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Knowledge Graph Analysis of Innovation and Entrepreneurship Education Research in China

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Abstract: Cultivating innovative and entrepreneurial talents is crucial for providing innovative vitality support for the development of new productive forces. This study utilizes a knowledge graph tool, CiteSpace, to analyze innovation and entrepreneurship education in China visually. The goal is to comprehensively, scientifically, and objectively present this field's knowledge characteristics and research hotspots, providing valuable insights for researchers and collectively advancing the development of innovation and entrepreneurship education in China.

Keywords: Innovation and entrepreneurship education; Knowledge graph; CiteSpace; Visual analysis

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1. Research design

To better organize the research trends in the field of innovation and entrepreneurship education and ensure the academic representativeness of this study, the study selected high-level literature from the China Social Science Citation Index Database (CSSCI) as the data source. Using the theme keyword "Innovation and entrepreneurship education," this study conducted precise searches. After standardized screening, we ultimately obtained 1230 articles.

A scientific knowledge graph is an image that displays the development process and structural relationship of scientific knowledge based on the knowledge domain [1]. This study utilized the typical knowledge graph research tool CiteSpace to convert literature into recognizable data formats, with a time span of 1999–2021 and a 3-year time slice. All other settings were set by default.

2. Spatiotemporal knowledge graph and analysis

2.1. Analysis of annual document volume trends

The annual publication volume is an important indicator to examine a specific research field's development history and future trends. The research on innovation and entrepreneurship education has gone through four stages:

(1) The first stage, from 1999 to 2008, is a research exploration period, producing a total of 37 papers,

which attracted more attention from scholars studying innovation and entrepreneurship education in the next six years.

(2) The second stage, from 2009 to 2014, is the growth stage of research, with 198 papers in total. In 2015, China elevated entrepreneurship and entrepreneurship work to a national strategy, and the related research continued to increase.

(3) The third stage, from 2015 to 2018, is a period of rapid growth in research results, with an average of over 185 articles per year for three consecutive years and a total of 671 papers published.

(4) The fourth stage. Since entering the mature period in 2019, the number of publications has been at its peak and relatively stable compared to the previous period.

2.2. Co-occurrence analysis of publishing institutions

Academic productivity can be determined by the number of publications from research institutions, and core institutions can be identified through institutional co-occurrence networks [2]. Northeast Normal University has published a total of 45 articles, leading other institutions in terms of publication volume, with scholars such as Wang Z and Li Y as the main contributors [3–4]. Next are Zhejiang University, Wenzhou University, Tsinghua University, Xiamen University, etc. Further analysis shows that Northeast Normal University established the Innovation and Entrepreneurship Center in 2003, making it one of the earliest institutions to do so. In addition, institutions related to innovation and entrepreneurship education research are more concentrated in the Southeastern region of China, known for its active innovation and entrepreneurship activities. This suggests a strong correlation between research in this field and regional innovation and entrepreneurship activity. The co-occurrence analysis indicates that the collaborative knowledge graph has 65 nodes with zero connectivity and connection density. It signifies that indicating that current research on innovation and entrepreneurship education in China is mainly conducted independently, lacking cooperation among institutions.

2.3. Co-occurrence analysis of core authors

The co-occurrence analysis of core authors can demonstrate the collaborative relationship between the core author group [2]. Currently, the maximum number of published papers by authors is 19, and 13 scholars have published more than 5 papers. The knowledge graph shows 129 network nodes, 70 connections between nodes, and a connection density of 0.0085, indicating some degree of cooperation among individual scholars. Further analysis based on research institutions reveals that these collaborative relationships come from the same institution, with few collaborations across universities, disciplines, and professional fields. However, most scholars have limited connections and collaborations, and a collaborative model for joint research and publication has not yet been established.

3. Content knowledge graph and analysis

3.1. Research hotspots and trend analysis

Keyword co-occurrence analysis represents a common concern among researchers over a period of time. To ensure the completeness and rigor of the keyword clustering graph, combined with manual analysis, no keywords with poor correlation were found. The keywords with higher frequency include “Innovation and entrepreneurship,” “Entrepreneurship education,” “Universities,” “Talent cultivation,” etc. It can be seen that the cultivation of innovation and entrepreneurship ability is the core connotation of high-quality higher education [5] but the lack of relevant theoretical research makes it difficult to reach a consensus on the concept of innovation and entrepreneurship education [6].

