Mapping and clustering analysis on UIC in animation education: A bibliometric analysis

Xiaoxin Chen[1,2]*, Mohd Noor Abdul Hamid[3], Mohd Fitri Yusof[1]

[1]*School of Creative Industry Management & Performing Arts, Universiti Utara Malaysia, Sintok, Kedah, Malaysia*
[2]*School of Digital Media, Chongqing Polytechnic University of Electronic Technology, Chongqing 401331, China*
[3]*College of Digital Media, Chongqing Polytechnic University of Electronic Technology, Chongqing 401331, China*

Corresponding author: Xiaoxin Chen (*Email: chenxiaoxin654321@163.com*)

Abstract

This study aims to analyze the trends, core themes, and challenges in University-Industry Cooperation (UIC) in animation education, particularly in the context of vocational education in China, through a bibliometric analysis. Using data from articles published between 1999 and 2021, this study applies bibliometric methods, including citation analysis, bibliographic coupling, and keyword co-occurrence analysis, to examine the evolution of research on UIC in animation education. The study utilizes Scopus as the primary database and employs VOSviewer and RStudio software for data visualization and analysis. The bibliometric analysis reveals a significant increase in publications on UIC in animation education, especially after 2015. It identifies key research areas, such as the integration of industry and education, school-enterprise cooperation, and the role of vocational colleges in bridging the gap between education and industry. The study also highlights challenges in aligning educational practices with industry needs, insufficient enterprise participation, and the need for more integrated models of cooperation. The findings indicate that while research on UIC in animation education has grown substantially, there are still significant gaps, particularly in creating deeper, long-term industry partnerships. The study suggests that more innovative models, such as co-designed curricula and shared innovation centers, are needed to enhance the effectiveness of UIC in this field. This study provides valuable insights for policymakers, educators, and industry stakeholders, emphasizing the importance of improving UIC models to meet the evolving needs of the animation industry. The findings suggest exploring deeper collaboration models and strengthening government support for industry-education integration.

1. Introduction

University-Industry Cooperation (UIC) has taken center stage in the attention of educational institutions and industries around the world. University-Industry Cooperation is regarded as an important strategy to strengthen vocational education and to meet the growing demand for professionally skilled personnel in various industries [1, 2]. While Western countries have always been at the forefront of implementing successful models, such as the 'cooperative education' in the United States, the 'dual system' of higher education in Germany, and the 'dual-teacher system' in Singapore [3], China has been quick to recognize the necessity of industry-academia integration, especially in the field of animation, despite starting to explore vocational education relatively late [4].

UIC offers numerous positive impacts: it bridges the gap between education and industry needs, enhances student employment prospects, fosters the development of vocational colleges, and ensures a steady supply of talent for enterprises [5]. This collaborative model promotes an organic connection between the education chain, talent chain, industry chain, and innovation chain, thereby bolstering economic growth and development.

The animation and comics industry, a core component of the 21st-century knowledge economy, epitomizes this urgent need for cooperation. The global animation and comics industry is valued at US$211.3 billion in 2022, with China making a significant contribution to this growth. The industry is expected to grow by more than 40% by 2023, with a total value of US$1.5 billion in 2020. The output value of China's animation industry has soared from about 76 billion yuan in 2012 to 221.2 billion yuan in 2020 and is expected to exceed 300 billion yuan by 2023. Notwithstanding the expanding scale of the industry, there is still a shortage of skilled animation professionals, which poses a recruitment challenge for animation companies [6].

However, there are challenges associated with cooperation between universities and firms that remain. Superficial collaboration between universities and businesses is still prevalent and is often limited to rudimentary forms such as "factory-in-school" and "school-in-factory" [7]. The term "school-in-factory" refers to the establishment of small-scale industrial facilities within an educational institution to provide students with exposure to practical operations. Meanwhile, "college-in-factory" refers to the integration of academic training into an industrial setting to align education with industrial practice. Whereas these approaches provide a foundation for collaboration, they often lack depth and focus on short-term, superficial interactions rather than fostering meaningful, long-term partnerships. Unaligned goals, resource constraints, and cultural barriers often hinder the effectiveness of these models, highlighting the need for more integrated approaches such as co-designed curricula, shared innovation centers, and collaborative R&D centers to bridge the gap between academia and industry. The stakeholders' lack of deep understanding and effective implementation of collaborative models is coupled with insufficient government policies to support and regulate innovation practices [8].

This rapid development of information and communication technologies (ICTs) has greatly impacted various industries in the last few years, including the animation industry. The use of the Internet and smartphones has transformed the animation industry, changing both the supply side (new products, services, and agents) and the demand side (consumer behavior). Such technological advances provide a unique opportunity for vocational educational institutions to adapt their teaching methods and curricula to meet the evolving needs of the industry [9].

The critical importance of vocational institutions in training animation professionals has given rise to a new and growing genre of research. While several recent studies have addressed some aspects of university-vocational education, there is still a need for a comprehensive bibliometric analysis of current university-vocational education models, especially in the context of vocational colleges and universities offering animation programs in China [10].

Bibliometric analysis helps to identify trends, novel applications, research priorities, and key references in a subject area based on the geographical distribution of literature and research networks [11]. This technology allows scholars to study a specific research area by analyzing citations, co-citations, and word frequencies to draw useful conclusions. For investigators, it provides tools to assess academic productivity, impact, and influence; to define the knowledge structure of a research topic and its evolution; and to identify different subtopics and their conceptual frameworks.

In a nutshell, despite the important role of University-Industry-Research Cooperation (UIRC) in enhancing the quality of vocational education and meeting the needs of the industry, its mode of cooperation in the animation program of Chinese vocational colleges and universities still faces outstanding problems, such as insufficient participation of enterprises and a disconnection between the curriculum and industrial needs. To address this issue, this study systematically analyzes the current research status of industry-university-research cooperation globally between 1999 and 2021 through bibliometric analysis, with a special focus on the practice of animation education in Chinese vocational colleges and universities. The study aims to reveal the research trends, core themes, and key challenges in this field and provide a theoretical basis and practical guidance for optimizing the strategy of industry-academia integration. Through performance analysis, citation analysis, and keyword co-occurrence mapping, this study not only fills the gaps in the existing literature but also points out the direction for future research, which is of great significance in promoting talent cultivation and innovative development in the animation industry.

2. Literature Review

The concept of the industry-academia model has been defined diversely by scholars, evolving from a focus on vocational colleges to broader collaborations. Early perspectives, such as Chen Nianyou's, emphasized vocational colleges working closely with industries to enhance students' skills and boost industrial productivity. Later, Cao [12] stressed that aligning university education with industry needs is essential for industry advancement, while Cao [12] and Wang [13] highlighted the necessity of deeper cooperation among government, universities, and industries to meet modern skill demands and foster innovation.

