interest remained consistently high. This suggests that educational collaboration research has gradually attracted attention and sustained interest from Chinese scholars, with a steady increase in publication numbers over time.(according to Figure 1)

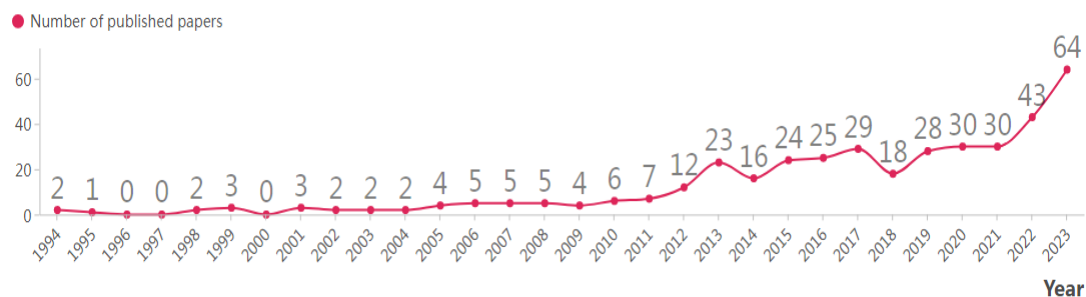


Figure 1: Trend chart of publication years for educational collaboration research articles

3.2 Analysis of Authors, Institutions, and Collaborative Networks in Publications

In the field of educational collaboration research, universities, vocational colleges, research institutes, and their scholars are the core forces driving research in this area. In terms of publication quantity, individuals engaged in educational collaboration research in China are relatively dispersed. The highest number of publications is attributed to Jinlong Sang (4 papers), followed by Kongzhen Li (3 papers), with other authors having published 3 or fewer papers each. Authors with three or more publications collectively account for only 0.005% of all authors, and there is little difference in the number of publications among them. In terms of author collaboration, several research groups have formed in the field of educational collaboration research, with authors such as Yijun Wang, Linqian Wu, Youran Yang, Bing Gao, Xingshu Hou, Binglin Zhong, and Qixuan Luo at their core. However, these groups have not yet formed a cohesive academic community with extensive inter-group communication and close collaboration.

In terms of research institutions, Beijing Normal University has the highest number of publications

in educational collaboration research (12 papers). Other institutions with five or more publications include Beijing Academy of Educational Sciences (11 papers), Capital Normal University (7 papers), East China Normal University (7 papers), Southwest University (5 papers), Tongji University (5 papers), and South China Normal University (5 papers). Jinlong Sang from the Beijing Academy of Educational Sciences and Kongzhen Li from Capital Normal University are representative scholars in their respective research institutions. Jinlong Sang primarily focuses on the strategic planning and systematic implementation of educational collaboration in the Beijing-Tianjin-Hebei region, while Kongzhen Li focuses on the management models for collaborative development in the Beijing-Tianjin-Hebei region.

From the collaboration among researchers and institutions in educational collaboration research in China, a core academic research group has formed with the Shanghai Institute of Educational Sciences as the nucleus. This group includes multiple research institutions such as the Shanghai Vocational Education Association, East China Normal University, and the Academic Committee of the China Higher Education Society, along with associated scholars such as Qin Wang, Chen Zhang, Shuchao Ma, and Lin Yang. They focus on the clustering of research topics around education modernization and conduct studies on the coordination and development of vocational education, as well as the coordination between vocational education and general education, along with corresponding strategies and solutions. Additionally, collaboration networks have emerged between the Beijing Academy of Educational Sciences, Capital Normal University, Nanjing Industrial Vocational and Technical College, and researchers like Bing Gao, Xingshu Hou, and Yipeng Tang. They concentrate on researching the practical characteristics, development trends, explorations of paths, and promotion strategies for educational collaboration in the Beijing-Tianjin-Hebei region. From the research cooperation network graph of educational collaboration (see Figure 2), the overall network density is 0.0032, which is lower than the normal level of 0.1. The total number of nodes for authors and institutions is 461, while the number of collaboration links is 339. The low and brief link density indicates that the collaborative connections between research institutions and authors in educational collaboration research are relatively dispersed, with a strong degree of independence. A more extensive and cohesive academic collaboration network has yet to be established.



Figure 2: Knowledge Graph of Research Collaboration in Educational Collaboration Research

3.3 Keyword Knowledge Graph Analysis

3.3.1 Co-occurrence Network of Keywords

Keywords are pivotal elements of research literature, reflecting the thematic content of the studies. By constructing a co-occurrence knowledge graph of keywords, one can grasp their frequency of appearance and relationships, thus understanding the research hotspots, trends, and knowledge structure in the field. Using CiteSpace's word frequency statistics feature, we identified the top 20 keywords with higher frequencies in educational collaboration research (see Table 1). The higher the co-occurrence frequency of keywords, the more they highlight the research significance and importance. The statistical results reveal that keywords such as *collaborative development*, *collaborative innovation*, *vocational education*, *higher education*, *ideological and political education*, *collaborative education*, *Beijing-Tianjin-Hebei*, *collaborative governance*, *collaborative mechanism*, *innovation and entrepreneurship education*, *continuing education*, *basic education*, *Guangdong-Hong Kong-Macao*

Greater Bay Area, teacher education, and college students have the highest occurrence frequencies. This reflects the focal points and changes in the areas of concern during the advancement and development of educational collaboration.

