Analysis on the Training Mode of Engineering Practice in Computer Courses

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Abstract. This paper takes the literature related to the computer engineering practice training mode on CNKI as a sample, conducts a quantitative analysis of the literature from the dimensions of high-impact authors, high-frequency keywords, and time-space distribution, sorts out the research context of my country's engineering practice training mode, and reveals this field. The research hotspots and research trends of this paper provide a reference for the further development of related research on the engineering practice training mode of computer courses.

Keywords: engineering practice · training mode · computer · bibliometrics · visual analysis

1 Introduction

In the context of the rapid rise of emerging technologies around the world, in order to conform to the trend of the times, in the 14th five-year plan and the proposals for the long-term goal of 2035, my country has particularly emphasized the importance of artificial intelligence, quantum information, integrated Focus on areas such as circuits, and also pointed out that it is necessary to accelerate the development of a new generation of information technology, and promote the deep integration of the Internet, big data, artificial intelligence and other industries. This requires all-round training for college students majoring in computer science and other related majors, especially in terms of engineering practice ability.

Engineering practice ability is the ability to use engineering thinking and apply the acquired knowledge to design, manufacture, test, operation, management or other engineering practice links to solve realistic engineering problems [1]. The many abilities that college students must have in today's society include engineering practice ability. It aims at cultivating senior specialized technical personnel with strong engineering practice ability, and emphasizes that basic theory teaching should be necessary and sufficient. In the face of the current rapid development of emerging industries and international competition and challenges, colleges and universities should achieve the same track in talent training mode, especially in the cultivation of engineering practice ability, to meet the needs of the country and society.

P. Qi and Z. Chen (Eds.): ICBDIE 2023, AISR 178, pp. 355–363, 2024.
https://doi.org/10.2991/978-94-6463-238-5_49

This paper uses the method of metrology to analyze the relevant literature on the field of computer course engineering practice training mode on China National Knowledge Network from 2000 to the present, including high-impact authors in this field, research hotspots, and research status. This paper explores the frontier trend and development direction of the research on the engineering practice training mode of computer courses, and provides a reference for the further development of related research on the engineering practice training mode of computer courses.

2 Data Selection and Analysis Tools

2.1 Data Selection

The data samples in this article are selected from the China National Knowledge Infrastructure (CNKI) from 2000 to 2022, and the combined search is carried out through the keyword "engineering practice training mode", and on the basis of selecting computer related subjects in the subject column, the search results are removed A total of 287 relevant documents were finally retrieved after data cleaning such as revisions and errata. The retrieval time was March 10, 2023, and the document data was finally exported in refwork format.

2.2 Analysis Tools

Based on the VOSviewer analysis tool, this paper conducts a co-occurrence analysis on the highly influential authors and institutions that published articles on the engineering practice training mode, and the evolution trajectory of high-frequency keywords, etc., trying to analyze the dynamic changes in the research field of computer-related engineering practice training in recent years and Development trends, providing further references for research in this field.

The VOSviewer software for analyzing literature data was developed by Van Eck and Waltman of the Center for Science and Technology Studies (CWTS) of Leiden University in the Netherlands in 2009. It mainly focuses on the visualization of scientific knowledge [2]. Compared with other bibliometric software, the biggest advantage of VOSviewer is that it can visually reflect the characteristics of large-scale data analysis through strong graphic display capabilities, and it has strong versatility and is suitable for various formats of various databases. Source data.

3 Literature Statistical Analysis

3.1 Quantitative Analysis of Literature Published

By using CNKI's own data analysis tools, the trend chart of the number of papers published is obtained, as shown in Fig. 1. It can be seen from the figure that only one related article was published in 2000, and there was a gap period between 2001 and 2005. One of the reasons was that my country did not pay enough attention to students' engineering practice ability at that time. After that, there was a trend of increasing year

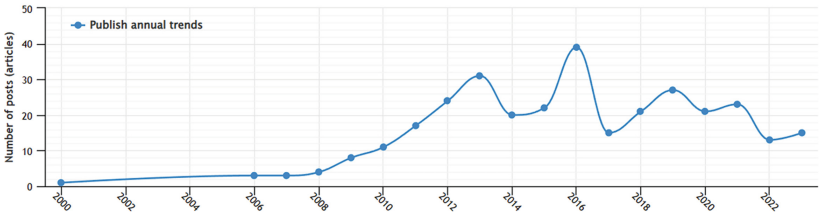

Fig. 1. Analysis of the number of published documents

by year, most notably from 2008 to 2013. Although the number of published articles fluctuated in the next few years, the average level basically remained the same. The year with the peak number of publications is 2016, and the number of publications in 2023 is predicted to be 15. On the whole, with the advent of a new round of scientific and technological revolution and industrial revolution, my country has attached great importance to the engineering practice ability of college students, which also makes Chinese scholars pay high attention to the cultivation of engineering practice ability. It also discusses the training mode of engineering practical ability in computer courses from many aspects.