The model operates at both macro and micro levels. At the macro level, it integrates vocational education with socio-economic development, aligning with national policies and fostering collaboration among government, industries, and educational institutions. This approach aims to cultivate versatile talent suited to industry needs and global standards. At the micro level, the focus is on aligning curricula, talent development, and teaching methods in vocational colleges with industrial trends, ensuring students acquire practical skills and theoretical grounding to meet contemporary demands [14].

China has recognized the effectiveness of these models and is rapidly developing its own approaches to integrate industry and academia, especially in sectors with escalating demands for skilled talent like the animation industry [4]. The Vocational Education Law of the People's Republic of China mandates that vocational education must adhere to industry-academia collaboration, highlighting the government's commitment to this strategy [15]. This collaborative model seeks to forge a synergistic connection between the education chain, talent chain, industry chain, and innovation chain. By doing so, it aims to enhance student employment prospects, foster the development of vocational colleges, and ensure a consistent supply of skilled talent to meet the needs of enterprises [5].

Government initiatives have further amplified this focus. The Decision on Accelerating the Development of Modern Vocational Education issued by the State Council [16] emphasized deepening industry-academia collaboration to cultivate high-quality workers and technically skilled personnel [16]. Subsequent affirmations by General Secretary Xi Jinping in 2017 and 2019 reiterated the strategic importance of this collaboration for national development [17].

3. Research Methodology

3.1. Bibliometric Analysis

Bibliometrics is an interdisciplinary field that employs mathematical and statistical methods to quantitatively analyze knowledge resources. It integrates concepts from mathematics, statistics, and philology to create a comprehensive framework for understanding and measuring various elements of academic and scientific outputs. Key metrics include the number of publications (particularly journal articles and citations), authors (individuals or groups), and document identifiers such as thesauri.

The applications of bibliometrics span both micro and macro levels. At the micro level, it is used to identify key records, review publications, evaluate document utilization, and manage library and information resources. At the macro level, it contributes to designing efficient information systems, enhancing intelligence processing, identifying gaps in document services, forecasting publishing trends, and advancing foundational theories of information science. Recent applications of bibliometric methods include analyzing journals, disciplines, institutions, and countries.

This study leverages bibliometric analysis to examine the trends and structure of literature related to academia-industry models in animation majors in vocational institutes. Literature performance is evaluated through citation counts, while scientific mapping visualizes the field's structure and dynamics. The analysis includes:

Citation and co-citation analysis: Assessing the influence of journals, papers, or authors and simplifying complex relationships between works.

Bibliographic Coupling: Highlighting thematic similarities between documents.

Keyword Co-occurrence Analysis: Identifying research trends and hotspots by analyzing keyword relationships.

These methods collectively reveal the importance, thematic connections, and emerging areas of focus within the industry integration education model research landscape.

3.2. Database Selection and Search Terms

Scopus was chosen as the primary source for bibliometric analysis due to its broader coverage of articles, ease of exporting data, and suitability for this type of research (Shahzad et al. [18] and Farhan and Iqbal [19]). Compared to the Web of Science (WoS) database, Scopus provides a more comprehensive range of documents in the field of industry-academia collaboration, making it particularly relevant for this study [20-22].
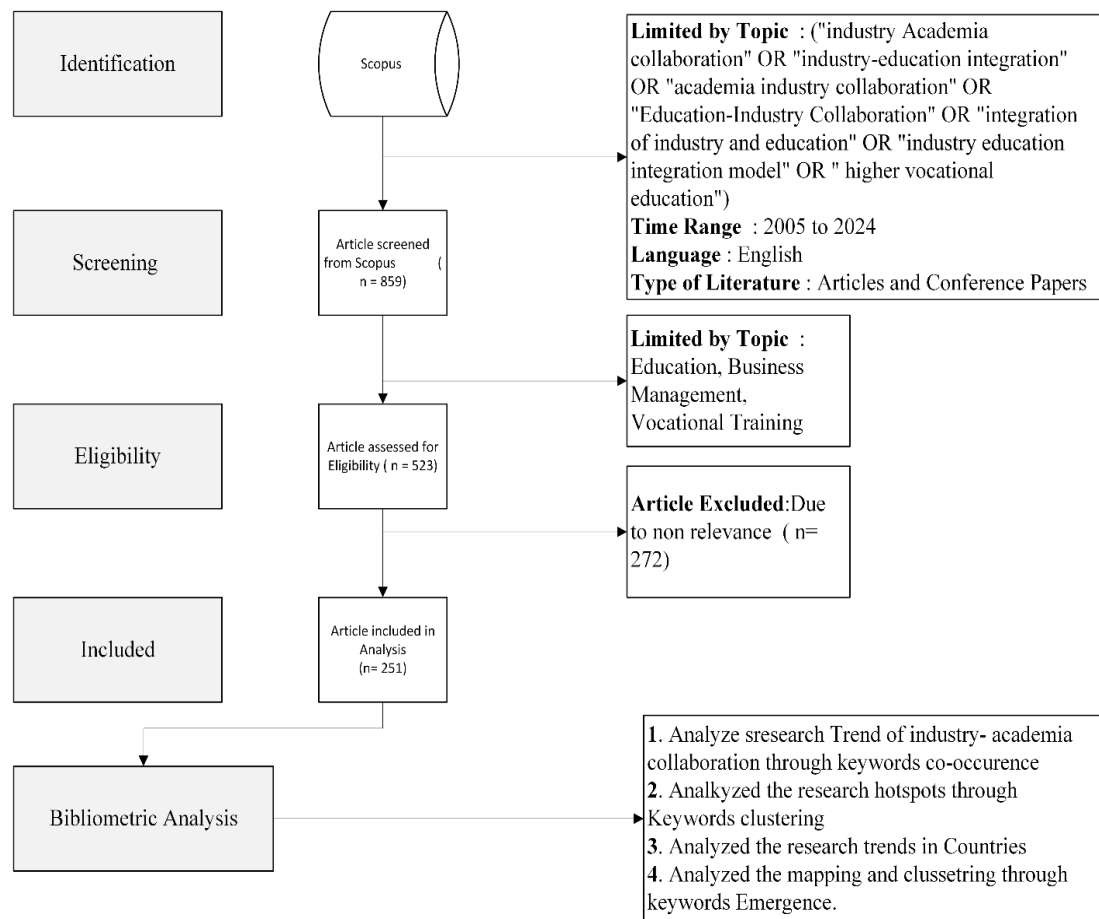
Figure 1.
Overall methodology of bibliometric analysis.