Table 1. Keyword co-occurrence frequency, centrality, and age (top 20)

Number	Frequency	Centrality	Year	Keyword
1	194	0.35	2010	Innovation and entrepreneurship
2	161	0.41	1999	Entrepreneurship education
3	84	0.18	2008	Colleges and universities
4	72	0.17	2008	Personnel training
5	69	0.09	2008	University student
6	37	0.06	2009	Innovate
7	33	0.11	1999	Innovative education
8	29	0.09	2010	Vocational colleges
9	28	0.06	2010	Professional education
10	28	0.04	2007	Higher education
11	27	0.03	2008	Entrepreneurship
12	19	0.04	2012	Local universities
13	18	0.03	2003	Entrepreneurial ability
14	17	0.06	2014	Path
15	17	0.05	2015	Ecosystem
16	17	0.05	2015	Curriculum system
17	16	0.01	2015	Maker education
18	15	0.04	2001	Creative spirit
19	15	0.03	2015	Collaborative education
20	13	0.03	2010	Education

Keyword clustering analysis helps to better understand the structure and content of research hotspots in a research field [7]. Merge synonymous keywords such as “Chinese universities” and “University of China,” with a clustering map value of 0.75 and an average contour value of 0.9152. The clustering results are reasonable. According to the commonly used keyword clustering label extraction algorithm LLR, 17 clusters were generated.

The time point graph of keyword clustering can reflect a research field’s research evolution and development trend, as shown in **Figure 1**. The number of research nodes in innovation and entrepreneurship education has shown a decreasing trend, with key nodes gradually shifting from singularity to diversification and enrichment.

Table 2. Keyword Cluster Analysis

Cluster number	Cluster name	Scale	*S*-value	Average year	Label
0	Entrepreneurship education	43	0.988	2011	Entrepreneurship education (53.08, 1.0E-4); Innovation mode (11.85, 0.001); Fusion (11.85, 0.001); Innovation and entrepreneurship (8.84, 0.005); Practical teaching (8.78, 0.005)
1	Colleges and universities	40	0.903	2015	Universities (43.22, 1.0E-4); Ecosystem (36.01, 1.0E-4); Crowd Creation Space (17.91, 1.0E-4); Influencing factors (17.23, 1.0E-4); Chinese characteristics (13.41, 0.001)
2	Innovative education	37	0.916	2009	Innovation education (60.5, 1.0E-4); Quality education (24.97, 1.0E-4); Professional education (19.57, 1.0E-4); Innovative talents (15.46, 1.0E-4); Teaching reform (15.2, 1.0E-4)

Table 1 (Continued)

Cluster number	Cluster name	Scale	*S*-value	Average year	Label
3	Entrepreneurship	35	0.911	2013	Entrepreneurship (81.12, 1.0E-4); Innovation (75.87, 1.0E-4); College students (21.66, 1.0E-4); Cultivation mode (13.78, 0.001); Education (13.07, 0.001)
4	Innovation and entrepreneurship	30	0.857	2016	Innovation and entrepreneurship (100.26, 1.0E-4); Education system (26.16, 1.0E-4); Entrepreneurship education (14.25, 0.001); Innovation and entrepreneurship education (11.97, 0.001); Higher education institutions (11.16, 0.001)
5	Innovation ability	29	0.86	2010	Innovation capability (41.31, 1.0E-4); Entrepreneurial ability (36.43, 1.0E-4); Innovative spirit (35.19, 1.0E-4); Higher education (22.19, 1.0E-4); Operating efficiency (20.52, 1.0E-4)
6	Personnel training	28	0.925	2014	Talent cultivation (62.71, 1.0E-4); Integration of industry and education (21.8, 1.0E-4); Big data (16.18, 1.0E-4); Vocational education (10.77, 0.005); School enterprise cooperation (10.77, 0.005)
7	Vocational colleges	24	0.907	2013	Vocational colleges (46.36, 1.0E-4); Ministry of Education (17.36, 1.0E-4); Local universities (17.36, 1.0E-4); Ecosystem (12.97, 0.001); Integration of Engineering and Learning (11.55, 0.001)
8	Path	22	0.876	2016	Path (37.31, 1.0E-4); Maker Movement (24.53, 1.0E-4); Countermeasures (19.62, 1.0E-4); Question (18.35, 1.0E-4); Internet plus (18.35, 1.0E-4)
9	Collaborative education	21	0.925	2017	Collaborative education (21.82, 1.0E-4); The spirit of craftsmanship (13.3, 0.001); Ideological and political education (13.3, 0.001); Practice platform (13.3, 0.001); Practical exploration (9.55, 0.005)