3.2 Visual Analytics for Researchers

Professors Guan Chun and Hu Jun from Nanchang University and Professor Wei Yuntao from Jiamusi University published the most articles, followed by Professor Huang Xianying from Chongqing University of Technology, Professor Lu Wei from Beijing Jiaotong University and Chen Ningjiang from Guangxi University Professor et al., who published 3 articles related to this field.

In order to study the relevant authors and their collaborative relationship, this paper uses VOSviewer software, the threshold is set to 2, and 70 qualified authors and 33 cooperative groups are retrieved from the data derived from 287 documents. The resulting images are shown in Figs. 2 and 3. In Fig. 2, each dot represents an author, and its size represents the degree of activity, that is, the number of published articles, and all dots of the same color form a cluster. Figure 3 is a density map drawn according to the number of papers published by researchers. The higher the density, the closer the color is to red, indicating that the number of papers is more, and the closer to blue, the less papers are published. It can be seen from the figure that the cooperation of researchers is relatively scattered. Professors such as Guan Chun, Wei Yuntao, Huang Xianying, and Lu Wei have published more papers, but the intensity and density of cooperation between them are very low, and there is almost no cooperative relationship. There is also less cooperation among highly productive authors, and no long-term and stable cooperative network has been formed. From the perspective of the overall research in this field, the current research in this field is developing in diversification, and no author with high centrality has appeared yet.

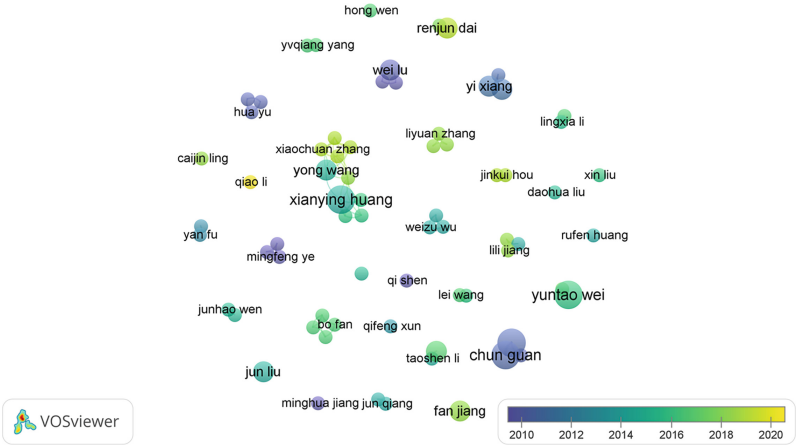

Fig. 2. Visual map of researcher collaboration network

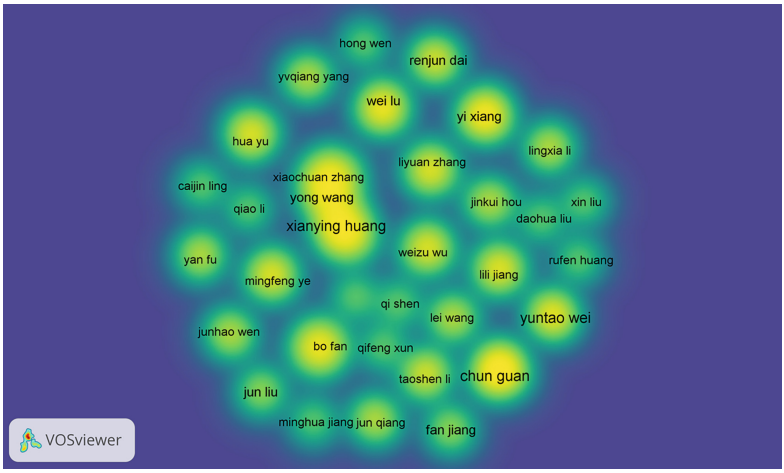

Fig. 3. Researcher Analysis Density View

3.3 Analysis of Research Hot Topics

Keywords are a high-level summary of research papers, and researching hotspots through keyword analysis is a common means of document analysis. Therefore, by using VOSviewer software to conduct statistical and visual analysis of keywords, their inherent correlation can most directly and accurately capture hot spots in a certain research field and grasp the evolution path.