The process began with identification, where Scopus was searched for articles using specific keywords such as "industry-academia collaboration," "industry-education integration," "academia-industry collaboration," "education-industry collaboration," "integration of industry and education," "industry education integration model," and "higher vocational education." The search was limited to articles and conference papers published between 2005 and 2024, in English. This step yielded an initial dataset of 859 documents. Next, during the screening phase, the articles were further filtered to ensure relevance to the analysis. The discipline categories were narrowed down to focus on education, business management, and vocational training. This step reduced the dataset to 523 articles, with 336 articles excluded due to irrelevance to the specified criteria.

The third phase, Eligibility, involved a more detailed assessment of the remaining articles. Articles were excluded if they lacked relevance to the core themes of industry-academia collaboration, resulting in a final dataset of 251 articles being included in the analysis. This process highlights a systematic approach to filtering and analyzing relevant literature, ensuring that only the most pertinent articles are included for detailed bibliometric analysis. By leveraging Scopus's broad coverage and advanced search functionalities, this study provides a comprehensive overview of the trends and key areas of focus in the field of industry-academia collaboration research.

After collecting and cleaning the literature data, the next step was to analyze the indicators in the data. In the literature, two main types of indicators [23] are used for bibliometric analysis: performance and science mapping. Performance analysis mainly evaluates productivity and influence through the number of publications and the number of citations. Scientific mapping visualizes the information in the literature and clearly shows the research dynamics and structure of the field.

3.3. Software and Technique

This article mainly uses two analysis software: VOSviewer and RStudio. VOSviewer is a free software based on Java, developed by Van Eck and Waltman of The Centre for Science and Technology Studies (CWTS) of Leiden University in the Netherlands in 2009, and is mainly for literature data citations. These tools can generate visual images of literature, and graphs can show hotspots, emerging trends, and intelligent networks in the research field.

4. Results and Discussion

4.1. Publication Trend

Figure 2 illustrates the publication and citation trends from 2005 to 2024, highlighting the relationship between research output and its academic impact over time through the citation-to-publication ratio. This ratio provides insight into how publications have been received and cited in the academic community, shedding light on both the quantity and quality of research contributions. As of 2024, 57 articles have been published, representing the highest number of publications recorded in a single year. The data shows a consistent upward trend in research output, particularly from 2015 onwards, highlighting the growing academic focus on this field.

From 2008 to 2014, the number of publications remained relatively modest, ranging between 1 and 7 articles annually. However, starting in 2015, there was a notable increase in publication activity, with 9 publications in 2016 and a sharp rise to 17 in 2017. This upward trend demonstrates an increasing interest in the topic, likely driven by the growing recognition of the importance of industry-academia collaboration in addressing real-world challenges.

Between 2018 and 2020, the number of publications stabilized, with 9 to 25 articles published annually. The year 2020 marked a significant milestone, with 25 publications, reflecting a peak in research momentum during this period. Post-2020, publication output continued to grow steadily, with 26 articles in 2021, 37 in 2022, and a substantial jump to 57 publications in 2024.

This consistent increase in publications underscores the expanding scope and relevance of research in industry-education integration. The surge in research output, particularly after 2020, indicates a growing need to address the intersection of industry and education to solve complex societal and economic challenges. Moreover, the peak in 2024 reflects a heightened academic and practical interest in exploring innovative solutions and frameworks within this field. This trend emphasizes the sustained importance of research in bridging the gap between academia and industry while promoting knowledge transfer and practical applications.
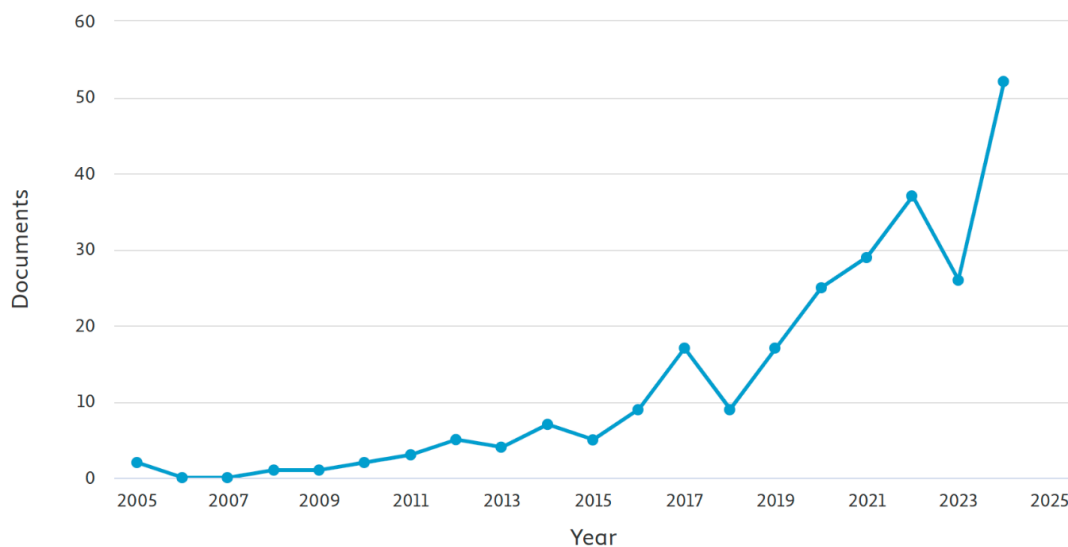

Figure 2.
Publication Trend.

Table 1 illustrates the publication and citation trends from 2005 to 2024, highlighting the relationship between research output and its academic impact over time through the citation-to-publication ratio. This ratio provides insight into how publications have been received and cited in the academic community, shedding light on both the quantity and quality of research contributions.

In the earlier years, such as 2008 to 2013, the ratio remained relatively modest, reflecting limited academic attention despite the emergence of publications in the field. For instance, in 2013, with 4 publications, the citation-to-publication ratio was 2.4, indicating relatively low academic recognition for each work. However, by 2014, the ratio showed slight improvement, with 7 publications and a ratio of 1.77. This period signaled a steady increase in publications, but the academic impact, as measured by citations, remained relatively subdued.

The trend began to shift significantly after 2016, with both publication counts and citations experiencing substantial growth. In 2016, for example, there were 9 publications with a ratio of 4.5, and by 2019, this had increased to 17 publications with a ratio of 8.33, demonstrating greater academic recognition. Post-2020, the field witnessed remarkable developments, with the citation-to-publication ratio peaking in 2023 at 12.63, when 26 publications garnered 203 citations. This reflects the increasing academic focus on and relevance of the field.