Using CiteSpace software, we generated a co-occurrence knowledge graph of keywords in educational collaboration research (see Figure 3). In the graph, larger nodes indicate higher keyword frequencies, while more connections between nodes represent higher co-occurrence frequencies. Thicker connections indicate stronger relationships. The graph consists of 399 nodes and 682 edges, with an overall density of 0.0086. Keywords such as *collaborative development, collaborative innovation, vocational education, higher education, ideological and political education, collaborative education, Beijing-Tianjin-Hebei, innovation and entrepreneurship education, collaborative governance, and collaborative mechanism* are positioned prominently in the graph. The connections between these keywords are long and thick, densely linking with other keywords. This indicates close associations among these keywords, occupying a central position in the entire knowledge graph. They represent core concepts in the field, serving as highly concentrated key themes in research with extensive literature support, signifying mature research in these areas. Furthermore, the graph shows relatively independent networks of connections between some keywords, reflecting the presence of sub-themes related to the core topics. These independent networks represent emerging research directions or potential research topics. Overall, compared to the collaboration network among research institutions, the structure and performance of the keyword co-occurrence network have been significantly optimized and enhanced. Its tight structure, high density, and prominent core themes fully reflect the diversity and complexity of research in this field. Future research should focus on strengthening research in potential areas represented by independent networks of connections to improve the knowledge structure in the field. This information is crucial for gaining deeper insights into the knowledge structure of the field and guiding future research directions.

Table 1: Ranking of High-Frequency and High-Centrality Keywords in Educational Collaboration Research

Serial number	Keyword	Frequency	Initial Year	Serial number	Keyword	Frequency	Initial Year
1	Coordinated development	44	2007	11	Innovation and entrepreneurship education	11	2017
2	Collaborative innovation	39	2013	12	Continuing education	8	2023
3	Vocational education	38	2010	13	Basic education	7	2009
4	Higher education	32	2007	14	Coordinated development of the Beijing-Tianjin-Hebei region	7	2017
5	Ideological and political education	31	2013	15	Guangdong-Hong Kong-Macao Greater Bay Area	7	2022
6	Collaborative education	26	2013	16	synergy	6	2013
7	Coordinated development	22	2003	17	mechanism	6	2006
8	Beijing-Tianjin-Hebei region	20	2015	18	Teacher education	6	2005
9	Collaborative governance	14	2016	19	Higher vocational education	5	2012
10	collaborative mechanism	11	2008	20	College student	5	2010

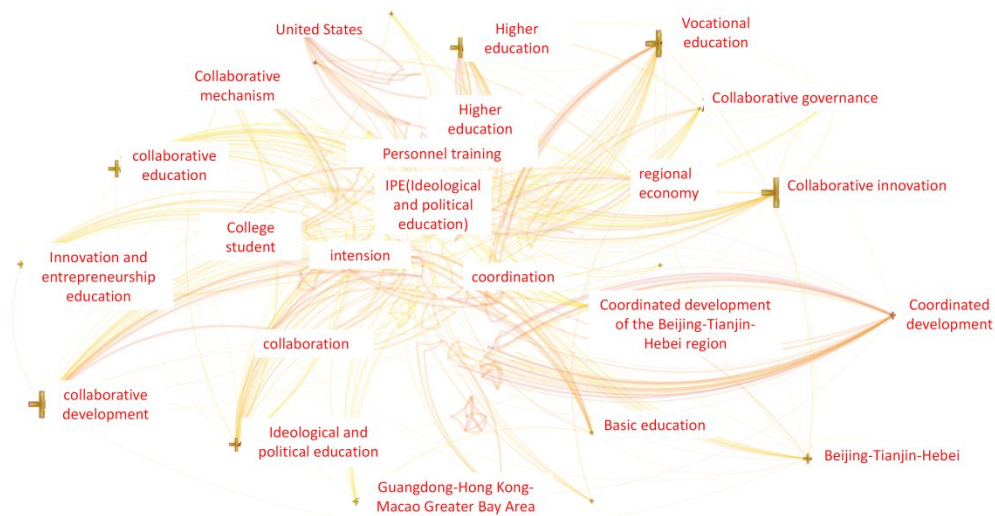


Figure 3: Knowledge Graph of Keyword Co-occurrence in Educational Collaboration Research

3.3.2 Cluster Analysis of Keywords

Based on the keyword co-occurrence graph, extracting cluster labels of educational collaboration research keywords allows for a deeper understanding of the research hotspots in this field. Utilizing CiteSpace software's clustering algorithm, we generated a keyword clustering graph of educational collaboration research (see Figure 4). It is generally accepted that a modularity value (Q value) >0.3 indicates effective clustering, and a weighted mean silhouette value (S value) >0.5 indicates reasonable clustering, with $S > 0.7$ suggesting credible clustering. In Figure 4, the keyword co-occurrence graph of educational collaboration research has $Q = 0.7556$ and $S = 0.9116$, indicating that this clustering graph is effective and has high credibility. As shown in Figure 4, the keyword co-occurrence graph of educational collaboration research forms 14 significant clusters of different sizes and colors: #0 Universities, #1 Beijing-Tianjin-Hebei, #2 Innovation and Entrepreneurship Education, #3 Regional Economy, #4 Higher Education, #5 Coordinated Development, #6 Collaborative Education, #7 Guangdong-Hong Kong-Macao Greater Bay Area, #8 United States, #10 Symbiotic Model, #11 Collaborative Development of Vocational Education, #13 Institutional Design, #14 Institutional Design, and #20 Institutional Design. Clusters are numbered from #0 to #20, and the numerical order of clusters indicates the decreasing volume of literature included in each cluster, with overlapping parts indicating close connections. Combining the keyword clustering graph with literature, the research hotspots in educational collaboration research can be categorized as follows.

