

# Research Progress and Trend Prospect of Industrial Colleges in China: A Bibliometric Analysis Based on CiteSpace

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**Abstract.** Industrial colleges in China are playing a vital role in promoting the integration of industry and education and fostering strong ties among industry, university, and research. To explore the hot spots and research trends within this domain, this paper analyzes 266 core journal papers included in the China National Knowledge Infrastructure from 2007 to 2022, employing the bibliometric tool software, CiteSpace. The analysis reveals a lack of leading research subjects, core authors, and core research institutions in Chinese industrial colleges. Consequently, the research field and topics require further expansion. Strengthening exchanges and cooperation between industries and universities is instrumental in building cross-organizational research teams and achieving in-depth exploration of the research areas.

**Keywords:** Industrial College Research; CiteSpace; Bibliometric Analysis.

## 1 Introduction

According to the “Guidelines for the Construction of Modern Industrial Colleges (Trial)” (No.16, 2020), the establishment of modern industrial colleges plays a crucial role in encouraging enterprises to actively participate in education and facilitating the integration of industry and education. Moreover, researchers view industrial colleges as a novel model of college-enterprise collaboration and a facilitator for industry and education integration [1]. This concept effectively elucidates the intrinsic relationship between “industry” and “education,” [2] making the construction of industrial colleges instrumental in advancing the talent training mode in universities. The exploration of industrial colleges commenced in 2007 in China, spearheaded by Yu [3] and Xu [4] from Zhejiang Technical Institute of Economics. Focusing on the theme of “industrial colleges,” their papers summarize the university’s practical experiences in harmonizing industry, education, and research to cultivate talents. In December 2017, the General Office of the State Council issued “Several Opinions on Deepening the Integration of Industry and Education” (No.95, 2017), marking the official introduction of the term “industrial college.” Subsequently, “industrial college” swiftly emerged as a new hot spot for academic research in the education domain.

This study aims to acquire insights into the research progress, trends, shortcomings, and other aspects concerning industrial colleges in China and provide a reference for further research in this field. To achieve these goals, we sort out the core journal papers included in the China

National Knowledge Infrastructure (CNKI) database from 2007 to 2022 and conduct a bibliometric analysis utilizing a bibliometric analysis tool, CiteSpace.

## **2 Data and methodology**

### **2.1 Data collection**

The research sample primarily originated from the CNKI database. To ensure more effective research outcomes, the author refined the sample documents by focusing on journals included in the “Chinese Social Sciences Citation Index (CSSCI)” and “Peking University Core Journal List (PKU Core).” Through manual screening, irrelevant content such as news and other works were excluded, and 266 core journal articles were finally obtained as the valid sample for this study. The sample data were downloaded and saved in RefWorks format, thus forming the research sample dataset, which comprised essential information such as the title, author, author’s organization, journal name, publication date, issue details, page numbers, abstract, keywords, and literature digital identification code (DOI).

### **2.2 Methodology**

The sample data underwent an extensive knowledge graph analysis with CiteSpace software (V6.2.R2) [5]. First, the basic settings of CiteSpace were configured, with the Time Slicing from January 2007 to December 2022 and the Term Sources for Text Processing, including the Title, Abstract, Author, Keywords, and Keywords Plus. Second, the author set the Link Strength of the mutual citation relationship among works to PMI, maintaining a standard value of 0.5. Additionally, to simplify the highlighting of the core structure and main features of the network, the pathfinder algorithm was employed to streamline the data network. After completing the basic settings, the author utilized CiteSpace to conduct a visual analysis of the relationships among the selected documents.

## **3 Data analysis results**

### **3.1 Core authors**

To gain information on the core authors and their academic relationships within the domain of industrial colleges, CiteSpace was applied to create a visualization map of the authors [6]. The analysis encompassed 266 documents, resulting in 183 author nodes and 119 links among the nodes, with a density of 0.0071 (Fig.1). The findings reveal a low and dispersed connection density among authors.