Table 1.
Publication and citations.

Year	Publications	Citations	Citation Ratio
2008	1	0	7.5
2009	1	0	5.8
2010	2	4	6.3
2011	3	4	7.1
2012	5	4	6.87
2013	4	9	2.4
2014	7	8	1.77
2015	5	7	4.7
2016	9	32	4.5
2017	17	35	3.57
2018	9	57	5
2019	17	48	8.33
2020	25	92	10.11
2021	26	116	11.22
2022	37	170	8
2023	26	203	12.63
2024	57	263	9.31

By 2024, the number of publications reached its highest point at 52, accompanied by 263 citations and a ratio of 9.31. This indicates that while the publication count expanded significantly, the citation-to-publication ratio slightly decreased compared to 2023, suggesting a potential shift in how new research outputs are being cited.

The selected text in Word presents the publication trend as an extension with citations as well. The peak years highlighted in the data carry significant broader implications for the evolution and impact of research in the field. These years reflect a convergence of increased academic interest, societal relevance, and advancements in research quality. The consistent rise in the citation-to-publication ratio during these periods indicates that the field not only experienced growth in terms of the number of publications but also gained substantial recognition for its academic contributions. This trend suggests that research in the field has been addressing pressing and emerging issues, capturing the attention of both scholars and practitioners. For instance, the peak in 2023, with the highest citation-to-publication ratio of 12.63, underscores the high impact of research outputs during this period, signaling that these studies addressed critical challenges or offered groundbreaking insights. Additionally, the high publication volume in 2024 reflects a broadening of research efforts, highlighting sustained relevance and growing collaboration across disciplines.

These peak years also demonstrate a shift towards quality over quantity, with research outputs receiving more citations on average, pointing to their increased importance and influence. Furthermore, the alignment of these peaks with broader academic and societal shifts suggests that the field is closely tied to evolving global priorities, underscoring its practical and theoretical significance. These years not only mark milestones in the field's growth but also serve as a foundation for future research, indicating that the topic has matured into a critical area of study with long-term relevance for both academia and real-world applications.

Figure 3 pie chart illustrates the distribution of articles across various journals that have contributed to the field of industry-education integration research. It is evident from the chart that certain journals play a dominant role in publishing articles on this topic, with the top contributors accounting for a significant share of the total publications. The journal Modern Vocational Education stands out as the leading contributor, publishing 57 articles, which constitutes 22.71% of the total. This indicates its central role in disseminating research on vocational and industry-education integration. Following this, the Industry and Technology Forum accounts for 17 articles (6.77%), and the Journal of Hubei Open Vocational College published 15 articles (5.98%). These journals, along with others like the Higher Education Journal (5.58%) and Science and Education Guide (6.77%), form the core platforms for scholarly work in this field.
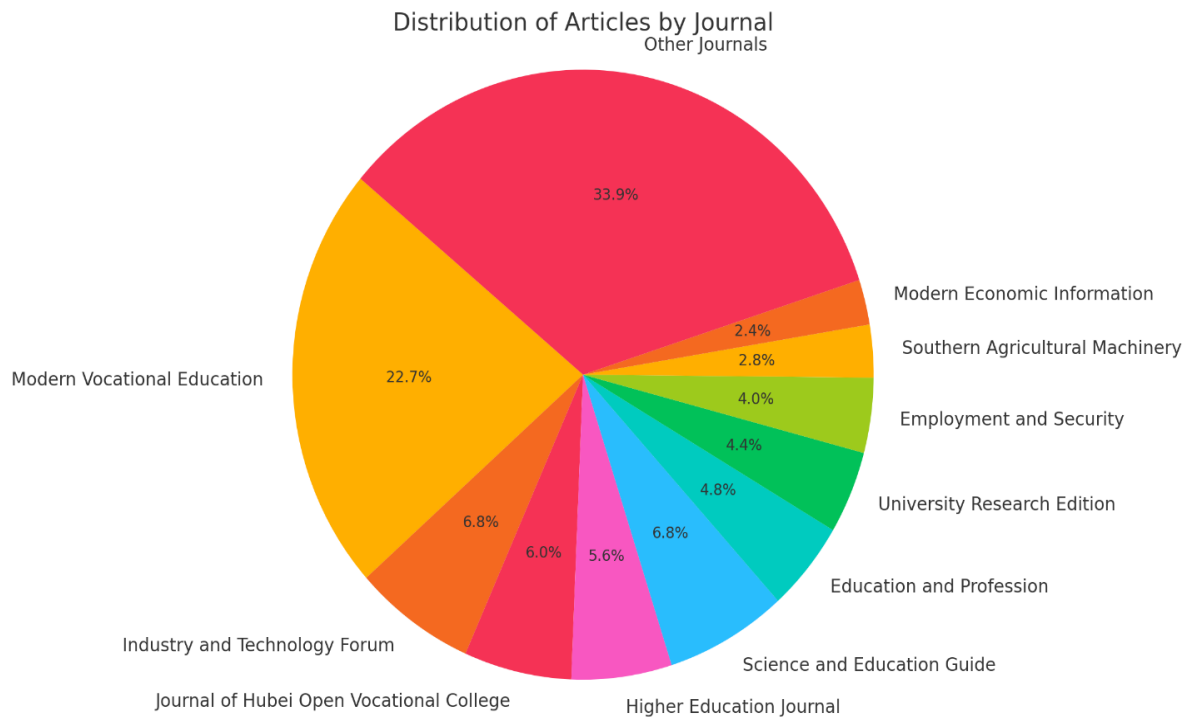
Figure 3.
Journal publication trend.

In addition, other journals, such as Education and Profession, University Research Edition, and Employment and Security, contribute notable shares ranging from approximately 4% to 6%, showcasing a diverse set of interests and approaches to the topic. Less dominant but still influential journals, like Southern Agricultural Machinery and Modern Economic Information, show a broader interdisciplinary impact by addressing niche areas within the industry-education integration framework. Overall, the distribution emphasizes the interest in industry-education integration, spanning from core vocational education journals to those focusing on technology, employment, and professional training, highlighting the growing recognition of the importance of such integration across different domains and regions.

Table 2.
Number of Articles published in a Journal.

No.	Journal Name	Articles	Percentage
1	Modern Vocational Education	57	22.71
2	Industry and Technology Forum	17	6.77
3	Journal of Hubei Open Vocational College	15	5.98
4	Higher Education Journal	14	5.58
5	Science and Education Guide	17	6.77
6	Education and Profession	12	4.78
7	University Research Edition	11	4.38
8	Employment and Security	10	3.98
9	Southern Agricultural Machinery	7	2.79
10	Modern Economic Information	6	2.39
11	Other Journals	85	33.86

4.2. Authors' Bibliography

Table 3 ranks the most productive authors contributing to publications in the analyzed field. The table shows that Felderer, M., is the most productive author with 9 publications, demonstrating a significant contribution to the research landscape. Following closely is Garousi, V., who has published 8 documents, showcasing substantial academic output in this area.