One of the key research themes is theoretical research on educational collaboration. Representative keywords in this theme include *collaboration mechanism*, *regional coordination*, *management model*, *collaborative education*, *development path*, *institutional design*, and *collaborative assessment*. The research mainly explores the theoretical foundation, practical issues, mechanism research, practical paths, and response strategies of educational collaboration. The research believes that educational collaboration aims to maximize the public interests of education through negotiation and cooperation among multiple stakeholders^[1], leveraging the advantages of collective action and collaborative schooling. Currently, there are problems in various collaborative efforts in education, such as unclear rights and responsibilities of educational collaboration entities, inadequate coordination and communication mechanisms, uneven resource allocation, imperfect cooperation platforms, homogenization of talent cultivation, and inadequate supervision and evaluation. These issues have led to the failure to form a diverse collaborative pattern, the inability of various elements to effectively play their roles, the failure to achieve dynamic interaction at various levels, and the failure to achieve rational coordination of various value appeals. Overall, educational collaboration lacks long-term mechanisms, and the actual benefits of educational collaboration need to be improved. This is a prominent common problem in various forms of collaborative efforts in education. In response to these issues, the research suggests that educational collaboration should run through various fields and processes of collaborative work and promote collaboration from multiple dimensions such as mechanism, content, carrier, method, and evaluation. In terms of mechanisms, it is necessary to

establish organizational structures for collaborative work, clarify relationships between superiors and subordinates, between departments, and within departments, and clarify rights and responsibilities. It is also important to establish communication mechanisms, strengthen communication and liaison among various entities, normalize communication, promptly mediate conflicts, and coordinate multiple parties to reach consensus. In terms of content, educational collaboration can focus on teaching, scientific research, teacher training, and teaching resource construction. In terms of carriers, existing educational platforms in the region should be integrated, and emphasis should be placed on building digital education platforms to break down platform barriers across departments, disciplines, and regions. In terms of methods, advantage-led, regional linkage, and diverse collaboration are the main collaboration models^[2], characterized by highlighting features, adapting to local conditions, orderly cooperation, reasonable competition, advantage development, and achieving win-win results. This is specifically reflected in measures such as joint talent training, collaborative research and development, resource sharing, and emphasis on digital technology application. In terms of evaluation, third-party educational evaluation agencies should be nurtured to form a cross-regional monitoring and evaluation mechanism^[3]. In addition, policy, funding, institutional guarantees, etc., are also needed to sustainably promote collaborative work.

The second theme is the research on regional education collaboration. Representative keywords in this theme include *Belt and Road*, *Beijing-Tianjin-Hebei*, *Yangtze River Delta*, *Guangdong-Hong Kong-Macao Greater Bay Area*, *Suzhou-Wuxi-Changzhou*, *Industry-University-Research Collaboration*, *Institutional Design*, *Collaborative Cooperation Mechanism*, *East-West Collaboration*, *Regional Innovation System*, and *Internal Mechanism*. The research focuses on the current situation, challenges, and countermeasures of collaboration in basic education, higher education, vocational education, lifelong education, teacher education, and elderly education in regions such as Beijing-Tianjin-Hebei, Yangtze River Delta, Suzhou-Wuxi-Changzhou, and the Guangdong-Hong Kong-Macao Greater Bay Area.

In the field of education collaboration in the Beijing-Tianjin-Hebei region, attention is focused on the issues and strategies for collaboration in various areas including basic education, higher education, vocational education, teacher education, special education, and lifelong education. In basic education, prominent issues such as uneven distribution of resources are addressed by establishing a mechanism for balanced development. For instance, in Hebei Province, excellent resources from Beijing and Tianjin are attracted through forms such as establishing branch campuses of renowned schools and government procurement of educational services. Additionally, a unified training program for teachers and a rotational exchange mechanism for school principals and teachers across the three regions are proposed to enhance the quality of education and achieve balanced development^[4]. At the same time, it is proposed to establish a monitoring and evaluation mechanism for coordinated development of education to ensure effective implementation of policies in various regions^[5]. In higher education, challenges include uneven layout and quality, as well as a lack of coordination in talent scale, structure, and level. The specific implementation path is Overall planning, starting with the easy tasks, regional linkage, and overall improvement^[6]. Strategies involve implementing an overall plan to establish mechanisms for cross-school course selection and credit recognition, improving the sharing platform for online education resources, and promoting cooperation in joint educational programs to facilitate resource flow and sharing^[7]. In vocational education, issues such as uneven distribution and unreasonable program settings are tackled by establishing a collaborative management mechanism led by the government. Employment market demand is considered for optimizing the layout of institutions and majors^[8], and emphasis is placed on developing distinctive majors based on regional industrial advantages^[9]. In teacher education, policies conducive to teacher education are proposed along with the establishment of a collaborative development community. Support from Beijing and Tianjin to Hebei's teacher education is emphasized, and collaboration among industry, academia, and research in the Beijing-Tianjin-Hebei region is encouraged to support the construction of teacher education resources in the three regions^[10]. In special education, uneven distribution characterizes the prevalence of special education, as well as disparities in quality assurance factors such as teaching staff, funding, and school conditions. A lack of coordination in the development of special education hampers collaborative efforts in education cooperation and development. Addressing challenges in special education involves strategies such as improving collaboration mechanisms and promoting mutual sharing and development of special education resources in the Beijing-Tianjin-Hebei region^[11]. Lastly, in lifelong education, the management mechanism still needs to be streamlined, and social influence is insufficient. There is a heavy emphasis on educational content construction, with inadequate focus on researching the needs of learners. Evaluation indicators also need further refinement. These are the primary challenges currently faced in educational cooperation. strategies include establishing a collaborative development alliance