Import the exported document information into VOSviewer, obtain 711 keywords through data analysis, set the minimum keyword co-occurrence parameter to "3", get 87 items and 11 clusters, and finally the visual analysis map is shown in Fig. 4 and Fig. 5. In a co-occurrence graph, each circle represents a theme element, and the size

of the circle indicates how active the theme is. In the evolution trend chart, time is used as the reference coordinates, and different color areas correspond to different time axes, progressing from dark blue to light yellow, which shows the research hotspots of different periods.

Combined with the two figures, it can be seen that the research hotspots focus on training mode, software engineering, school-enterprise cooperation, engineering practice, new engineering, CDIO and other directions. Among them, the training mode of school-enterprise cooperation, CDIO, outstanding engineers and new engineering has been studied by the majority of scholars.

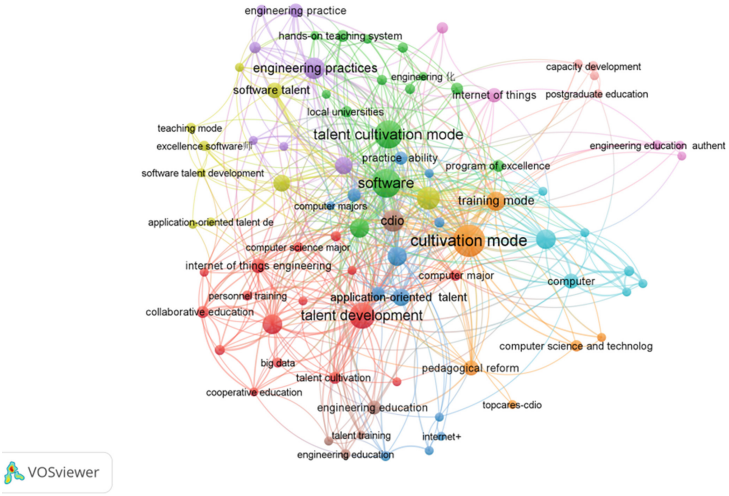

Fig. 4. Co-occurrence map of research hotspots

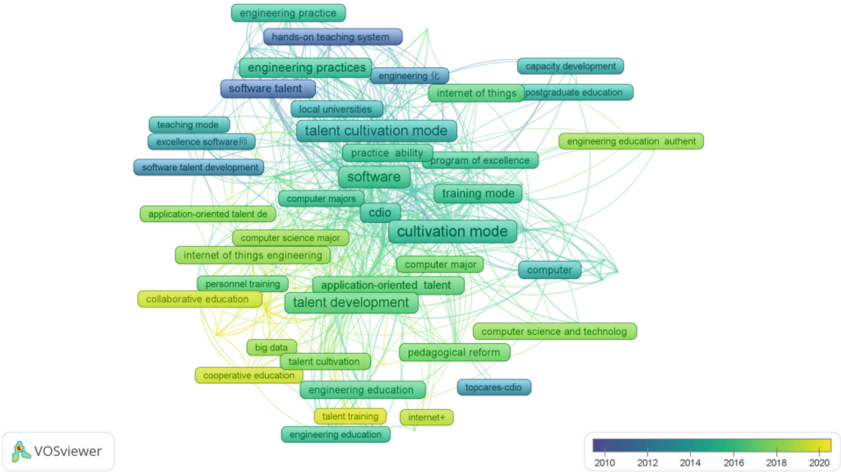

Fig. 5. Keyword evolution trend

In the co-emergence map, the keyword of school-enterprise cooperation is closely related to the key words such as training mode, talent training, software engineering, engineering practice, computer major, teaching reform, application-oriented talents, CDIO, excellent engineers, practical teaching, curriculum system, etc., among which the most research is carried out in the field of software engineering, and it can be seen that the society has higher requirements for the engineering practice ability of software talents [3]. School-enterprise cooperation is a systematic project, which requires close cooperation between universities and enterprises to formulate relevant courses and engineering practice teaching that meet the needs of the current society, and at the same time refine the training model to ensure that the courses offered in the school and enterprise are on the same track as the needs of the times, and at the same time formulate a systematic plan for training quality monitoring and feedback.

