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A Bibliometric Analysis of Industry-Education Integration Research Based on Web of Science

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Abstract. This study aims to gain a deeper understanding of the research dynamics and trends in industry-education integration through a quantitative analysis of the literature in this field. Eight hundred ninety-five relevant articles were retrieved from the Web of Science Core Collection database, and the research focused on the annual publication trends, prominent authors, institutions and countries, highly cited articles, keywords, and collaborative networks. The study found that the field of industry-education integration has undergone three stages. Secondly, researchers from China and the United States ranked first and second in the number of publications in this field. Thirdly, highly cited articles have a particular influence on industry-education integration, but the overall citation count is relatively limited. Fourthly, keywords such as "cooperative education," "students," and "performance" are hot topics in this field. Finally, the analysis of collaborative networks revealed the existence of multiple communities, but the overall scale of collaboration is relatively small, and the influence is limited. This study provides profound insights into the academic research in industry-education integration. It helps scholars, policymakers, and practitioners better understand this field's development trends.

Keywords. Industry-education integration; Bibliometrics; Research trends

1. Introduction

Industry-education integration refers to the cooperation and integration between the industry and education sectors, aiming to improve the quality of education, promote industrial development, and cultivate talents that meet market demands [1]. Industry-education integration is essential for vocational education and a crucial approach to achieving high-quality products [2]. China has attached great importance to developing industry-education integration in recent years and has implemented policy measures to provide more robust support [3-5]. In this context, conducting scientific research and evaluating industry-education integration is essential. Bibliometrics analysis is a method for studying literature's characteristics and development trends. It can consider and analyze literature from multiple dimensions, such as quantity, quality, citations, authors, and institutions, to understand the development status and trends in the field of literature

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and provide support for academic research and discipline construction.

This article uses bibliometrics analysis to systematically analyze the literature on industry-education integration research in the Web of Science database. It seeks to uncover its development process, main characteristics, core themes, knowledge structure, influencing factors, and comparative analysis with relevant domestic literature to provide reference and inspiration for industry-education integration research in China.

The expected contributions of this article are as follows:

(1) This article is the first comprehensive and systematic bibliometric analysis of international industry-education integration research using the Web of Science database. It fills the domestic and international research gap and provides a global perspective and reference for industry-education integration research in China.

(2) This article adopts various bibliometric analysis techniques, such as literature statistics, co-word analysis, clustering analysis, and social network analysis. It explores industry-education integration research from different angles and levels, providing a multidimensional and multi-level analysis framework and methods for industry-education integration research in China.

(3) Based on the results of bibliometric analysis, this article provides insightful discussions on the development trends, disciplinary frontiers, hot issues, knowledge structure, and influencing factors of industry-education integration research. It offers new ideas and directions for industry-education integration research in China.

2. Literature Review

2.1. The Main Theories and Definition of Industry-Education Integration

Industry-education integration has multidimensional connotations and is defined differently in government policy documents. The General Office of the State Council defines it as a process promoting comprehensive integration of talent cultivation and industry demands [5]. The National Medium- and Long-Term Education Reform and Development Plan defines it as a process centered around market demands, industrial development, talent cultivation, innovation, and entrepreneurship, and win-win cooperation [4]. The National Vocational Education Reform Implementation Plan emphasizes the principles of school-enterprise cooperation and joint construction and sharing [2]. From an academic research perspective, industry-education integration can be categorized into cooperative development, integrated development, and regional economic service-oriented approaches [6-9].

The main theories of industry-education integration include the pluralistic shared governance perspective, which emphasizes the participation of multiple actors to maximize public interests; the transaction cost theory, which highlights the reduction of transaction costs to promote cooperation; the triple helix theory, which emphasizes the interaction and collaboration among government, industry, and education; the community theory, which highlights the establishment of a shared vision and a community to achieve a common goal; and the value orientation, which emphasizes the long-term development and quality [1, 6].

2.2. History and Development Trend of Industry-Education Integration

The integration of industry and education originated in China during the reform and

opening-up period of the 1980s. With the changes in market demand and industrial structure, the education sector began collaborating with the industry, gradually forming an important educational model [1]. Over the past forty years, the integration of industry and education has gone through three stages: initial exploration, diverse innovation, and continuous deepening [6]. The active promotion by the government, as well as the attention and support from various levels of government and universities, have enabled the rapid development of the integration of industry and education [6].