Table 3.
Publication authors.

Number	Authors	Publications
1	Felderer, M.	9
2	Garousi, V.	8
3	Santos, W.B.	5
4	Akili, W.	3
5	Dong, L.	3
6	Fucci, D.	3
7	Marijan, D.	3
8	Qi, R.	3
9	Ramler, R.	3
10	Runeson, P.	3

Santos, W.B., with five publications, stands out as the third most active author, highlighting his role in advancing the field. Meanwhile, authors such as Akili, W., Dong, L., Fucci, D., Marijan, D., Qi, R., Ramler, R., and Runeson, P. have each contributed three publications, reflecting their steady involvement in the research domain.
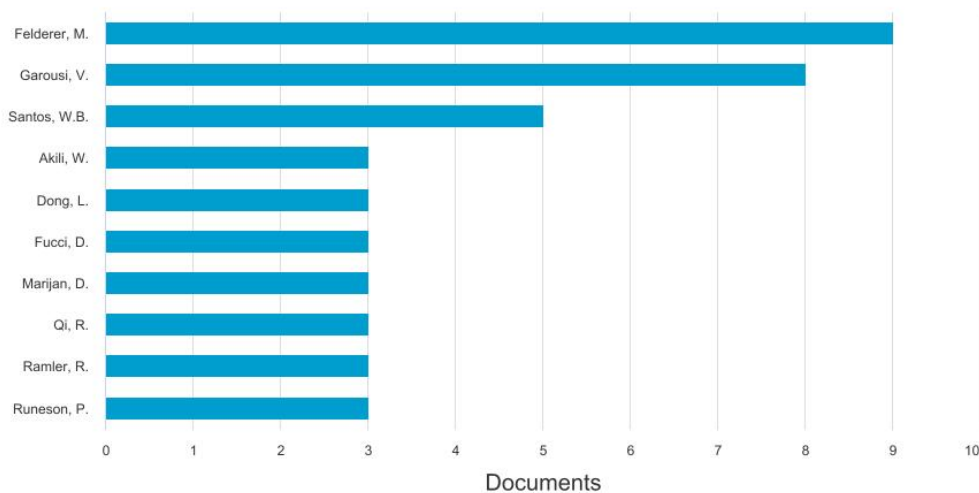
Figure 4.
Publication by Authors.

While Felderer, M., and Garousi, V. emerge as the leading contributors, it is also essential to recognize the significant efforts of the other authors who, although having a smaller number of publications, add diversity and depth to the body of research. This combination of high-output and steady contributors underscores the collaborative and multifaceted nature of the research in this field.

4.3. Countries Bibliography

Figure 5 represents the bibliographic coupling of countries, where the analysis measures the similarity between research sources to explore commonalities in different research domains. Bibliographic coupling is evident when two documents cite the same third study. At the country level, this coupling reflects situations where publications from two countries reference a shared document, illustrating the degree to which countries utilize similar literature and focus on comparable research topics.

In the visualization, each circle symbolizes a specific country or region, and the size of the circle corresponds to its influence or the number of publications in the bibliographic coupling network. The connections between these circles (lines) denote shared references among the countries, while the color-coded clusters group countries with similar research focus. There are nine distinct clusters in this analysis, indicating a diversity of research topics or challenges being addressed.

Countries within the same cluster tend to face similar "industry education integration model" problems or concentrate on related issues. For instance, major contributors like China and the United States are depicted with large circles, reflecting their central role in the network. European nations such as Germany, the United Kingdom, and France form tightly interconnected clusters, signifying regional collaboration or shared research priorities. Emerging economies like Brazil and South Africa are also linked but occupy smaller clusters, indicating their distinct but connected research focuses. The figure highlights that while certain challenges overlap across regions, issues related to industry education integration models vary significantly in scope and emphasis among different countries.
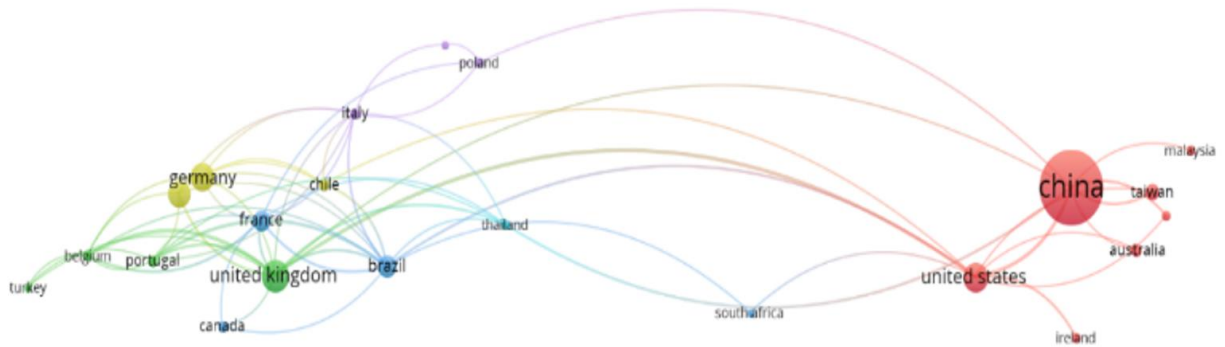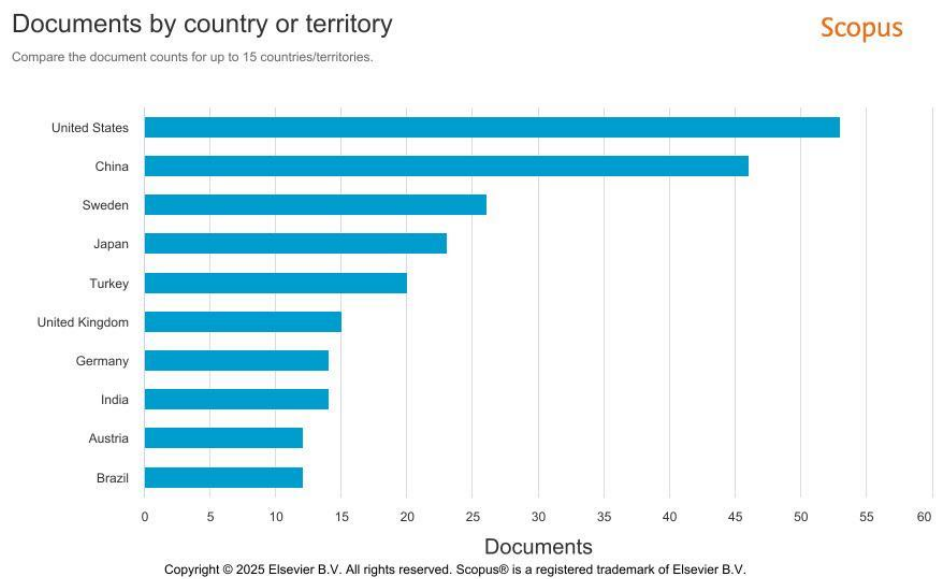
Figure 5.
Publication trend in countries.

