

Tracking Global Trends in Personalized Teaching: A Bibliometric and Keyword Co-Occurrence Analysis

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Abstract

This article employs bibliometric analysis to examine the temporal changes in publication output in personalized teaching, including the evolution of publication sources, publication output of different countries over time, and the collaboration and trends among countries and institutions. Additionally, it analyzes the co-occurrence of keywords. These analyses are of great significance for revealing research trends and the evolution of the field in personalized teaching.

Keywords

Personalized learning ; education; performance; e-learning; artificial intelligence; Introduction.

1. Introduction

Advances in technology have increased the opportunities for teachers to personalise instruction based on student actions^[1]. The rapid advancement of information technology and the continuous innovation of educational concepts have driven higher education to shift from the traditional "standardized" teaching model to a "personalized" one. Personalized teaching emphasizes the provision of customized learning content and support based on individual differences among students, such as learning styles, cognitive abilities, and interest preferences, thereby enhancing learning outcomes and educational quality. Against this backdrop, the scientific evaluation of the research progress, hotspots, and future trends in personalized teaching has become a significant issue for educational researchers and practitioners.

With the acceleration of the global digital transformation of education and the diversification of learners' needs, personalized teaching in higher education has gradually become a core issue in educational reform^[1]. Its importance is mainly reflected in the following aspects:

1. Meeting Diverse Learning Needs of Students

The modern student body in higher education exhibits significant differences in cognitive abilities, learning styles, cultural backgrounds, and career goals. The traditional "one-size-fits-all" teaching model is unable to meet the diverse needs of students. In contrast, personalized teaching, by customizing learning paths, adjusting the pace and content of instruction, can more accurately match individual differences among students, thereby improving learning efficiency and satisfaction^[3].

2. Enhancing Learning Outcomes and Academic Performance

Research indicates that personalized teaching can significantly increase student engagement, knowledge acquisition, and academic achievement. For instance, adaptive learning systems based on artificial intelligence (AI) can analyze students' learning data in real-time and dynamically adjust teaching strategies to ensure that each student progresses in an environment suitable for their level.

3. Promoting Educational Equity and Inclusiveness

Personalized teaching helps to reduce educational inequality. For example, the system can provide additional tutoring resources for students who struggle with learning and offer more challenging tasks for high-achieving students. Moreover, online learning platforms and blended teaching models enable students in remote areas or with special needs to access high-quality educational resources.

4. Facilitating the Digital Transformation of Education

The development of technologies such as big data, artificial intelligence, and learning analytics has provided strong technical support for personalized teaching. Educational institutions can use learning management systems (LMS) to collect student behavior data, optimize course design, and achieve precise teaching.

5. Responding to the Challenges of the Future Labor Market

In the rapidly changing labor market, students need to possess lifelong learning capabilities and adaptability. Personalized teaching, which emphasizes self-directed learning, critical thinking, and problem-solving skills, can better cultivate students' core competencies and prepare them for future career demands.

6. Improving Teaching Efficiency for Educators

Personalized teaching does not rely solely on technology but emphasizes a collaborative model of "teacher + AI." Educators can use data analysis tools to identify students' learning bottlenecks, optimize teaching strategies, thereby reducing repetitive work and focusing on more creative teaching activities.

Bibliometrics, as a research method based on quantitative analysis, can reveal the research dynamics, knowledge structure, and academic influence of a particular field through systematic mining and statistical analysis of academic literature^[4]. In the study of personalized teaching in higher education, the application of bibliometrics plays the following important roles:

1. **Research Trend Analysis:** By examining indicators such as the number of publications and their temporal distribution, it reveals the developmental trajectory of research on personalized teaching, identifies key developmental stages, and points to future research directions.

2. **Hotspot Topic Identification:** Utilizing methods such as keyword co-occurrence analysis and topic clustering, it uncovers core issues in the field of personalized teaching (such as adaptive learning technologies, learner profiling, and data-driven teaching decisions), providing theoretical support for practice.