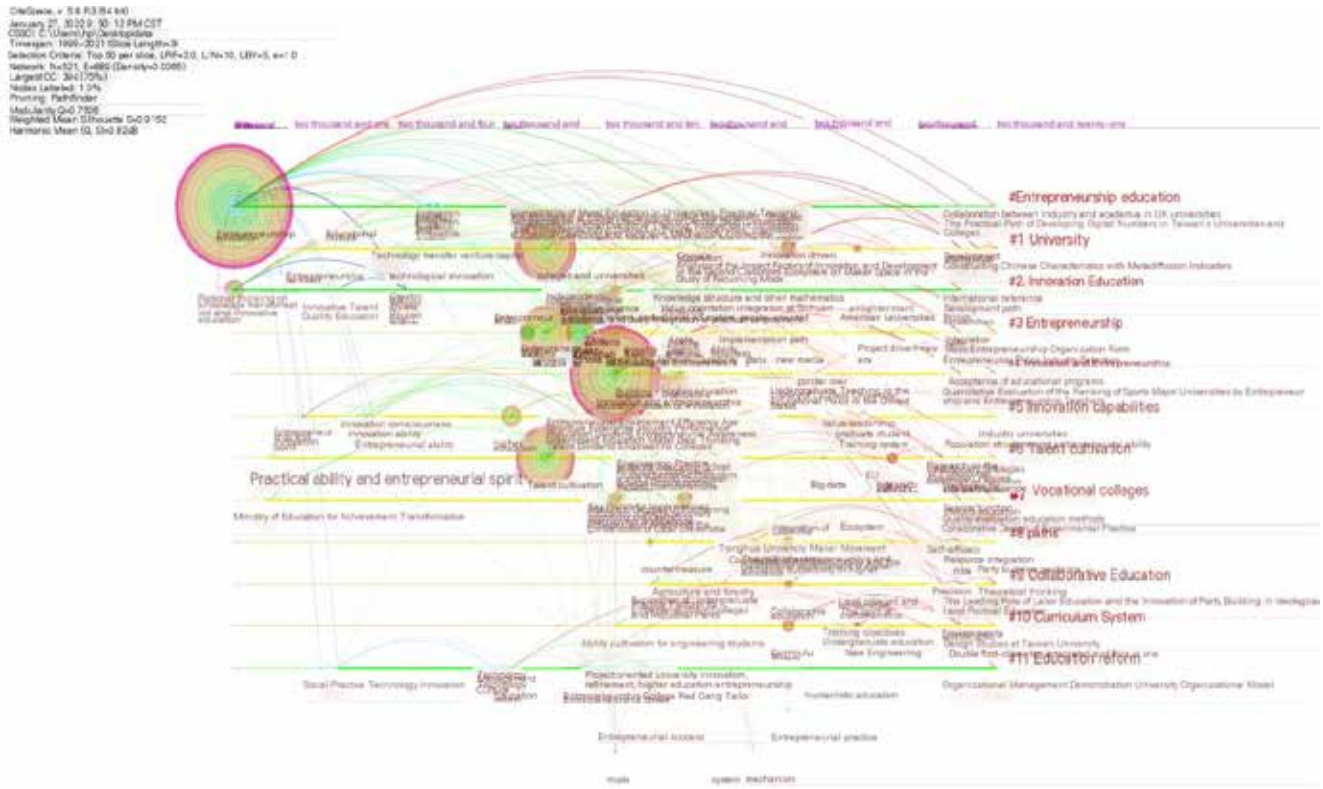

Figure 1. Keyword clustering time point graph.

3.2. Keyword trend analysis

Mutant words are words that appear frequently or frequently in a short period of time and can be used to determine the forefront and trends of the research field based on changes in word frequency [8]. Using the burst detect function, 19 mutated words were obtained. “Entrepreneurship education” and “Quality education” appeared in 1999 and 2002, respectively, and continued until 2016, indicating that entrepreneurship education has received attention. The key mutation words from 2008 to 2013 were innovation and entrepreneurship, indicating that innovative education has received academic attention. The key mutation words from 2017 to 2019 were innovation and entrepreneurship, new engineering, etc., indicating a shift in research perspective to talent cultivation in higher education institutions. Since 2017, with the emergence of key mutation words such as industry education integration and ideological and political education, it indicates that research on innovation and entrepreneurship education is expanding in depth, with more elements. Combining policies such as curriculum ideology and integration of industry and education, this paper explores the relationship between curriculum ideology and innovation and entrepreneurship education [9], industry education integration and innovation and entrepreneurship education [10], as well as innovation and entrepreneurship education and teaching reform [11], and innovation and entrepreneurship education in the era of artificial intelligence [12]. This will also be a hot research topic in the future.