Figure 6.
Publication trend by countries.

4.4. Keywords Bibliography Coupling

To explore the research dynamics and future directions in the context of industry-education integration, a co-occurrence analysis of keywords was conducted. Keywords serve as the most concise representation of an academic article, and their co-occurrence provides insights into research hotspots and emerging trends within the field. A keyword co-occurrence graph was created using VOSviewer, as depicted in Figure 7. For this analysis, a minimum threshold was set for the frequency of keyword occurrences, ensuring that the focus was on the most significant terms within the dataset.
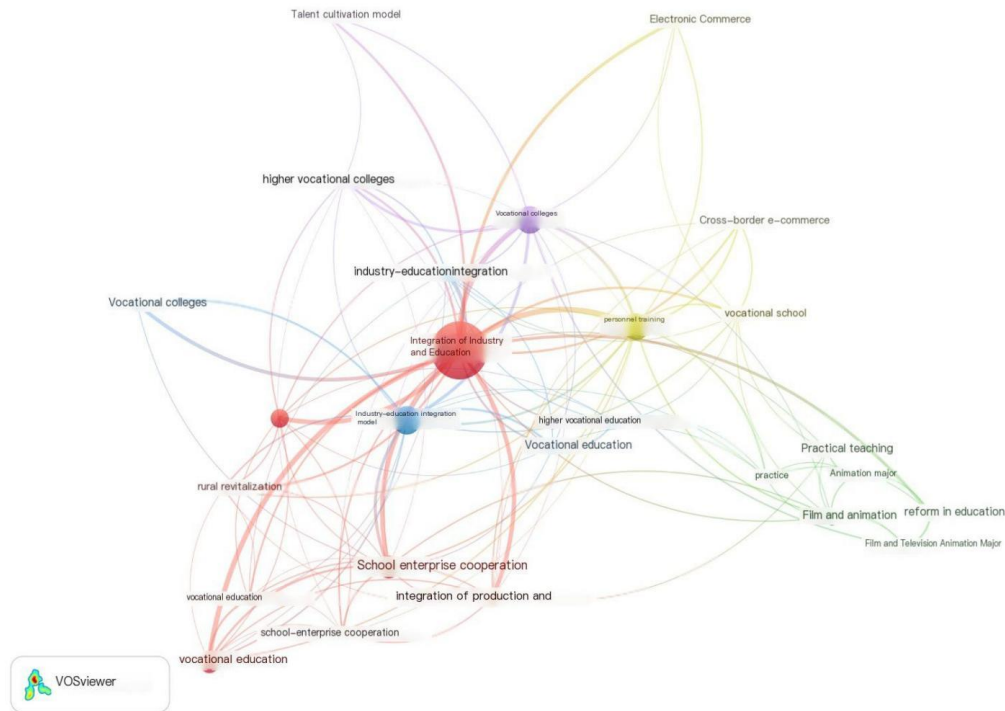
Figure 7.
Keyword density.

In the visual representation, each node corresponds to a specific keyword, with the size of the node reflecting the frequency of its occurrence in the research corpus. The proximity between nodes and the thickness of the connecting lines signify the strength of co-occurrence between keyword pairs. Clusters, represented by distinct colors, group together keywords that frequently co-occur, highlighting broad research topics and thematic concentrations. For example, keywords such as "industry-education integration," "higher vocational colleges," and "school-enterprise cooperation" form central nodes, suggesting their prominence in the field.

The map illustrates the co-occurrence network of keywords in the context of "Integration of Industry and Education." The size of each node represents the frequency with which a keyword appears in the analyzed literature, with the central and largest node, "Integration of Industry and Education," signifying its primary importance. The connections (edges) between the nodes depict the strength of co-occurrence between keywords, with thicker lines indicating stronger associations. Additionally, the colors differentiate between clusters of keywords, grouping closely related topics into thematic areas that highlight subdomains of research and discussion.

The red cluster is particularly prominent, encompassing core themes such as "Industry-Education Integration Model" and "School-Enterprise Cooperation," This cluster underscores the critical role of aligning educational institutions with industry needs to foster practical skill development and create a workforce tailored to the demands of modern economies. It reflects the necessity of collaborative frameworks where industries and educational institutions mutually support one another through resource sharing, talent cultivation, and technological innovation. Such partnerships are pivotal for ensuring that education systems remain relevant and adaptable to changing socio-economic conditions.

The emphasis on industry-academia collaboration in the red cluster aligns with global trends in vocational education. Historical developments demonstrate that high-quality vocational education is intrinsically linked to rapid economic and social progress. For instance, in 2017, General Secretary Xi Jinping emphasized the need to improve vocational education systems by deepening collaboration between industries and academia, a strategy aimed at integrating specialized training with market needs. Scholars have long studied the concept, tracing its roots to cooperative education models such as Marx's vision of integrating labor with education and Allan's emphasis on combining production and learning. Examples like Germany's "dual system" and the global cooperative education initiatives further illustrate the value of embedding practical experiences into academic frameworks. These efforts foster a dynamic synergy between theory and practice, benefiting vocational education, industries, and society at large by providing skilled talent, enhancing innovation, and driving sustainable development.

The blue cluster, dominated by keywords like "Higher Vocational Colleges" and "Vocational Colleges," underscores the critical role of vocational education institutions in bridging education and industry demands. This cluster explores educational models designed to enhance career-oriented and practical learning, particularly in vocational education. Higher vocational colleges in China have emerged as a key segment within the broader framework of vocational education. These institutions are specialized higher education entities that focus on providing vocational training and education programs. According to the Chinese Ministry of Education's guidelines established at the end of the 20th century, non-teacher training, non-medical, and non-public security institutions within the full-time higher education category standardized their nomenclature to

"vocational and technical colleges." This distinction sets them apart from traditional undergraduate universities, as their core focus lies in cultivating applied talents who integrate theoretical knowledge with practical skills to meet industry needs [24].