3. **Academic Influence Assessment:** Through citation network analysis, it identifies high-impact literature, authors, and institutions, thereby promoting academic communication and cooperation.

4. **Interdisciplinary Integration Exploration:** Personalized teaching involves multiple disciplines such as education, psychology, and computer science. Bibliometrics can help clarify the intersections between disciplines and drive innovative research.

This paper systematically analyzes the relevant literature in the field of personalized teaching in higher education in recent years using bibliometric methods. It aims to reveal the current research status, knowledge base, and cutting-edge trends in this area, providing references for subsequent research and practice. Through quantitative analysis, we hope to provide a scientific basis for the optimization and promotion of personalized teaching, further advancing the digital transformation and quality improvement of higher education.

2. Data Sources and Methods

2.1. Data sources and search strategy

Bibliometric analysis is a systematic method for quantitatively analyzing academic literature to identify research characteristics, proposed by Alan Pritchard. Initially applied in library and

information science, bibliometric analysis has now been widely used across various fields to measure scientific progress^[5]. The application of bibliometrics typically focuses on the distribution structure of publication time, authors, journals, and hot topics within a specific research area. As a powerful and valuable tool for information visualization, bibliometric analysis enables scholars to capture the research performance and growth trends of global scientific literature in specific fields or topics. Additionally, it provides a comprehensive macro overview of influential academic literature in a particular field or topic from the perspectives of major authors, journals, institutions, and countries.

In this study, bibliometric analysis is combined with scientific mapping methods to provide quantitative and qualitative insights into measuring research growth trends in a specific field. The Web of Science (WoS) database, developed by Thomson Reuters, is used as it covers the most important scientific search engines and the most relevant databases for retrieving bibliometric data. Compared with other databases such as PubMed, Scopus, and Google Scholar, WoS is considered the global leading quality-oriented database, containing more standardized records for retrieving global scientific literature across multidisciplinary fields and research areas. The WoS database also provides a set of metadata crucial for bibliometric and network analysis^[6] including abstracts, document types, timelines, citation counts, scholar lists, countries, universities, and journal impact factors. Therefore, this study selects WoS as the scientific data source for bibliometric analysis.

This paper uses the Web of Science (WOS) Core Collection to search for the subject scope of keywords. The keyword search formula is “personalized teaching” or “individualization teaching” or “individual teaching” or “personalized learning” not “primary school” or “middle school” or “junior high school” or “secondary school” or “kindergartens school” or “nursery” or “preschool”. The keywords are combined using the Boolean operator “OR”. The search range is from January 1, 2010, to December 31, 2024. By carefully reading the titles and abstracts of each document and excluding as many irrelevant documents as possible, we manually selected 721 publications that fit the research topic.

2.2. Statical analysis

A variety of software tools are available for conducting bibliometric analysis. The choice of VOSviewer for this study is due to its exceptional capability in generating network visualizations. VOSviewer is a powerful bibliometric analysis tool that employs a weighted variational algorithm based on modular clustering, resulting in clusters with high consistency and stability. Optimal clustering outcomes are achieved when the modularity Q value is maximized. This software is capable of producing visual network diagrams, such as co-citation, bibliographic coupling, and co-occurrence networks, which effectively assess the relationships among publications, institutions, and authors.

