

Research Hotspots and Frontiers of China's Higher Engineering Education Certification

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Keywords: Engineering certification; Engineering education professional certification; Engineering certification knowledge map; Cluster analysis

Abstract: [Objective] Through the analysis of engineering certification research literature, explore the development trend of engineering certification research in China. Provide a reference for the sustainability of engineering certification. [Methods] CNKI literature was selected as a sample to conduct quantitative analysis and visualization of the published volume, author institution cooperation network and high frequency keywords, and cluster analysis of domestic research hotspots to study the hot development trends. [Results] The number of publications has increased year by year, the authors are unevenly distributed, and multi-author cooperation is more common. Engineering ability and teaching reform are the main research objects. [Conclusion] The future development direction of China's higher engineering education is dominated by teaching reform, engineering practice is the core, and its content is "curriculum reform" and "engineering practice" that are compatible with engineering education reform.

1. Introduction

Engineering education professional certification is an internationally accepted quality assurance system for engineering education. It is also an important basis for achieving international mutual recognition of engineering education and international recognition of engineer qualifications. The core of engineering education professional certification is to confirm that engineering graduates meet the industry-recognized established quality standards, which is a qualification evaluation based on training objectives and graduation export requirements[1]. The degree of perfection of engineering education professional certification needs to be strengthened in China, and deepen the multi-faceted cooperation between schools and enterprises to develop a sound system. With the development of the quality assurance movement of higher education, the field of engineering certification has received more and more attention from scholars in recent years[2]. This paper uses Cite Space software, combined with the literature to conduct quantitative analysis and cluster analysis of engineering certification research, grasp the research status of domestic authors and institutions, and analyze the research hotspots in this field.

2. Research Method

Information visualization technology is a kind of document measurement method. It visualizes the relationship between documents and documents through knowledge maps to discover the research status and development law of a certain field[3]. Through the visualization software Cite Space V, the papers related to "Engineering Certification" in CNKI are analyzed by the authors' cooperative network, and the research results of domestic high-impact authors and high-yield institutions are mastered, and the keywords are measured and statistically obtained, and high-frequency keywords are obtained. It conducts cluster analysis and obtains research hotspots and development trends in the field of domestic engineering certification research.

3. Data Sources

In this study, the CNKI database is used as the source of literature statistics, and the "engineering certification" is the key word. The advanced search is not limited to the search period (the search date is March 1, 2019). A total of 123 documents related to engineering certification have been selected. These documents were used as research samples for data analysis. With the help of CNKI's own database, the publication time, country/region, citations, cited documents and citations of related documents are obtained. The sample of measurement visualization analysis collects the annual volume of publications, the annual trends of publication, and the volume of publications of each research topic. This will analyze the time, spatial distribution and research hotspots in the field of engineering certification[4].

4. Engineering Certification Research Analysis

4.1 Trends in the Issue Volume of Engineering Certification Studies.

The time distribution of research publications reflects the domestic enthusiasm for engineering certification research in different time periods, as well as the government's emphasis on engineering certification and investment in research funding. In this paper, using the statistical visualization of CNKI database literature, the paper publishes the statistics according to the time distribution. As shown in Figure 1, it reflects the amount of publications on engineering certification research in 2014-2018, and the domestic research engineering certification began to contact in 2009. Engineering certification research was slow during 2009-2014. Engineering certification research was developed during 2015-2016. In 2017-2018, there is a rapid development trend. Since the beginning of a literature on engineering certification research in 2009, 32 articles in 2017 and 58 articles in 2018, the year-on-year growth in the volume of publications has shown the rapid development of research in this field, indicating that international scholars have paid attention to engineering certification research.