for lifelong education in the Beijing-Tianjin-Hebei region, focusing on planning, curriculum development based on audience needs, evaluation system improvement, and promoting family education and learning culture^[12].

In the Yangtze River Delta region, research on educational collaboration focuses on the main bottlenecks and breakthrough paths in collaboration in higher education, vocational education, and innovation and entrepreneurship education. In higher education, the fragmented administrative management mode and the absence of a regional integrated development mechanism hinder the integrated development of higher education in the Yangtze River Delta region^[13]. To address this issue, education collaboration should be guided by *the concept of playing as one and pursuing high quality*. Central coordination should be implemented to establish a multi-center operation and governance model involving the government, universities, and society. This model should integrate different types, levels, and characteristics of higher education resources, eliminate barriers such as regional division, resource monopolization, and inefficient talent mobility, and achieve free flow, efficient allocation, and complementary advantages of higher education resources and elements. In vocational education, administrative divisions between provinces and cities, imbalances in vocational education development, inconsistencies in skill talent training standards, and imperfect collaborative development mechanisms hinder the further integration of vocational education in the Yangtze River Delta. Currently, issues such as the lack of top-level design and organizational guarantees, uneven resource allocation, and a single cooperation model are prominent. To address this, it is necessary for provinces and cities to negotiate and form a policy system for integrated development, construct a new governance model, and establish mutually beneficial cooperation mechanisms. This can be achieved through the construction of regional vocational education cooperation alliances, regional industry-university cooperation alliances, and alliances for professional course and teaching cooperation. Implementation of measures such as course interoperability, credit recognition, joint development of textbooks, joint construction of professional standards, joint cooperation forums, and information service networks should be promoted to deepen vocational education collaboration^[14]. In innovation and entrepreneurship education, incomplete coordination mechanisms and policies, and difficulties in resource interoperability are the main problems faced by collaboration. Therefore, it is necessary to establish a coordinated mechanism to reduce the negative impact of local administrative protection and fragmented division on the coordinated development of innovation and entrepreneurship education. Collaborative construction of training bases, teaching platforms, and incubation platforms should be promoted to achieve shared educational resources^[15].

Research on educational collaboration in the Guangdong-Hong Kong-Macao Greater Bay Area focuses on the collaborative foundations, challenges, and strategies in various fields such as basic education, higher education, vocational education, innovation and entrepreneurship education, teacher education, and elderly education. In basic education, the main problems in educational collaboration include the lack of a mechanism for coordinated development of teachers, insufficient coordination and integration mechanisms for students, lack of micro-operational rules, and inconsistent educational evaluation rules. To address these issues, it is necessary to strengthen top-level design and systematically construct cooperation mechanisms. This includes establishing school alliances to deepen cooperation in basic education curriculum and teaching, creating a platform for teacher education collaboration communities to form a normalized linkage mechanism for teacher collaboration, innovating student collaborative cooperation models, and improving policy support systems to form institutional guarantee mechanisms. Cultivating third-party evaluation agencies and establishing a cross-regional monitoring and evaluation mechanism^[16] can promote the integrated development of basic education in the Guangdong-Hong Kong-Macao Greater Bay Area. In higher education, disparities in student sources, differences in industrial support levels and structures, and variations in international academic reputation constitute the realistic basis for collaborative efforts among Guangdong, Hong Kong, and Macao. Overcoming difficulties in education collaboration involves advancing resource transformation based on advantages, achieving collaboration based on differences, and innovating institutions on the basis of norms^[17]. Strengthening top-level design, institutional innovation, promoting coordination between higher education and industries, and enhancing internationalization are essential to promote the integrated development of higher education in the Greater Bay Area. In vocational education, the unique advantages of location, resource endowment, and diverse institutional patterns provide the resource foundation for collaborative development of vocational education in the Greater Bay Area. Utilizing existing resources to promote collaboration is a challenge faced by vocational education cooperation in the area. It is necessary to optimize innovative top-level design, optimize layout structures, construct strategic alliances for vocational education^[18], build characteristic professional groups for vocational education, promote balanced resource allocation,