3. Results

3.1. Number of published articles

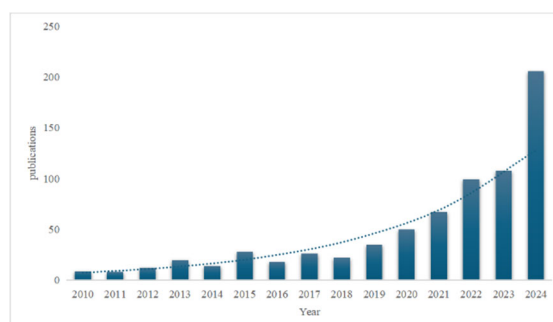


Figure 1. The Changes in Publication Output

3.2. The analys of countries

3.2.1. Number of articles by countries

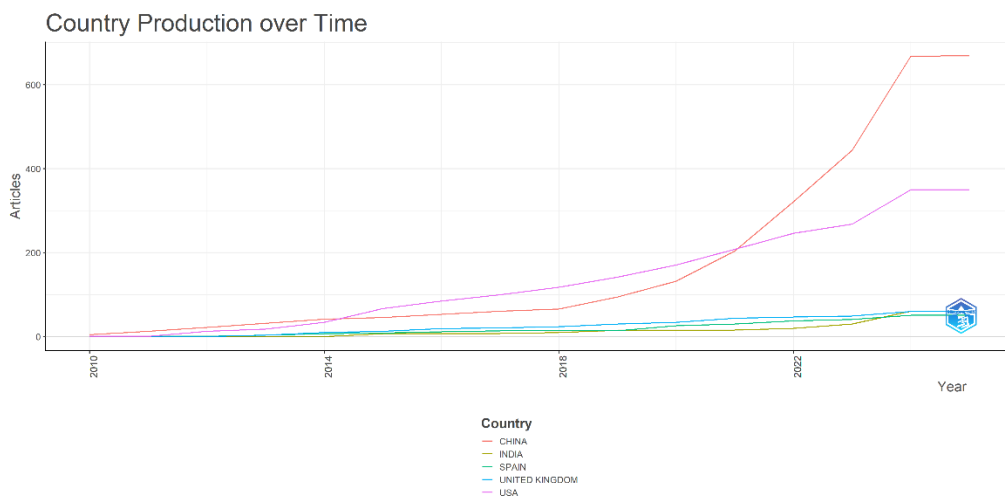


Figure 2. Publication Output of Countries Over Time

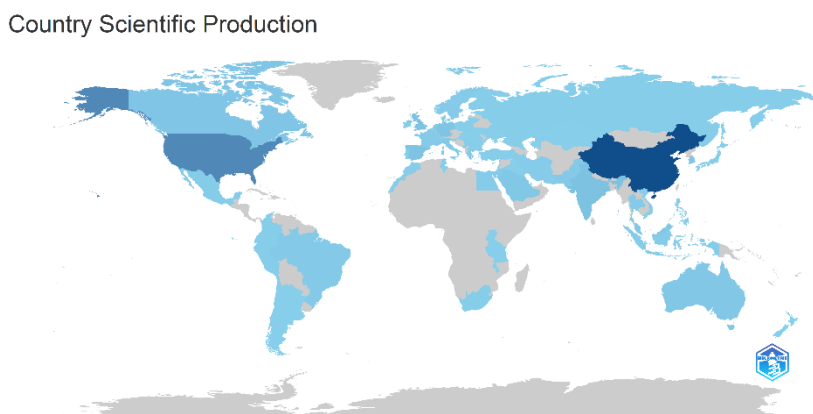


Figure 3. The scientific Production of countries

Figure 2 illustrates the trend of article output in the field of personalized teaching in higher education, encompassing five major Web of Science (WoS) subject categories. A total of 714 research articles on personalized teaching in higher education were retrieved from the WoS database, published between 2010 and 2024. During the first nine years (2010–2018), the growth of research publications on the selected topic was relatively slow, with some fluctuations and fewer than 15 publications recorded in certain years. In the subsequent seven years (2018–2024), the number of research papers increased rapidly, attracting significant attention from numerous scholars. As a result, 564 of the 714 articles were published during this period, accounting for 78.9% of all included studies.

By conducting statistical analysis of the number of papers and country information, a collaboration network involving 50 countries was constructed, as shown in Figure 3. The depth of color corresponds to the number of publications from each country. Research in the field of Individualized teaching into two phases. From 2010 to 2018, the field was in its early developmental stage, with a limited number of research papers being published. Since 2019, the field has been in a stage of rapid development, with a steady increase in the number of publications and a stable proportion of research and review papers. Among these publications, China has the highest number of publications in this field, taking a leading position. The United

States, India, the United Kingdom, Spain, and Germany also have a considerable number of publications.