As shown in Fig.1, only a few significant author networks exist, and most of the authors in a network are affiliated with the same research institution. For example, there is a substantial network of authors, including researchers like Busong Yu, Wei Wang, Weiping Zhang, Liping Zhu, and Ziqin Wang, predominantly affiliated with the Zhejiang Technical Institute of Economics. Moreover, researchers from the Fujian University of Technology, such as Guomai Liu, Zhe Jiang, and Ning Li, form a rather stable internal institutional relationship network. Similarly, researchers from Guangxi Modern Polytechnic College, namely Yang Kui, Liu Zeting, and Pan Yang, constitute a relatively cohesive research team. These observations

indicate that by the end of 2022, cross-institutional researcher relationship networks in the field of industrial colleges have yet to manifest prominently



Fig.1. Author co-occurrence map of industrial colleges

Next, Price’s Law was employed to further analyze the core author group. Based on the law, the highest value of author publications in this study is three, while the lowest value is approximately 0.749 times the square root of the highest value, resulting in two publications. Consequently, authors with two or more publications can be identified as core authors in the field of industrial colleges. Notably, a total of 37 core authors meet the criteria, collectively contributing around 78 articles, which account for 29.32% of the entire sample literature. This percentage falls significantly below the standard in Price’s Law, which posits that “half of the papers on the same topic are written by a group of highly productive authors” [7]. The result further confirms that the core author group on the research of industrial colleges has yet to take shape.

### 3.2 Core institutions

CiteSpace was also used to generate a visualization map of research institutions. The results present a total of 146 research institution nodes in the 266 high-quality works, with 71 connections and a density of 0.0067 (Fig.2), demonstrating a low and scattered connection density among research institutions. As depicted in Fig.2, the institutional networks mainly consist of the relationship among different departments within the same institution, with only a handful of cross-institutional network relationships. For instance, Changshu Institute of Technology and Nanjing Normal University have established a cross-institutional research network on industrial colleges. A similar scenario exists between the Zhongshan Polytechnic and Hunan Academy of Education Sciences.

According to Price's Law [7], institutions that publish more than three papers within a research field are recognized as core institutions. Numerically, 19 institutions fulfill this standard, with a total of 86 papers published, accounting for 32.22% of the sample papers. However, this percentage falls considerably short of the standard of 50%, indicating that there is no core research institution group in this field yet



Fig.2. Institution co-occurrence map of industrial colleges

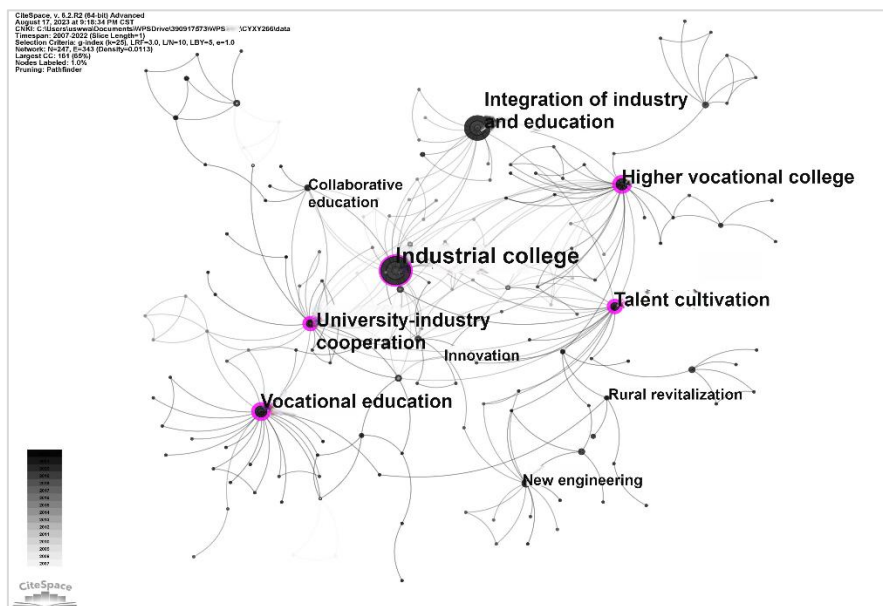
### 3.3 Research hotspots: keyword co-occurrence analysis

This study also utilized CiteSpace to visually analyze the literature keywords, which provided valuable insights into the distribution of research hotspots in the field of industrial colleges. Throughout the analysis, the threshold value of the keyword co-occurrence frequency was set to 4, and CiteSpace (V6.2.R2) was run to obtain the keyword co-occurrence map (Fig.3) and the keyword relationship list (Table 1). The results reveal a total of 247 keyword nodes and 343 links, indicating a density of 0.0113.