and facilitate collaborative development of vocational education in the Greater Bay Area. In innovation and entrepreneurship education, weak interaction among double innovation organizations in universities and between these organizations and government and enterprise innovation bases, insufficient integration of industry and education, theoretical emphasis and single teaching methods in innovation and entrepreneurship education courses, and severe shortage of teaching staff are the main problems facing collaborative efforts in the Greater Bay Area^[19]. Universities should rely on the innovation and entrepreneurship resources and industrial characteristics of core cities in the Greater Bay Area, improve the collaborative mechanism among universities, society, and government, establish a hierarchical and classified system of innovation and entrepreneurship education, develop targeted courses integrating professional education and innovation and entrepreneurship education, and carry out teacher training^[20]. In teacher education, there are still many unresolved issues in collaborative development of teacher education in the Greater Bay Area. These include the lack of a long-term mechanism for collaborative development, differences in governance operations, and the formation of new cooperation forms. Strengthening the construction of first-class education disciplines and teacher education disciplines, optimizing the structure of teaching staff, improving the structure of training levels for undergraduate, postgraduate, and master's degree teachers, and enhancing teacher education and training efforts can promote in-depth educational cooperation in the Greater Bay Area^[21]. In elderly education, collaborative development of elderly education in the Greater Bay Area has a certain realistic basis, but there is insufficient coordination of resource elements, and high-level collaboration is still distant. To advance the collaborative development of elderly education in the Greater Bay Area, it is necessary to adopt the concept of collaboration as the guiding principle, resource collaboration as the path, and the establishment of a Greater Bay Area open university for the elderly as the carrier^[22]. This can promote collaborative development in elderly education across Guangdong, Hong Kong, and Macao.

Research on educational collaboration in the Suzhou-Wuxi-Changzhou region focuses on the value, challenges, and practical pathways of vocational education collaboration. Advancing vocational education collaboration in the Suzhou-Wuxi-Changzhou region is conducive to the construction of regional professional clusters, the integrated development of the Yangtze River Delta, and the promotion of high-quality development of vocational education. Currently, the asynchronous cooperation among governments, the lack of smooth integration between industry and education, and the issue of homogenized talent training are prominent, which hinder the development of vocational education collaboration in the Suzhou-Wuxi-Changzhou region. Therefore, it is necessary to strengthen government leadership, deepen industry alignment, promote collaboration between schools, optimize the layout of majors, and implement the simultaneous development of professional clusters and distinctive features to promote the development of vocational education collaboration in the Suzhou-Wuxi-Changzhou region^[23].

The third area of research focuses on collaborative innovation and entrepreneurship education. Representative keywords in this research theme include *collaborative development*, *innovation and entrepreneurship education*, *internal logic*, *innovation and entrepreneurship platform*, *collaborative mechanism*, *dual-teacher educational team*, and *professional practice*. The research explores the theoretical and practical aspects of collaborative innovation and entrepreneurship education among college students. It particularly targets higher vocational colleges and applied undergraduate colleges, examining the main characteristics, existing problems, and strategies for addressing them in collaborative innovation and entrepreneurship education among college students. The research also investigates the collaborative development of innovation and entrepreneurship education with different fields of education such as professional education, academic education, and labor education. The main features of collaborative innovation and entrepreneurship education include pluralistic subjects, common goals, and shared resources^[24]. Currently, issues in collaborative innovation and entrepreneurship education at universities include insufficient government coordination, inadequate consolidation of the core status of universities, insufficient activation of internal motivation within enterprises, and ineffective stimulation of students' enthusiasm for innovation and entrepreneurship^[25]. To address these issues, promoting collaborative innovation and entrepreneurship education at universities requires government-led construction of collaborative mechanisms, strengthening of faculty development to create dual-teacher educational teams, reforming innovation and entrepreneurship courses through methods such as establishing innovation and entrepreneurship clubs, building student entrepreneurship incubation parks, and organizing innovation and entrepreneurship competitions to inspire student enthusiasm, strengthening school-enterprise cooperation, integrating social resources, and leveraging the strength and role of enterprises in innovation and entrepreneurship education. In the research on the collaboration between innovation and entrepreneurship education and

different fields of education, labor education and innovation and entrepreneurship education have a collaborative foundation. The two share similar educational goals, complementary educational contents, mutual penetration of educational processes, and mutual promotion of educational methods. Innovation and entrepreneurship education serve as important carriers and effective tools for implementing labor education, at the same time labor education can provide value guidance and moral support for innovation and entrepreneurship education. They can promote educational collaboration through establishing collaborative educational goals, integrating collaborative curriculum systems, optimizing teacher resource allocation, and improving assessment systems. Research on the collaboration between innovation and entrepreneurship education and professional education indicates that current innovation and entrepreneurship education has not been integrated into the professional talent training system, lacks effective connections in educational content, and lacks effective methods and means in curriculum teaching. By reforming courses and teaching methods, creating and simulating enterprise scenarios, and triggering students' autonomous learning, these issues regarding the integration with professional education can be addressed^[26].