Functionally, higher vocational colleges aim to develop highly skilled personnel with practical abilities, emphasizing application and teaching [25]. Their primary mission is to train professional talents required for various industries, making them distinct from regular universities. A select few also provide preparatory undergraduate education or professional upgrading programs, and some experiment with five-year vocational education models. Based on their unique professional focus, these colleges are further categorized into types such as teacher training institutions, higher technical colleges, comprehensive colleges, and broad-spectrum science universities. The evolving industrial structure in China has amplified the demand for skilled professionals, positioning higher vocational education as an indispensable component of the nation's education system. This education form complements other higher education systems, collectively forming the holistic structure of higher education in China [24, 26]. As such, higher vocational colleges play a vital role in bridging the gap between education and employment by equipping students with industry-relevant skills.

The yellow cluster centers around themes such as "Practical Teaching," and "Personnel Training," emphasizing the importance of hands-on, skills-based learning to improve workforce preparedness. This cluster suggests a focus on reforming teaching methodologies to integrate more experiential learning approaches. It focuses on "Practical Training," emphasizing the challenges and opportunities within the industry-academia model of talent development. Practical training plays a vital role in bridging the gap between theoretical education and the demands of the labor market. However, significant challenges persist at three levels: government, enterprises, and colleges. Research highlights issues such as insufficient support from local governments, weak engagement from enterprises, and shortcomings in vocational colleges themselves [27]. For instance, many enterprises show a limited willingness to participate due to the uncertainty of market environments, speculative behaviors, and challenges in assessing the professional quality of college graduates. Additionally, vocational colleges often struggle to adapt their curricula to the rapidly changing needs of industries, leaving students with inadequate exposure to real-world production processes, technologies, and enterprise demands. These gaps result in a disconnect between the skills imparted by vocational education and the requirements of employers, compelling enterprises to provide extensive pre-employment training for new graduates [28].

To address these issues, scholars propose a multifaceted approach involving government intervention, institutional reform, and deeper enterprise engagement. The government must shift from a leading to a guiding role, providing robust policies and frameworks to support collaborative initiatives [29]. Colleges should enhance their capacity to engage with industries by establishing dual-teacher professional teams, updating curricula to align with industrial needs, and integrating practical training directly into educational models. Enterprises, as key stakeholders, are encouraged to take a more active role by collaborating with colleges to co-create training programs, share resources, and establish on-site training platforms. Furthermore, strategies such as the construction of information-sharing platforms, blended learning models, and order-based class systems can improve the alignment between academic and industrial practices, promoting deeper integration and ensuring that vocational education produces industry-ready graduates. By strengthening these collaborative mechanisms, practical training within the industry-academia model can meet the challenges of modern economic demands while fostering innovation and sustainable development.

Overall, the map underscores the centrality of "Integration of Industry and Education" as a foundational theme that links various subdomains of vocational and higher education to industrial collaboration. It reveals emerging trends, such as the increasing importance of e-commerce and globalization, while also highlighting the enduring necessity of practical, skills-based learning. This visualization provides valuable insights into the evolving relationship between education and industry, aligning educational strategies with the demands of modern economies and specialized industries.

5. Conclusions

The bibliometric analysis of publications from 2005 to 2024 reveals significant and sustained growth in research on the academia-industry integration model. This upward trajectory, particularly pronounced after 2010 and peaking around 2019, underscores the increasing recognition of the importance of bridging the gap between educational institutions and industry. The surge in publications—a nearly sixfold increase between 2016 and 2020—reflects a global emphasis on fostering innovation and practical skill development through collaborative efforts.

The concentration of research in specific journals, notably Modern Vocational Education, which accounts for 22.88% of total publications, indicates a focused scholarly interest and the pivotal role of vocational education platforms in disseminating findings related to industry-education integration. The dominance of certain journals suggests that while the field is expanding, there is a core set of publications driving the conversation and influencing practice.

The bibliographic coupling at the country level highlights that nations like China and the United States are at the forefront of this research domain, contributing significantly to the global dialogue on integrating academia and industry. The formation of distinct clusters among countries illustrates both regional collaborations and the diversity of challenges faced in different contexts. European countries form tightly connected clusters, indicating shared research priorities and possibly collaborative initiatives aimed at addressing common issues in industry-education integration.

Keyword co-occurrence analysis further illuminates the thematic focus within the field. The centrality of terms like "industry-education integration," "higher vocational colleges," and "school-enterprise cooperation" indicates that efforts are concentrated on practical implementations of collaborative models. The prominence of the red cluster emphasizes the critical role of aligning educational curricula with industry needs, advocating for mutual support between sectors to enhance resource sharing and talent cultivation.

The blue cluster's focus on higher vocational colleges underscores the strategic importance of these institutions in preparing a workforce equipped with both theoretical knowledge and practical skills. This aligns with global trends recognizing vocational education as a cornerstone for economic and social development. The challenges identified, such as insufficient support from local governments and limited enterprise engagement, highlight areas where policy intervention and institutional reforms could foster more effective collaborations.

The yellow cluster sheds light on the imperative of practical teaching and personnel training, emphasizing experiential learning as a means to enhance workforce preparedness. Addressing the gaps between educational offerings and industry requirements necessitates innovative approaches, such as the development of dual-teacher professional teams and the integration of real-world production technologies into curricula.

In conclusion, the sustained growth and thematic developments in research on the academia-industry integration model reflect its critical role in shaping future educational and economic landscapes. The findings suggest a global movement towards more cohesive and practical collaborations between educational institutions and industries. However, challenges remain, particularly in harmonizing efforts across different sectors and regions. Future research should focus on developing standardized frameworks for collaboration, exploring the efficacy of various integration models, and addressing the specific barriers identified in different contexts.

By continuing to investigate and address these issues, scholars and practitioners can contribute to more effective strategies that not only enhance educational outcomes but also meet the evolving demands of industries. This, in turn, can lead to sustained economic growth, innovation, and the development of a workforce capable of navigating the complexities of the modern global economy.

References

[1]   L. Su, "Toward a cooperative paradigm for the history of women's education in the United States: An overview," *Advances in Historical Studies,* vol. 11, no. 1, pp. 15-26, 2022. https://doi.org/10.4236/ahs.2022.111002

[2]   H. Ertl, "Dual study programmes in Germany: blurring the boundaries between higher education and vocational training?," *Oxford Review of Education,* vol. 46, no. 1, pp. 79-95, 2020. https://doi.org/10.1080/03054985.2019.1687438

[3]   T. Chong, "Vocational education in Singapore: meritocracy and hidden narratives," *Discourse: Studies in the Cultural Politics of Education,* vol. 35, no. 5, pp. 637–648, 2014. https://doi.org/10.1080/01596306.2014.921996

[4]   J. Ren, Q. Wu, Z. Han, K. Gong, and D. Wang, "Research on the education of industry-academia for geological majors," *Educational Sciences: Theory & Practice,* vol. 18, no. 5, 2018. https://doi.org/10.12738/estp.2018.5.030

[5]   C. Xiang, "Reflections on the joint cultivation of undergraduate animation education in China and Thailand," *International Journal of Learning and Teaching,* vol. 6, no. 2, pp. 129-134, 2020.