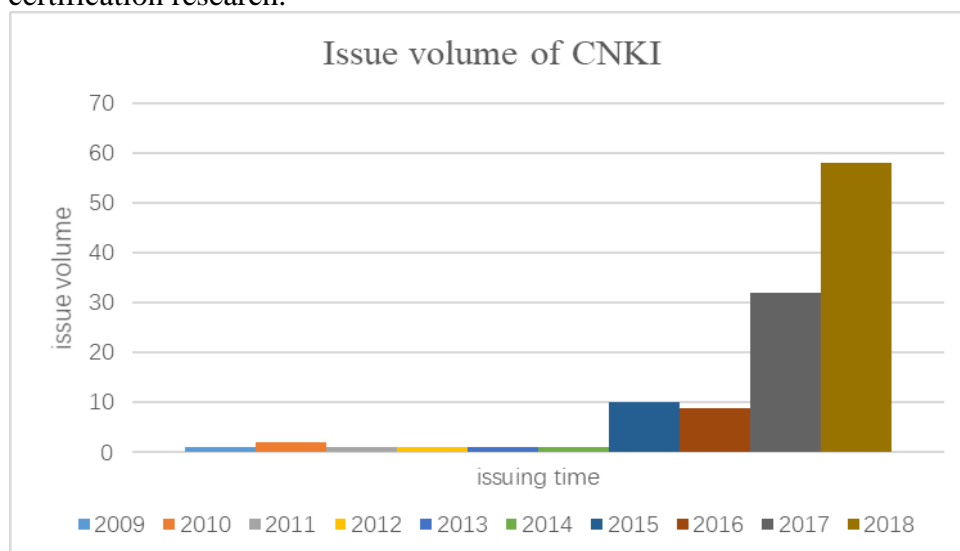


Figure 1. CNKI Issue statistics

4.2 Distribution of Research Institutions for Engineering Certification Research.

The author's institutional collaboration network reflects the level of focus of high-impact authors and high-yield institutions in this area. This paper uses Cite Space to conduct a co-occurrence analysis of the author's organization network[5]. The cooperation organization network diagram is shown in Figure 2. Each node represents the author and the organization, and the node size represents the author's influence and organizational output. The connection between nodes represents the author and author, author and institution, institution and institution. The largest output organization is

Beijing University of Architecture, followed by Shenyang University of Chemical Technology, Xihua University, Tongji University and Xuchang College. From the perspective of the types of universities, universities of science and engineering such as Beijing Jianzhu University and Shenyang University of Chemical Technology are at the forefront of research institutions. It can be seen that the engineering certification research strength is consistent with the strength of the school's engineering. From the perspective of the regional distribution of colleges and universities, there are 3 in the eastern region and 1 in the western region. It can be seen that the eastern universities are the main force in engineering certification education research. This is closely related to the imbalance of China's economic development level and the location distribution of colleges and universities. From the perspective of secondary research institutions, the Beijing University of Architecture Academic Affairs Office, Beijing University of Architecture Water Environment National Experimental Teaching Demonstration Center, Shenyang University of Chemical Technology School of Environmental and Safety Engineering, Tongji University School of Materials Science and Engineering, Xihua University Materials Science and Engineering The college has a large number of documents, which is an important force in engineering certification research.

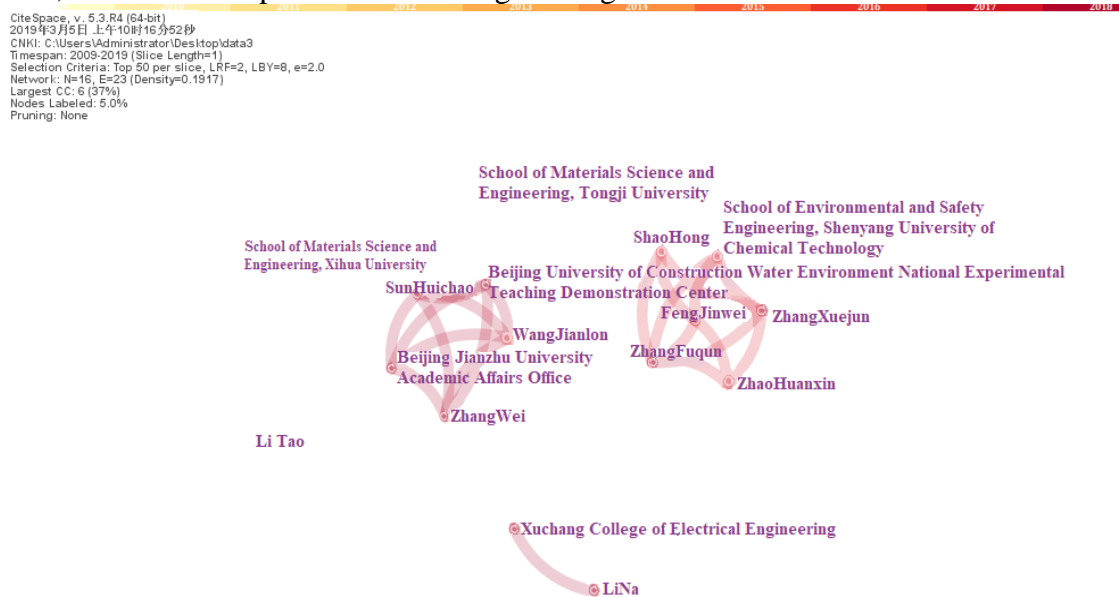


Figure 2. Author institution cooperation network

4.3 The Core Author of Engineering Certification Research.

There are 10 authors who have published more than 2 engineering certification research articles, including Zhang Fujin (2), Zhang Xuejun (2), Feng Xiaowei (2), Li Tao (2), and Li Na (2). Zhao Huanxin (2), Sun Huichao (2), Zhang Wei (2), Wang Jianlong (2), Shao Hong (2). From the perspective of the author's unit distribution. The core authors are mainly from universities with strong engineering strengths. Among them, Shenyang University of Chemical Technology has five core authors and Beijing Jianzhu University has three core authors. At the same time, from the perspective of co-authoring the thesis, about 70% of the papers are completed by three or more authors. This is closely related to the systematic nature of talent training in engineering education, the integration of industrial production, and the laws, characteristics and research paradigms of engineering science[6]; At the same time, from the distribution of the author's work units, engineering certification research is forming a new pattern with the participation of engineering researchers, education administrators and government administrators[7].