The fourth area of research focuses on vocational education collaboration. Representative keywords in this research theme include *collaborative development in the Beijing-Tianjin-Hebei region*, *collaborative development in vocational education*, *cooperation concepts and mechanisms*, *sharing of high-quality educational resources*, *empirical research*, and *policy tools*. The research explores the existing problems and countermeasures of vocational education collaboration from different perspectives, aiming to optimize and promote the overall development of the vocational education system to adapt to economic and social changes and demands. The research covers vocational education collaboration in different regions, education levels, education types, and education fields. In regional vocational education collaboration research, it involves collaboration in education among regions such as the Beijing-Tianjin-Hebei region, the Yangtze River Delta, Suzhou-Wuxi-Changzhou, the Guangdong-Hong Kong-Macao Greater Bay Area, the eastern and western regions, and the Jiaodong Peninsula. In vocational education collaboration research at different education levels, it explores collaboration between secondary vocational education and higher vocational education. In vocational education collaboration research involving different education types, it investigates collaboration among vocational education, higher education, and continuing education. The research believes that education collaboration is an important measure to improve the vocational education system and promote the high-quality development of vocational education. Mechanism construction is key to vocational education collaboration. Establishing a multi-subject collaborative architecture, improving the school-enterprise cooperation system, and perfecting modern vocational school systems are essential to form a new pattern of collaborative governance for vocational education with diverse participation, co-construction, sharing, and positive interaction among various parties, under the government's lawful management, schools' autonomous operation, and active participation and supervision from all sectors of society^[27]. In vocational education collaboration research at different education levels, issues such as vague talent training goal positioning and disconnection between professional content construction exist in the collaboration between secondary vocational education and higher vocational education^[28]. To address these issues, it is necessary to focus on demand orientation, coordinate the development of secondary and higher vocational education specialties based on regional development characteristics, and emphasize top-level design and systematic planning from aspects such as goal positioning, curriculum connection, faculty team, and enrollment system. In vocational education collaboration research involving different education types, higher education, vocational education, and continuing education, as three subsystems of the overall education system, have cooperative and competitive relationships in management, resources, etc. Collaboration among them needs to start from optimizing relationships, improving mechanisms for coordinated development, improving relevant laws, clarifying management authority, transforming investment mechanisms, optimizing quality evaluation, strengthening policy guidance^[29], and specific measures can be taken in areas such as exam enrollment classification interoperability, talent training integration interoperability, and education resource sharing interoperability^[30].

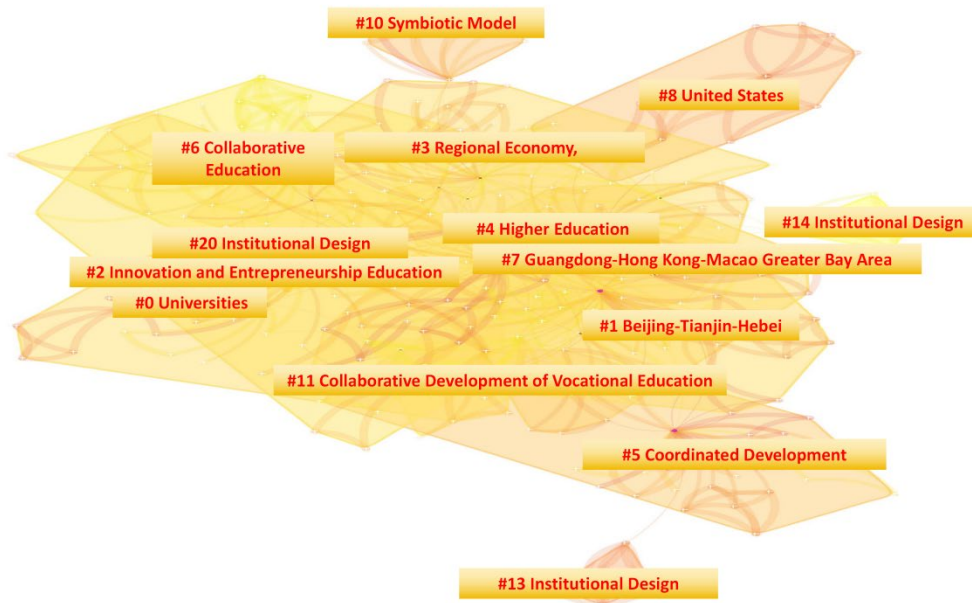


Figure 4: Clustered Keyword graph of Education Collaboration Research

3.3.3 Development Path of Keywords

Citation bursts of the keywords can reflect the influential research areas over a period of time. The list of keywords with citation bursts in the analysis of education collaboration keywords (see Figure 5) shows the distribution and intensity of mutations over the years. Building upon the keyword clustering analysis, the co-occurrence temporal graph of education collaboration research keywords (see Figure 6) is constructed to demonstrate the interactive relationships and evolutionary paths among clustered research areas in the field of education collaboration over time. Figures 5 and 6 collectively illustrate the evolutionary path of education collaboration research frontiers, highlighting the transition of main research themes in different years. Through the comprehensive analysis of academic literature, keyword co-occurrence temporal graphs, and knowledge graph of keywords with the strongest citation bursts, the forefront trends in the field of education collaboration research can be captured.

From Figure 5, it can be observed that the strength, start, and end times of each keyword in different time periods are as follows: *Coordinated Development* (4.54, 2003-2014), *Collaborative Innovation* (3.57, 2014-2015), *Beijing-Tianjin-Hebei* (5.12, 2016-2017), *Guangdong-Hong Kong-Macao Greater Bay Area* (3.49, 2022-2024), and *Continuing Education* (4.33, 2023-2024). *Coordinated Development* received significant attention from 2003 to 2014 but gradually declined thereafter. Although *Collaborative Innovation* garnered some attention from 2014 to 2015, its duration was short-lived. *Beijing-Tianjin-Hebei* and *Guangdong-Hong Kong-Macao Greater Bay Area* received considerable attention from 2016 to 2017 and 2022 to 2024, respectively, reflecting academia's focus on the educational collaboration development in these regions. *Continuing Education* exhibited high intensity from 2023 to 2024, indicating academia's emphasis on lifelong learning. These changes reflect the evolutionary path of education collaboration research and also reflect the changes in societal and governmental policy focuses.