Centrality serves as a crucial indicator of the significance of keywords within the CiteSpace framework. Nodes with a centrality value exceeding 0.1 are classified as key nodes, denoting their significant influence in related fields [8]. As shown in Table 1, keywords with a centrality surpassing 0.1 include “university-industry cooperation (0.40),” “higher vocational college (0.34),” “talent cultivation (0.23),” “vocational education (0.22),” and “industrial college (0.17),” which essentially encapsulate the research hotspots on industrial colleges in China from 2007 to 2022. Meanwhile, Keywords with higher centrality values are highlighted in Fig.3. In appearance, these keywords notes show a very distinct outer ring, making them significantly different from other nodes [9].

**Table 1.** Keyword frequency and centrality

ID	Keyword	Co-occurrence frequency	Centrality	Year
1	Industrial college	119	0.17	2007
2	Integration of industry and education	88	0.07	2015
3	Higher vocational college	30	0.34	2012
4	Vocational education	26	0.22	2017
5	University-industry cooperation	22	0.40	2010
6	Talent cultivation	20	0.23	2015
7	New engineering	13	0.07	2018
8	Collaborative education	11	0.04	2013
9	Rural revitalization	5	0.04	2021
10	Innovation	5	0.02	2016
11	Double-high plan	4	0.06	2020
12	Higher vocational education	4	0.05	2008
13	System and mechanism	4	0.05	2013
14	Vocational college	4	0.04	2021
15	Specialty cluster	4	0.03	2015
16	Innovation and entrepreneurship	4	0.02	2019



**Fig.3.** Keyword Co-occurrence Map

### 3.4 Research content: keyword cluster analysis

To further examine the research content, the author utilized the log-likelihood ratio (LLR) to cluster keywords, which facilitated the creation of a keyword cluster map within the CiteSpace software (Fig.4). The figure indicates that the modularity value (Q) of 0.764, surpassing the 0.3 threshold, signifies a highly significant clustering outcome. Simultaneously, the weighted



Cluster topic	Cluster label and name	Cluster size	Outline value	Average year	Keywords
III	Industry Cooperation	8	0.960	2020	Mechanism; Multiple cooperation
	#7 Teaching Organization Community				Construction path; Double-high plan; Practice strategy; Value orientation
	#2 Vocational Education	24	0.954	2019	Long-term mechanism; Industrial college; Dual education; Board of directors
	#3 New Engineer-ing	21	0.921	2020	Rural revitalization; Symbiosis theory; Innovation and entrepreneur-ship; Integration of industry and education
	#5 High Quality	13	0.870	2016	Internal governance; Industry-university-research; Industry association; Function of industrial college

**Cluster topic I: exploration of the connotation and functions of industrial colleges.** This cluster topic mainly includes two key aspects: #1 Higher Vocational Colleges and #6 Connotation. Researchers examined industrial colleges from multiple perspectives, positing that these institutions can be regarded as a novel schooling mode, a fresh organizational form, and a pioneering facilitator for the integration of industry and education, etc. They believe that industrial colleges will play a pivotal role in nurturing technical and skilled talents.

**Cluster topic II: investigation into the construction path and management mode of industrial colleges.** This topic primarily revolves around #0 Integration of Industry and Education, #4 University-Industry Cooperation, and #7 Teaching Organization Community. As the research and practice of industrial colleges are still in their early stage, they exhibit diverse characteristics in terms of their construction paths and practical modes. Correspondingly, research findings in this field currently vary significantly. Colleges and universities can learn from different construction paths and modes, tailoring them to suit their specific needs in college construction and development.

**Cluster topic III: research on the operational mechanisms of industrial colleges.** This topic encompasses three aspects: #2 Vocational Education, #3 New Engineering, and #5 High Quality. The operational mechanisms and the basic operating principle of industrial colleges tend to diverge significantly among various colleges. Accordingly, research findings in this field exhibit a notable degree of differentiation. Colleges and universities should draw insights from diverse operational mechanisms, aligning them with their own development environment and trends.