The future development trends of the integration of industry and education can be divided into four main directions. Firstly, integrating industry and education will further innovate its forms and contents. It will include traditional internships and practical training and involve industrial research, technology transfer, and talent development in various fields. Emphasis will be placed on improving talent development's quality and innovative capabilities [7]. Secondly, integrating industry and education will expand its scope and domains, including international cooperation and cross-border integration. This will broaden the perspectives and resources for talent development, enhancing competitiveness [7]. The participation of social organizations and individuals will promote the diversity and influence of the integration of industry and education [9]. Thirdly, government support and guidance will continue optimizing the environment and conditions for integrating the sector and education. Formulating policies and measures will encourage and support the integration of industry and education [8]. Meanwhile, using the Internet and digital technologies will improve educational efficiency and quality [1]. Lastly, integrating industry and education will continuously enhance its effectiveness and value. Technological innovation and technology transfer will drive the development of the integration of industry and education [10]. The principles of sustainable development will guide the development of the integration of industry and education, aiming to achieve coordinated economic, social, and ecological development [10].

2.3. Major Practices and Experiences in the Integration of Industry and Education

Since its development, the integration of industry and education has accumulated a wealth of experience. In summary, in terms of the forms and contents of the integration of industry and education, it can be divided into the integration of industry, education, and research [10], joint development of industry and education [11], guidance of industry and education projects [7], and talent development and exchange [1]. There are three categories in terms of mechanisms and models of integrating industry and education. The first category is the school-enterprise cooperation mechanism [8, 1], the second category is modern management models [6], and the third category is diverse models [10]. Regarding influencing factors, the integration of industry and education can be divided into internal, external, and coupling factors [11]. These factors directly impact the depth and breadth of the integration of industry and education and need to be strengthened and optimized.

3. Methodology

3.1. Data Sources and Data Analysis

The Web of Science core ensemble database is selected, and relevant search keywords

are extended based on industry-education integration. The search formula is written as: ("Industry-education integration") OR ("Production-education integration") OR (" School-industry collaboration") OR ("Cooperative education") OR ("School-industry partnership") OR ("Dual education system") OR ("Industry- linked capstone projects") OR ("academic-industry partnership"). The timeframe for the search was from the build to August 22, 2023. Eight hundred ninety-five relevant documents with the above search terms in the title and keywords were retrieved. The retrieved literature was analyzed econometrically using R 4.3.1 and Bibliometric.

4. Results and Discussion

4.1. Annual Trends in Literature Publication

The publication of literature on industry-education integration reflects the trends in research in this field. Figure 1 shows that this analysis can be divided into three phases. The first phase, from 1946 to 1960, had limited research activities. The second phase, from the 1960s to 2007, saw an increase in research on topics such as cooperative education models, academic and vocational benefits, international cooperation, and institutionalized cooperative education. The third phase, starting in 2008, has shown significant growth in research interest. Research on industry-education integration has remained consistently active, reflecting the growing recognition of its importance in higher education.



Figure 1. Annual literature publication trends in the field of industry-education integration research

4.2. Lead Authors, Institutions and Countries

Canadian authors T. Judene Prett and David Drewery have the highest number of publications in the field, with 10 and 9, respectively, with research focusing on cooperative education, work-integrated learning, and related topics aimed at understanding the impact of various factors in these areas on students and the workplace.

China has the highest number of publications at 27.2%, followed by the United States at 18.8%. This is likely due to their large education systems and strong collaborations between higher education and industry. However, research from other countries is also valuable for understanding industry-education integration in different regions.

Asia-Pacific Journal of Cooperative Education has the most publications, with 2.8%. Waterloo University in Canada is the most developed institution in the field, with 5.7%.

4.3. Highly Cited Literature

Highly cited literature refers to papers ranked in the top 1% regarding citation frequency, which are widely influential and well-known in the academic world and are often regarded as essential references in specific fields [12]. The top 10 highly cited literature in the field of integration of industry and education in this study are shown in Table 1. This highly cited literature dramatically influences the academic world and provides an essential theoretical and practical foundation for research on integrating industry and education.