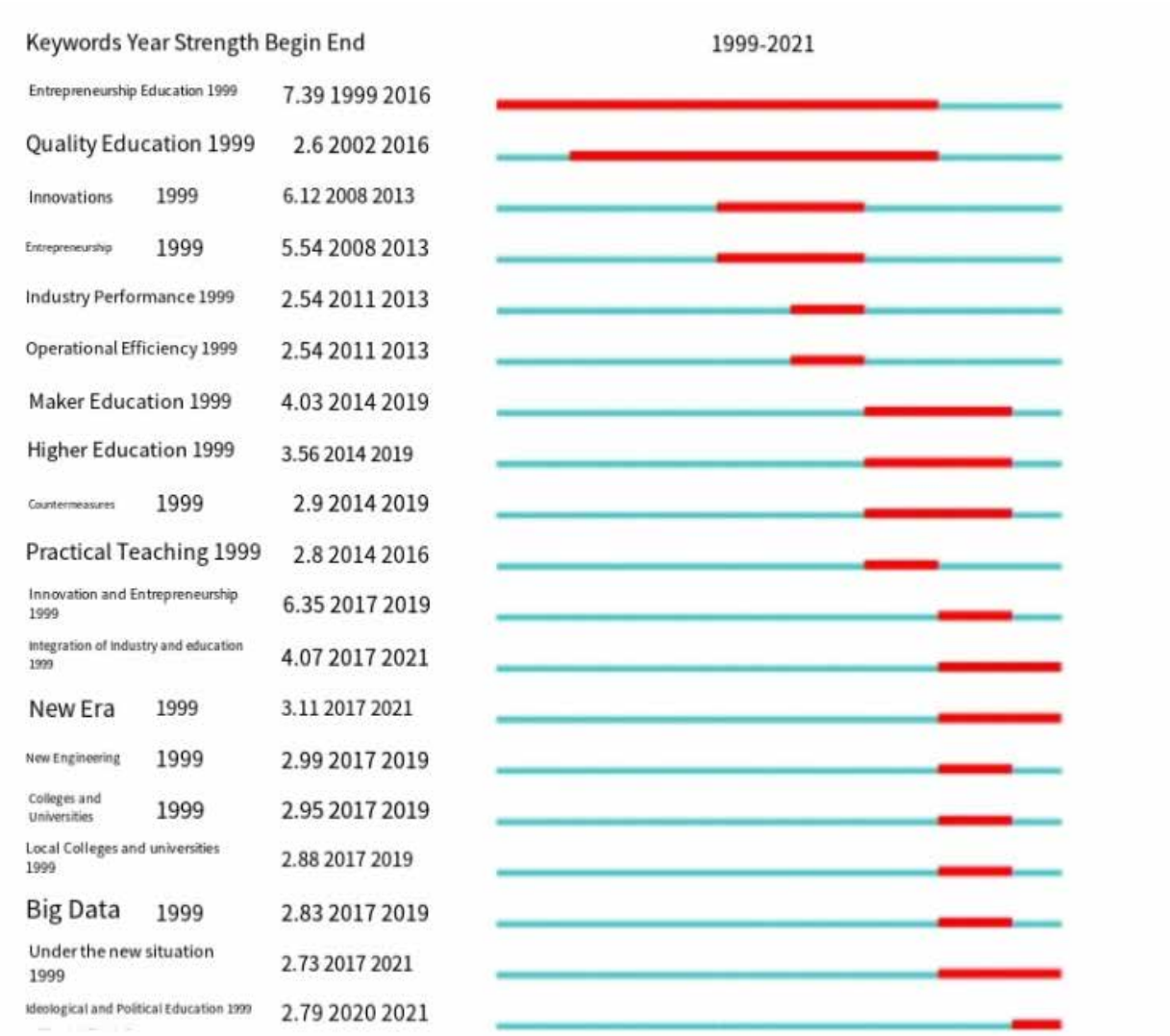

Figure 2. Key highlighting words: Top 19 keywords with the strongest citation bursts.

4. Conclusion and reflection

The spatiotemporal knowledge graph shows that research on innovation and entrepreneurship education in China began in 1999 and has accumulated relatively rich research results. However, even more involvement and focus from researchers are expected in the future, with many achievements [13]. From a spatial perspective, relatively many institutions are participating in research on innovation and entrepreneurship education, with influential research institutions and leading figures emerging, but there is relatively little cooperation. In the future, we can consider establishing a long-term mechanism to promote full communication and cooperation and promote a virtuous cycle of innovation and entrepreneurship education research.