### 3.5 Research trends: analysis of Burst keywords

The Burst function of CiteSpace software offers a valuable means to delve further into the research trends of industrial colleges (Fig.5). First, in terms of the duration of Burst words, “Work-study combination” boasts the longest duration (eight years, from 2007 to 2015) and a relatively higher burst intensity (1.75). Among the second-level Burst words, “higher vocational education” and “specialty construction” both exhibit a duration of seven years. Second, through examining the time nodes of Burst words, a significant watershed in

industrial college research was marked by Document No. 95 issued by the State Council in 2017. This watershed year divided the 15 keywords into two parts. Before 2017, Burst words mainly included “work-study combination,” “higher vocational education,” “higher vocational colleges,” “system and mechanism,” “long-term mechanism,” etc., indicating that research and practice primarily focused on vocational education. However, due to a lack of policy guidance, remarkable achievements in both research and practice were challenging to attain during that stage. In contrast, Burst words after 2017 primarily encompass “independent legal person,” “governance structure,” “organization structure,” “colleges with specialty,” “collaborative education,” “organization characteristics,” etc., suggesting a more profound level of research. During this period, numerous universities began to build and operate industrial colleges under the guidance of the policies.

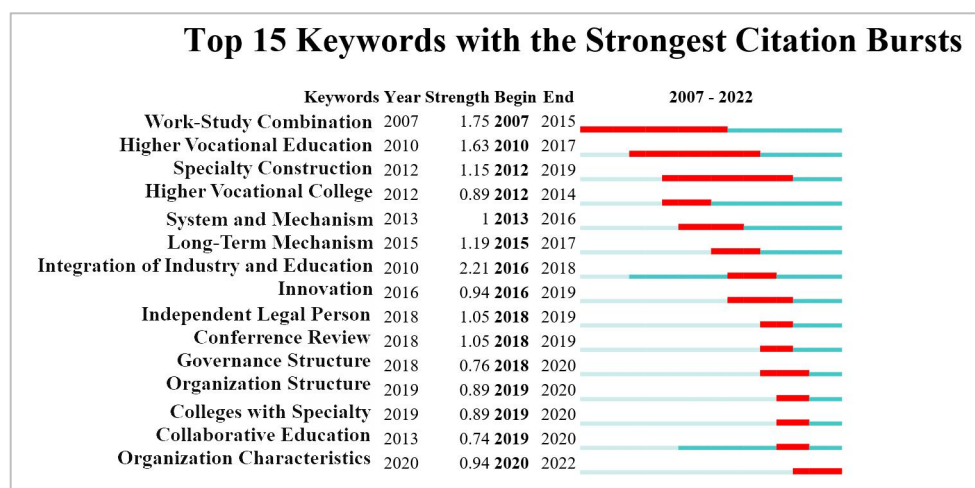


Fig.5. Map of Burst keywords

## 4 Conclusions and suggestions

### 4.1 Conclusions

**Core authors and core research institutions have not yet emerged.** In the field of industrial colleges, the quantity of high-quality literature has been steadily increasing over the years, establishing a robust theoretical foundation for further research. However, a lack of core researchers, core institutions, and cross-institutional research networks in this field indicates that most researchers are still operating in isolation, hindering the development of systematic research findings.

**Research topics require further expansion.** In addition to the existing research topics, it becomes evident that sufficient attention should be devoted to the stakeholders’ demands, the quality evaluation of industrial colleges, and the influencing factors of college construction and operation. In other words, it is necessary to further augment the research topics.



## 4.2 Suggestions

**Promotion of Cooperation and High-level Research Teams.** Researchers and research institutions tend to concentrate on their familiar areas, resulting in challenges in obtaining holistic and systematic achievements in the fields of industrial colleges. Therefore, it is advisable to enhance cooperation among research subjects (researchers and institutions) through academic exchanges and the establishment of cross-organization research teams to complement each other's strengths and achieve breakthroughs.

**Expansion of Research Fields and Topics.** The current literature mainly delves into macro research fields of industrial colleges, such as the connotation, roles, construction paths, and management mechanisms. While these findings theoretically enlighten the development direction of industrial colleges, their practical applicability is somewhat limited in the actual functioning of these colleges. Contrariwise, there is a significant demand for research achievements on influencing factors of the construction of industrial colleges, the quality evaluation system of their operation, talent cultivation mechanisms, teacher training protocols, etc. Therefore, it is suggested to promptly expand research topics to encompass these areas.

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