[6]   D. Haibin, "Interdisciplinary talents cultivation of animation education in universities based on university-enterprise cooperation mode," *International Journal of e-Education, e-Business, e-Management and e-Learning,* vol. 8, no. 3, pp. 165-172, 2018. https://doi.org/10.17706/ijeeee.2018.8.3.165-172

[7]   X. Wu and Y. Ye, *Technical and Vocational Education in China*. Singapore: Springer 2018.

[8]   Y. Ling, S. J. Chung, and L. Wang, "Research on the reform of management system of higher vocational education in China based on personality standard," *Current Psychology,* vol. 42, no. 2, pp. 1225-1237, 2023. https://doi.org/10.1007/s12144-021-01480-6

[9]   R. Kivits and S. Sawang, *Stakeholder theory. In R. Kivits & S. Sawang (Eds.), The Dynamism of Stakeholder Engagement: A Case Study of the Aviation Industry*. Springer. https://doi.org/10.1007/978-3-030-70428-5_1, 2021.

[10]   T. Yang, R. Qi, and L. Dong, "Research on the trend of the cultivation of 'double carbon' talents from the perspective of industry-academia model," in *Proceedings of the 9th Academic Conference of Geology Resource Management and Sustainable Development, Aussino Academic Publishing House*, 2022, pp. 1398–1404.

[11]   Z. Wang, Y. Zhao, and B. Wang, "A bibliometric analysis of climate change adaptation based on massive research literature data," *Journal of Cleaner Production,* vol. 199, pp. 1072–1082, 2018. https://doi.org/10.1016/j.jclepro.2018.06.183

[12]   D. Cao, "From 'industry-academia cooperation' to 'industry-academia model': Confusion and reflection on promoting in-depth industry-academia model in applied undergraduate colleges," *Tianzhong Academic Journal,* vol. 1, pp. 133–138, 2015.

[13]   Z. Wang, "From deepening the connotation of integration of industry and education to Innovating the Carrier," *China Higher Education Research,* vol. 12, pp. 61–64, 2019.

[14]   J. M. Gu and E. L. Bin, "Curriculum reform for deepening the integration of vocational education and industry from the perspective of knowledge governance," *Research in Higher Education of Engineering,* vol. 2, pp. 153–158, 2023.

[15]   National People's Congress of the People's Republic of China, "Vocational education law of the people's Republic of China," Retrieved: https://en.wikisource.org/wiki/Vocational_Education_Law_of_the_People%27s_Republic_of_China_%282022%29?utm_source=chatgpt.com, 2022.

[16]   State Council, "Planning outline for the construction of a social credit system (2014–2020)," Retrieved: https://digichina.stanford.edu/work/planning-outline-for-the-construction-of-a-social-credit-system-2014-2020/?utm_source=chatgpt.com, 2014.

[17]   J. Xiao, "From combination of industry and education to industry-academia model: Policy changes in vocational education over 40 years," *China Higher Education Research,* vol. 8, pp. 66–71, 2019.

[18]   I. A. Shahzad, M. Farrukh, Y. Wu, and N. Trunk, "Human systems management: A retrospective of 40 years," *Human Systems Management,* vol. 40, no. 1, pp. 15-30, 2021.

[19]   M. Farhan and M. K. Iqbal, "Twenty years of sustainable supply chain: Past trends and future research suggestions," *International Journal of Business and Psychology,* vol. 3, no. 1, pp. 1-16, 2021.

[20]   K. Nawaz, T. Aslam, and H. Saeed, "A bibliometric analysis of international journal of sports marketing & sponsorship," *International journal of business and psychology,* vol. 2, no. 1, pp. 45-60, 2020.

[21]   M. Farrukh, A. Raza, F. Meng, and Y. Wu, "CMS at 13: A retrospective of the journey," *Chinese Management Studies,* vol. 16, no. 1, pp. 119-139, 2022. https://doi.org/10.1108/cms-07-2020-0291

[22]   D. W. Aksnes and G. Sivertsen, "A criteria-based assessment of the coverage of scopus and web of science," *Journal of Data and Information Science,* vol. 4, pp. 1–21, 2019. https://doi.org/10.2478/jdis-2019-0001

[23]   V. Durieux and P. A. Gevenois, "Bibliometric indicators: Quality measurements of scientific publication," *Radiology,* vol. 255, no. 2, pp. 342-351, 2010. https://doi.org/10.1148/radiol.09090626

[24]   Y. Wen, H. Chen, L. Pang, and X. Gu, "The relationship between emotional intelligence and entrepreneurial self-efficacy of Chinese vocational college students," *International journal of environmental research and public health,* vol. 17, no. 12, p. 4511, 2020. https://doi.org/10.3390/ijerph17124511

[25]   N. Masri, A. Abdullah, S. Asimiran, and Z. Zaremohzzabieh, "The relationship between engagement in learning entrepreneurship education and entrepreneurial intention among vocational college students," *Pertanika Journal of Social Sciences & Humanities,* vol. 29, pp. 19–38, 2021. https://doi.org/10.47836/pjssh.29.s1.02

[26]   A. A. Khan, M. H. B. Hidthiir, and T. B. Wah, "Nonlinear impact of remittances on financial inclusion in developing countries: Does governance quality matter?," *Pakistan Journal of Commerce and Social Sciences,* vol. 18, no. 4, pp. 811-831, 2024.

[27]   T. Hua, "Dilemma and way out of 'industry-academia model and industry-academia cooperation' in universities," *China University Science and Technology,* vol. 11, pp. 56–57, 2017.

[28]   F. Gao and P. Zhang, "Performance evaluation of industry-education integration in Higher Vocational Colleges: An evidence from China," *International Journal of Emerging Technologies in Learning (iJET),* vol. 15, no. 23, pp. 208-219, 2020. https://doi.org/10.3991/ijet.v15i23.19025

[29]   Y. M. Wu, "Realistic problems and coping strategies of industry and education integration in vocational education: A case study of a city," *Vocational and Technical Education,* vol. 39, no. 31, pp. 44–50, 2018.