At the top of the list is Developing Graduate Employability Skills and Attributes: Curriculum Enhancement through Work-integrated Learning. This article explores how work-integrated learning, WIL) is a crucial strategy for enhancing graduate employability skills. In industry-education integration, WIL provides students with opportunities to interact with natural work environments, facilitating the development of the skills and qualities they need in their careers [13]. This topic is crucial for the current needs of the job market, which is why this article is more influential. However, it is also important to note that although the highly cited literature at the top of the list has attracted a certain amount of attention from academics within the field of industry-education integration, the number of citations for these ten articles is not large, which reflects that the influence of these articles is limited to a certain extent, which may be affected by the narrowness of the field, the timeliness, the source of the data, and the timeframe for retrieval, among other factors. Despite the limited number of citations, we still need to consider the quality and depth of this highly cited literature. They may provide deep theoretical insights, practical methodologies, or unique insights into specific issues. As the field of industry-education integration may still be a relatively new area of research, more studies may generate more citations over time, thus increasing the impact of the literature.

Table 1.	Тор	10	highly	cited	literature
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No.	Title of Literature	Periodical	TC	TC / year
1	Developing graduate employability skills and	Asia-Pacific Journal of	96	13.71
	attributes: Curriculum enhancement through work-	Cooperative Education		
	integrated learning			
2	Are the benefits of tourism and cooperative	Tourism Management	57	2.38
	education in UK undergraduate courses realized?			

No.	Title of Literature	Periodical	ТС	TC / year
3	Cooperative education work assignments: The role	Journal of Engineering	54	2.84
	of organizational and individual factors in	Education		
	enhancing ABET competencies and co-op			
	workplace well-being			
4	The Impact of Cooperative Education on Academic	Journal of Engineering	53	2.65
	Performance and Compensation of Engineering	Education		
	Majors			
5	Experiential education in the undergraduate	Communication	52	2.08
	curriculum	Education		
6	From sponsorship to partnership in academy-	R&D Management	46	1.92
	industry relations			
7	Bridging science and technology through	Research Policy	41	5.13
	academic-industry partnerships			
8	(How) Do work placements work? Scrutinizing the	Journal of Vocational	40	8.00
	quantitative evidence for a theory-driven future	Behavior		
	research agenda			
9	Tourism and hospitality internship experiences	Journal of Hospitality,	37	4.11
	overseas: A British perspective	Leisure, Sport &		
		Tourism Education		
10	Linking internships and classroom learning: A case	Journal of Hospitality,	36	4.50
	study examination of hospitality and tourism	Leisure, Sport &		
	management students	Tourism Education		

Continued Table 1

Note: TC= Total Citation.

4.4. Trend Topics

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Keywords are a natural language that reflects the core content of the literature, and highfrequency keywords reflect the hot topics that are concentrated in this research field [14]. According to the frequency analysis, the top 10 keywords are cooperative education, students, performance, impact, model, university, work, experience, education, and higher education.

Keyword co-occurrence analysis is a data visualization method usually used to analyze and show co-occurrence relationships between multiple things or concepts [15]. The parameters are set as follows: Clustering Algorithm is Walktrap, Normalization is an association, the Number of Nodes selected is 50, the Repulsion Force is 0.1, the Minimum number of edges is 2, and isolated Nodes. To get the keyword co-occurrence network graph (see Fig. 2), the nodes' size and the edges' thickness can reflect the importance or strength of association between these keys.



Figure 2. Keyword co-occurrence analysis network diagram

Item	Freq	Year_q1	Year_med	Year_q3
work	12	2013	2014	2019
choice	6	2012	2014	2014
academic-performance	5	2013	2014	2014
antecedents	6	2015	2016	2017
career	6	2013	2016	2020
outcomes	6	2016	2016	2020
commitment	6	2016	2017	2018
engagement	5	2017	2017	2021
support	5	2017	2017	2020
experience	11	2014	2018	2019

Table 2. Trend topics in industry-education integration research areas

Trend Topics indicate the hottest topics in a research field during a specific period. By analyzing these topics(see Table 2), we can identify key trends. "Work" is the most discussed topic, followed by "Career." Other popular topics include "Outcomes," "Commitment," and "Engagement." These trends reflect researchers' growing interest in products, dedication, and employment.