As you can see from the keyword evolution trend chart, CDIO is a relatively old topic. However, after more than 20 years of development, the CDIO engineering education model has systematically formed an operational engineering education training program and corresponding inspection and evaluation standards, representing the development direction of international engineering education. Its origins can be traced back to 2000, when the CDIO engineering education concept was founded after four years of collaborative exploration and research at four universities, including MIT and the Royal Swedish Institute of Technology. CDIO has a complete life cycle of learning that enables students to actively and practically connect between courses, and plays on its own four characteristics: conception, design, realization and operation. This allows students to acquire basic engineering knowledge while strengthening their individual abilities, interpersonal team skills and engineering systems skills [4]. Since the end of 2005, Shantou University carried out the reform of CDIO engineering mode, after more than ten years of development, CDIO has been combined with China's national conditions, and a Chinese-style CDIO training model has gradually formed. In 2016, Shantou University led the establishment of the "CDIO Engineering Education Alliance", and more than 100 universities have joined the alliance so far. In today's era of rapid development, only by keeping up with the context of the development of the times and the trend of higher education development, and constantly innovating training concepts and models, can CDIO adapt to China's national conditions and contribute to the cultivation of talents in China.

As can be seen from the keyword evolution trend chart, the excellent engineer training model is also a relatively old topic. The Outstanding Engineer Education and Training Program is a major reform project implemented by the Ministry of Education of the People's Republic of China to implement the Outline of the National Medium- and Long-term Education Reform and Development Plan (2010–2020) and the Outline of the National Medium- and Long-term Talent Development Plan (2010–2020), which is to promote China's transformation from a major engineering education country to an engineering education power [5, 6]. This major initiative aims to cultivate a large number of high-quality engineering and technical talents with strong innovation ability and meet the needs of economic and social development. However, China has continuously sought innovation in training models in combination with the development of the times, so it proposed the Excellent Engineer Education and Training Plan 2.0. It is an

upgraded version of the "Excellent Engineer Education and Training Program", that is, the construction of new engineering, which mainly refers to the new engineering research and practice project plan implemented by the Ministry of Education. As a result, many universities have implemented initiatives such as the establishment of new majors and future technology colleges geared towards the development of the times, as well as the establishment of industry-education integration research institutes in cities with a high degree of scientific and technological innovation.

As can be seen from the keyword evolution trend chart, new engineering is a relatively new topic. In order to cope with the new round of scientific and technological revolution and industrial revolution that the world is currently in, and to support a series of national strategies such as service innovation-driven development and "Made in China 2025", "new engineering" was born [7]. "New" and "old" are relative, "new" not only emphasizes the new knowledge, its "new" main purpose is to cultivate future emerging industries and new economic needs, strong practical ability, strong innovation ability, with international competitiveness of high-quality composite new engineering talents, so more emphasis is placed on the "new" talents. In the co-emergence map, it can be seen that new engineering and collaborative education belong to the same cluster, so the cultivation of engineering talents requires the joint efforts of schools, enterprises and society, closely docking emerging industries, integrating multiple resources, and collaboratively cultivating talents. At the same time, colleges and universities need to carry out in-depth research and practice of new engineering, build a number of multi-subject industrial colleges and future technology colleges, emerging engineering majors urgently needed by the industry, and new courses that reflect the latest development of industry and technology.

4 Conclusions

After analyzing all the relevant literature on the engineering practice training mode of computer courses that can be searched on CNKI, it is found that the training mode of engineering practice ability is mainly school-enterprise cooperation, CDIO, excellent engineer program and new engineering program. Through the establishment of the visual map, it is found that the homogeneity of scholars' research is serious, the research on course categories and systems is relatively single, and most scholars are at a low level of repeated research, staying on the surface of the problem, and there is no real innovation from the essence of the course to innovate the training mode of engineering practical ability. But in terms of the overall research status, scholars have also achieved good research results.

From the overall analysis, although most colleges and universities currently have problems such as poor operation of school-enterprise collaborative education mechanism, poor docking demand for engineering practice ability, insufficient course content to keep up with the development of the times, imperfect evaluation indicators, inability to closely combine multiple training modes, and failure to form a good talent training ecology. However, relevant departments and scholars in China are also constantly improving or proposing new training models according to the actual situation to face the development of the future era.

The cultivation of talents is not the solitary work of colleges and universities, nor is it the repeated application of models, which requires society and colleges and universities to dare to implement innovative training programs, strive to enhance teaching practice and the cultivation of students' practical operation ability and creative ability, build a three-level implementation system of industry-university cooperation and collaborative education projects, continue to improve the long-term mechanism of multi-subject collaborative education, and create a good ecology of industry-education integration and school-enterprise cooperation.

Acknowledgements. The work of this paper is supported by the 2021 Jilin Province Higher Education Research Key Project "Research on the Blended Teaching Mode of Procedural Courses under the Background of Golden Course" (project number: JGJX2021C15).

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