4.4 Hot Spots and Trends in Engineering Certification Research.

The key words are the refinement of a research topic and a high-level summary of the core ideas of the article. This article uses Cite Space to count the keywords with a frequency greater than 4. As shown in Table 1. The highest frequency is engineering certification (121 times), followed by

teaching reform (22 times) and practical teaching (8 times).

Table 1 High frequency keywords

Count	Centrality	Keywords
121	1.77	Engineering Certification
22	0.04	Teaching Reform
8	0.01	Practice Teaching
5	0.00	Teaching mode
4	0.00	Course System
4	0.00	Experimental Teaching
4	0.00	Curriculum Reform
4	0.01	Engineering Capability
4	0.02	Environmental Engineering

We use Cite Space to cluster high-frequency keywords and interpret clustering knowledge maps in engineering certification research fields. We can speculate on the development status and future research trends of engineering certification evolution, which is helpful for tracking frontier topics and predicting academic trends. Engineering certification researchers provide reliable quantitative information in the right direction. In the cluster evaluation index, the network modularity index $Q > 0.3$ indicates that the network community structure is significant; the network homogeneity index $Silhouette > 0.5$ indicates that the clustering result is reasonable.

In order to refine and classify related research fields and describe the evolution trend and influence of research topics, this paper clusters the keyword co-occurrence network maps, and labels the high frequency keywords with the same color as one. Among them, $Q = 0.3934$ and $Silhouette = 0.7572$, indicating that the clustering effect is reasonable and the credibility is strong. In Table 2, the knowledge domain of engineering certification domain is divided into 4 clusters, cluster 1 is the graduation requirement, cluster 2 is the engineering ability, cluster 3 is the teaching reform, and cluster 4 is the curriculum reform. It can be seen from this that China's research in the field of engineering certification is mainly aimed at the graduation requirements of college graduates, in order to improve the quality of graduates and change the graduation requirements. Engineering education professional certification refers to the professional certification of professional certification institutions for the implementation of engineering professional education in higher education institutions, with specialized occupations or industry associations (associations), professional associations with education experts in the field and relevant industry enterprise experts. The purpose is to provide preparatory education quality assurance for relevant engineering and technical personnel to enter the industry[8]. Teaching reforms are aimed at promoting education progress and improving the quality of teaching while reforming teaching content, methods, and systems[9]. In the future, in the field of engineering certification research, it will gradually move closer to the direction of teaching reform, change the teaching mode and curriculum system, so that college students can have professional skills when they graduate.

Table 2 Clustering result table

Numbering	Class	Class attribute
1	Graduation requirements	Results-oriented education; Degree of achievement
2	Engineering capability	Engineering certification; Practical teaching
3	Teaching Reform	Teaching philosophy; Obe concept
4	Course reform	Curriculum structure; Teaching method

5. Conclusion

From the research results in 2009-2018, it can be found that the research related to engineering certification is extensive and rapid. From the perspective of the number of documents issued, the

scientific and authoritative standard of improving the professional certification of engineering education has been widely recognized by the international community, and engineering certification research is getting hotter and hotter. The certification standards for engineering education are completely consistent with the level of talent training in applied colleges in China. Engineering talents are typical application talents, and the main research strength of engineering certification is concentrated in engineering colleges and universities. The high-frequency keywords of higher engineering education research are summarized, and the visual analysis method of scientific knowledge map is used to explore the research hotspots and trends of higher engineering education in China in the past 10 years. The research results show that the research of higher engineering education is based on the two key words of "engineering certification" and "teaching reform", and forms three research themes of teaching reform, engineering ability and graduation requirements with curriculum reform and teaching mode as the core.

Through the quantitative analysis of the literature in the field of engineering certification research, the author believes that the future development direction of China's higher engineering education is dominated by teaching reform, and engineering practice is the core. Its content is "course reform" and "engineering practice" that are compatible with engineering education reform. The basic means is to carry out "school-enterprise cooperation" and learn from "internationalization" experience.

Acknowledgements

Jilin Education Science "13th Five-Year Plan" Key (General Planning) Project.

Research on the Reform of Practical Teaching System of Computer Majors in Colleges and Universities under the Background of New Engineering.(GH180311)

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