This conclusion is also reflected in the co-occurrence temporal graph of keywords (see Figure 6). In the research encompassing the entire education sector, Cluster #5 focusing on Coordinated Development research shows a long time span and dense connections with multiple clusters, involving different educational levels (Cluster #0 Higher Education, #4 Higher Education), different educational fields (Cluster #2 Innovation and Entrepreneurship Education, #11 Collaborative Development of Vocational Education), different regional or national education (Cluster #1 Beijing-Tianjin-Hebei, #7 Guangdong-Hong Kong-Macao Greater Bay Area, #8 United States); the content of the research is cross-referenced with collaborative content (Cluster #6 Collaborative Education), collaborative models (Cluster #10 Symbiotic Models), and collaborative systems (Cluster #13 System Design, #14 System Design, #20 System Design). In regional education research, Cluster #1 Beijing-Tianjin-Hebei and Cluster #7 Guangdong-Hong Kong-Macao Greater Bay Area research have a relatively long duration, and they are closely connected with multiple clusters in terms of research subjects (Cluster #0 Higher Education), research fields (Cluster #2 Innovation and Entrepreneurship Education, Cluster #4 Higher

Education, Cluster #11 Collaborative Development of Vocational Education), and research content (Cluster #3 Regional Economy, Cluster #5 Coordinated Development, Cluster #6 Collaborative Education, Cluster #10 Symbiotic Models, Cluster #13 System Design, Cluster #14 System Design, Cluster #20 System Design).

Overall, in terms of education collaboration, research on overall coordinated development and regional education collaboration, such as *Beijing-Tianjin-Hebei* and *Guangdong-Hong Kong-Macao Greater Bay Area*, is relatively active and continues to receive sustained attention from academia. In future research, they will continue to deepen their research with diverse research content in different educational levels and fields, becoming forefront trends and research hotspots.

Top 5 Keywords with the Strongest Citation Bursts



Figure 5: Knowledge Graph of Keywords with the Strongest Citation Bursts in Education Collaboration Research

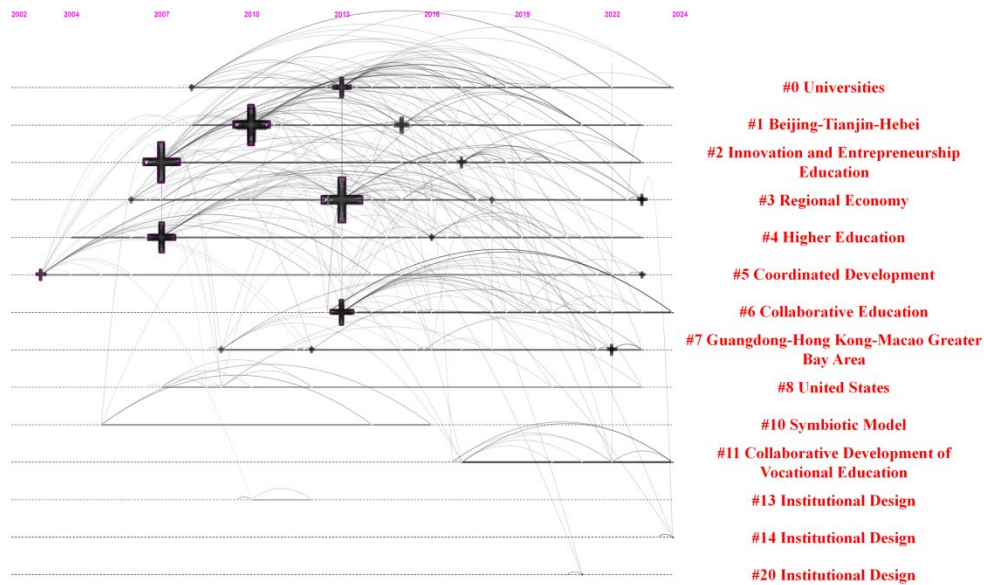


Figure 6: Temporal Graph of Keyword Co-occurrence in Education Collaboration Research

4. Conclusion and Future Prospects

4.1 Research Conclusion

This study conducted different levels of analysis and visualization research on the graph and related data of education collaboration research literature in CNKI from 1994 to 2024 using CiteSpace software, and drew the following conclusions:

The distribution spectrum over time shows that research on education collaboration in China started relatively early, beginning in 1994. Since 2010, the number of related research outcomes has gradually increased, indicating that education collaboration research has attracted significant attention and sustained interest from Chinese scholars. Overall, research on education collaboration is relatively abundant, showing a trend of continuous growth.

The spatial distribution graph shows that institutions participating in education collaboration research are mainly concentrated in higher education institutions, vocational colleges, and research institutes. Personnel engaged in education collaboration research are relatively dispersed, with independent research being predominant. Existing research institution collaborations are not sufficiently close, and there is a strong sense of independence. Measures need to be taken in the future to promote communication and collaboration among researchers and research institutions to strengthen the depth and breadth of education collaboration research and enhance its quality and impact.

The keyword co-occurrence graph indicates that the hot topics in education collaboration research include *collaborative development*, *collaborative innovation*, *vocational education*, *higher education*, *ideological and political education*, *collaborative education*, *Beijing-Tianjin-Hebei*, and *collaborative governance*. The keyword co-occurrence network structure is tight, with prominent core themes, fully reflecting the diversity and complexity of research in this field. In the future, researchers need to focus on studying the potential research areas represented by independent contact networks within the spectrum to improve the knowledge structure of this field.