The content knowledge graph indicates that the research hotspots are innovation and entrepreneurship education, talent cultivation, etc. However, the co-occurrence network structure of keywords is low in density and relatively loose. In the future, continuous attention should be paid to this field's research topics, content, and subjects [14]. The current research hotspots are shifting towards areas such as "Talent cultivation for innovation and entrepreneurship," "Integration of industry and education," and "Ideological and political education in the curriculum." This also witnesses the development of innovation and entrepreneurship education in China, reflecting the continuous enrichment of research themes, gradual diversification and expansion of research fields and scope. In the future, it is necessary to use new technologies to explore new research directions and carry out interdisciplinary and cross-disciplinary cooperation.

This study utilizes the CiteSpace tool to visually analyze the research topics of innovation and entrepreneurship education, providing some directions and suggestions for scholars to study the field of innovation and entrepreneurship education. The development of artificial intelligence has posed challenges to the demand for employment, and the cultivation of innovative and entrepreneurial talents is highly compatible with the talent needs of the artificial intelligence era [15]. Our proposition is that establishing clear innovation objectives, creating a conducive innovation environment, selecting appropriate innovation methods, and defining precise innovation content are essential prerequisites for innovation education. Cultivating innovation consciousness, innovative spirit, innovative methods, innovative abilities, and fostering practical innovation are integral to nurturing students' innovation capabilities throughout their educational journey. Future scholars can consider further analyzing innovation and entrepreneurship education both domestically and internationally. With the development of the economy and under the guidance of innovation and entrepreneurship policies in China, future research can delve more deeply into aligning closely with social development.

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References

[1] Chen Y, Chen C, Liu Z, et al., 2015, The Methodological Function of CiteSpace Knowledge Graph. Scientific Research, 33(2): 242–253.

[2] Hu Z, Sun J, Wu Y, 2013, Review on the Application of Knowledge Maps in China. Library and Information Work, 57(3): 131–137 + 84.

[3] Wang Z, 2015, Overall Concept of Innovation and Entrepreneurship Education Concept Transformation in Universities. China Higher Education Research, 2015(7): 75–78.

[4] Li Y, 2017, Investigation on the Current Situation of Entrepreneurship among Contemporary College Students and Research on Educational Guidance Strategies. Education Research, 38(2): 65–72.

[5] Wang H, 2021, Cultivation of Innovation and Entrepreneurship Ability: As the Core Connotation of High-Quality Higher Education. Jiangsu Higher Education, 2021(11): 21–27.

[6] Zheng Y, Yang Z, 2024, Institutional Dilemmas and Beyond in the Development of Innovation and Entrepreneurship Education in Universities. Higher Education Exploration, 2024(2): 23–30.

[7] Qin C, Hou H, 2009, Knowledge Graph: A New Field of Information Management and Knowledge Management. Journal of University Library, 27(1): 30–37 + 96.

[8] Wang J, Chen S, Wang L, Yang X, 2016, Research Hotspots and Trend Analysis of Education Big Data Based on CiteSpace. Modern Education Technology, 26(2): 5–13.

[9] Gu M, Ouyang Q, 2020, Construction of Innovation and Entrepreneurship Courses in Universities from the Perspective of Curriculum Ideology and Politics. School Party Building and Ideological Education, 2020(24): 71–72.

[10] Lu Q, 2018, Innovation Analysis of "Mass Creation Space" in Universities Based on the Integration of Industry and Education. China Youth Social Sciences, 37(3): 97–103.

[11] Xu Y, 2018, Exploration of the "Five Forces" Model for Cultivating Innovative and Entrepreneurial Talents. Chinese University Teaching, 2018(6): 81–85.

[12] Ma Y, Wang L, 2023, Innovation and Entrepreneurship Education in the Era of Artificial Intelligence: Value Orientation, Transformation Logic, and Practical Path. Education Research at Tsinghua University, 44(6): 115–124.

[13] Wang H, 2023, Innovation and Entrepreneurship Education: The Core Proposition of Higher Education Popularization. Journal of Sichuan Normal University (Social Science Edition), 50(5): 117–123.

[14] Yin G, Du H, Zhu Y, 2019, Construction of a Double Spiral Model of Innovation and Entrepreneurship Education Based on Co-Creation Between Teachers and Students: A Case Study of Zhejiang University. Higher Education Research, 40(8): 77–87.

[15] Khalid N, 2020, Artistic Intelligence Learning and Entrepreneurial Performance Among University Students: Evidence from Malaysian Higher Educational Institutions. Journal of Intelligent and Fuzzy Systems, 39(4): 5417–5435.