Trend Topics are usually used to indicate the hottest topics or keywords in a field or topic during a specific period, which can help researchers understand the current hot trends and focuses in the research field [14]. We can observe key trends based on the Trend Topics in this research area (see Table 2). First, the most frequently occurring topic in the research literature is "Work," which has received much attention in the past few years, especially reaching a peak in 2019. This demonstrates the continued influence of work-related research in academia. In addition, research on 'Career' also shows a long history of research, covering the period from 2013 to 2020. This reflects the exploration of career aspects. In addition, topics such as 'Outcomes,' 'Commitment,' and 'Engagement' have also received much attention recently, suggesting that researchers are interested in outcomes, commitment, and engagement. This indicates that research interest in products, dedication, and employment is rising.

In terms of high-frequency keywords and trends, we observed significant patterns. "Cooperative education" and "students" indicate a focus on integrating education and industry, highlighting the roles of educational institutions and students. "Performance" and "impact" show concern for the effects on student performance and social impact. "Higher education" and "university" emphasize the importance of these institutions in facilitating industry-education integration and student training.

4.5. Collaborative Network Analysis

Co-authorship network analysis provides insights into research collaboration relationships in the field [16]. We identified multiple communities within the network, reflecting collaborative dynamics. Three types of communities were observed: small neighborhoods of 2-3 researchers/entities, a significant linear community indicating a highly centralized collaborative relationship, and a large community with cross-connections indicating close relationships between sub-teams or research directions. Nodes represented by authors Wang Y, Drewery, and Pretti had higher centrality and influence within the co-authorship network.



Figure 3. Cooperative network diagram

Further analysis of the members, collaboration frequency, and joint research areas within these communities will help us better understand the characteristics and trends of research collaboration, providing valuable insights and guidance for future research and collaboration.

Through the observation of collaboration communities in the co-authorship network, it is worth noting that there are currently not many collaboration communities in the field of industry-education integration. Furthermore, most of the communities are relatively small in size, indicating limited influence. This suggests that industry-education integration has yet to establish more extensive and effective research groups. However, measures can be taken to enhance the power of the field. These measures may include promoting collaboration, increasing visibility, encouraging the participation of young researchers, and fostering interdisciplinary cooperation. By implementing these strategies, the field can strengthen its impact and establish more impactful research groups in industry-education integration.

5. Conclusion

The main objective of this study is to explore the research dynamics and trends in the field of industry-education integration, as well as to identify highly cited literature, keywords, and collaborative networks. Through the econometric analysis of 895 relevant literature in the Web of Science core ensemble database, we draw the following conclusions:

First, research activities in the field of industry-education integration have gone through different phases, including a starting phase, a phase of gradual growth, and a phase of rapid growth. This indicates that the field has attracted increasing academic attention and continues to grow.

Second, Canadian authors T. Judene Prett and David Drewery have the highest number of publications in the field, with China and the United States ranking first and second, respectively. This reflects that these two countries dominate the research activities in industry-industry integration.

Third, highly cited literature has a particular influence within the field of industryteaching integration, but the overall number of citations is relatively limited. The narrowness of the area, timeliness, and data sources may influence this.

Fourth, the keyword analysis revealed that keywords such as "collaborative education," "students," and "performance" are hot topics in the field, reflecting the focus of the research.

Fifth, the collaborative network analysis revealed the existence of multiple communities, but the overall collaboration was relatively small and had limited impact.

This study provides a comprehensive perspective, revealing the research trends and critical participants in the field of industry-education integration. It helps scholars better understand the development dynamics of industry-education integration, guiding future research directions and providing some reference value for policymakers and practitioners. Although this study offers an in-depth understanding of the field of industry-education integration, there are still many future research directions worth exploring. These include further investigating the content and impact of highly cited literature, exploring industry-education integration models in different countries and regions, analyzing the evolution of collaborative networks, and analyzing key terms and trends over various periods to track the development direction of the field.

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