The research frontier timeline graph shows that the research frontier of education collaboration is reflected in areas such as *coordinated development*, *Beijing-Tianjin-Hebei*, and *Guangdong-Hong Kong-Macao Greater Bay Area*. From the perspective of research development trajectory, the research content has shifted from collaboration research at the entire education level to regional education collaboration research, and the research focus has shifted from generalized education collaboration research to collaboration research in areas such as higher education, vocational education, innovation and entrepreneurship education, teacher education, and continuing education. Future research needs to further explore the theory and practice of education collaboration, expand more extensive research directions based on existing research, and continuously deepen research to enhance the practical effectiveness of education collaboration.

4.2 Research Prospects

Strengthening theoretical and practical research on education collaboration mechanisms is an urgent task in the current context of education collaboration. Breaking down barriers to interests is an important yet challenging issue in education collaboration, especially in multidimensional collaborations across departments, fields, and systems. Effectively balancing the relationship between horizontal cross-border cooperation and resource integration, as well as vertical cross-stage and full-process connectivity, is crucial for resolving conflicts and contradictions in multi-stakeholder collaborative governance. Therefore, it is essential to strengthen theoretical and practical research on education collaboration mechanisms, particularly focusing on optimizing the research on interest coordination mechanisms. In theoretical research, constructing a theoretical framework for interest coordination, analyzing the connotation, characteristics, and influencing factors of interest coordination, as well as the roles and interests of stakeholders. In-depth research on the design and operation of interest coordination mechanisms, exploring interest identification, balancing, and integration among different interest entities, as well as institutional arrangements and operational mechanisms for coordination mechanisms. Through in-depth theoretical research, provide theoretical support and methodological guidance for solving the problem of interest coordination in education collaboration. In practical research, conducting surveys on the interests, conflict points, and coordination needs of different stakeholders in education collaboration. Selecting representative education collaboration cases for in-depth analysis, summarizing the interest coordination mechanisms, problems, and challenges therein, as well as successful experiences and lessons learned. Participating in actual education collaboration projects, observing and documenting the process and effects of interest coordination, identifying problems in a timely manner, and proposing improvement measures. Additionally, organizing practical explorations of interest coordination mechanisms, attempting to establish and optimize collaboration platforms, deliberation mechanisms, etc., continuously accumulating practical experience and lessons, comprehensively understanding the actual situation and problems of interest coordination, finding effective solutions and strategies, and promoting the continuous improvement and development of education collaboration mechanisms.

Strengthening research on teacher education collaboration. Teachers are participants and promoters of education collaboration, playing important roles in the process. Currently, teacher education collaboration faces various challenges: lack of long-term mechanisms, with collaboration often remaining at temporary or project-based levels, lacking long-term stable mechanisms and institutional support, making it difficult for teacher collaboration to sustain and deepen; low participation of teachers, with some lacking understanding and willingness to participate in education collaboration,

lacking enthusiasm and initiative, affecting the development and effectiveness of collaborative activities; and uneven resource allocation, leading to greater challenges in teaching improvement and professional development for some teachers, and to some extent weakening the effectiveness and sustainability of education collaboration. In the future, it is necessary to strengthen research and practice in promoting long-term mechanisms for teacher education collaboration. Governments and education management departments should formulate relevant policies to provide institutional support and guarantees for teacher education collaboration. Establish teacher education development centers aimed at building long-term stable teacher collaboration mechanisms through normalized teacher training, research cooperation, secondment exchanges, and other project activities. Utilizing teacher education development centers as collaboration platforms to provide teachers with continuous opportunities for communication, learning, and cooperation, promote interaction and resource sharing among teachers, continuously promote the construction of a teacher community, consolidate consensus on teacher collaboration through teacher development, enhance the enthusiasm and initiative of teachers for collaboration, establish a cooperative atmosphere of mutual trust and support, and promote the long-term and sustainable development of education collaboration. At the same time, policy guidance and financial support from government departments and education management agencies are needed to promote rational resource allocation. By establishing cross-regional and cross-school resource sharing mechanisms, education resources can be complemented and shared, and the overall efficiency of education resource utilization can be improved.

Strengthening research on education collaboration evaluation. Education collaboration evaluation provides an effective monitoring and evaluation mechanism to ensure the quality and effectiveness of education collaboration work. Currently, there are certain deficiencies in research on education collaboration evaluation. Although the use of third parties for education collaboration evaluation has been proposed, there has not been sufficient in-depth research on the specific application of collaboration evaluation mechanisms, operational methods, and evaluation effectiveness. In the future, it is necessary to strengthen in-depth research on education collaboration evaluation. This includes establishing a sound evaluation mechanism, clarifying evaluation objectives, indicator systems, methods, and tools to ensure the scientific effectiveness of evaluation work. It is also necessary to explore the specific operational processes and methods of education collaboration evaluation, providing detailed operational guidance and practical experience for evaluation work. Additionally, emphasis should be placed on research into the application effects of evaluation results, exploring the specific application effects and impacts of evaluation results in policy formulation, practice promotion, and decision-making support. Furthermore, it is necessary to track the long-term effects of evaluation results to understand the role of evaluation in promoting the sustained development of education collaboration activities. In research, exploration of the application of new technologies in education collaboration evaluation should also be conducted to improve the efficiency and accuracy of evaluation work.

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