3.2.2. Co-authorship among countries

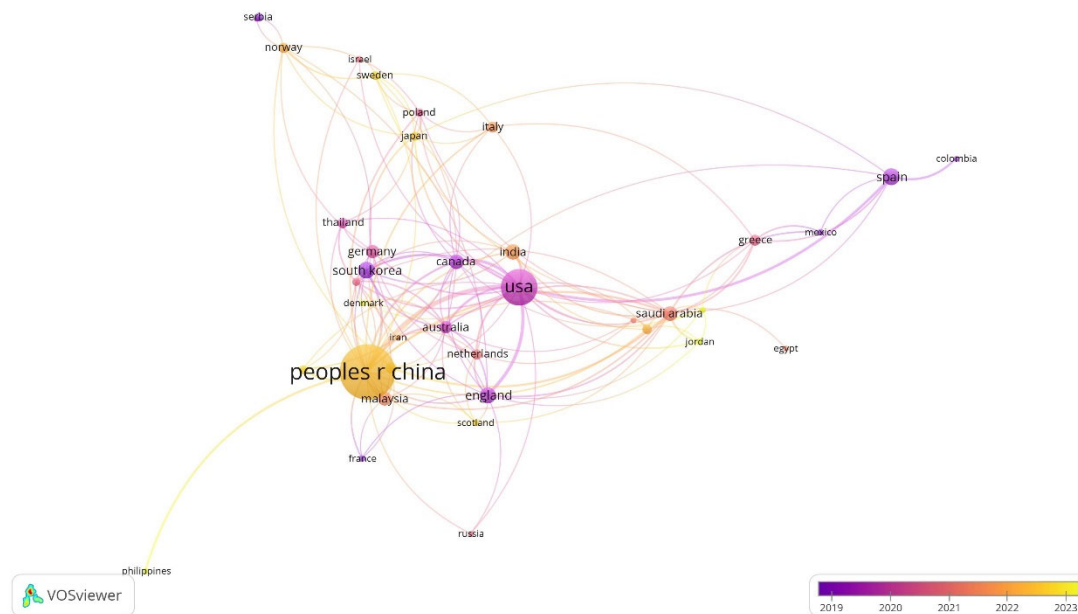


Figure 4. International Collaboration in Personalized Teaching: A Network Analysis

Figure 4 presents the co-occurrence of international collaboration, with a minimum of four publications required for inclusion. From a pool of 78 countries, 42 met this criterion. The figure illustrates the extent of communication and collaboration among authors from different countries in the field of personalized teaching. The strength of the links is determined by the size of the nodes. Generally, the larger the node of a country, the more extensive its collaboration and cooperation with researchers in personalized teaching from other countries. China (with 23 links and a total link strength of 76) played a pivotal role in this research topic, closely collaborating with various countries and possessing the largest node and the highest number of links in the co-authorship map. The co-authorship analysis also revealed that the United States (23 links, total link strength of 76) had the highest link strength among all countries, followed by Saudi Arabia (18 links, total link strength of 33), Australia (14 links, total link strength of 27), and the United Kingdom (14 links, total link strength of 26).

This study indicates that the United States, the United Kingdom, Saudi Arabia, and Australia initiated research on personalized teaching relatively early, with the majority of their publications emerging around 2019. In contrast, China's primary output of publications occurred around 2022, which may be associated with the COVID-19 pandemic. The timeline in the lower right corner shows that research collaborations in personalized teaching shifted from partnerships with developed European countries such as the United States, the United Kingdom, and Spain in 2020, to collaborations with Asian developing countries like China, Jordan, and Qatar. This trend suggests that the field still holds immense potential for exploration, with international collaboration being a key trend for in-depth research.

3.3. Co-authorship among organizations

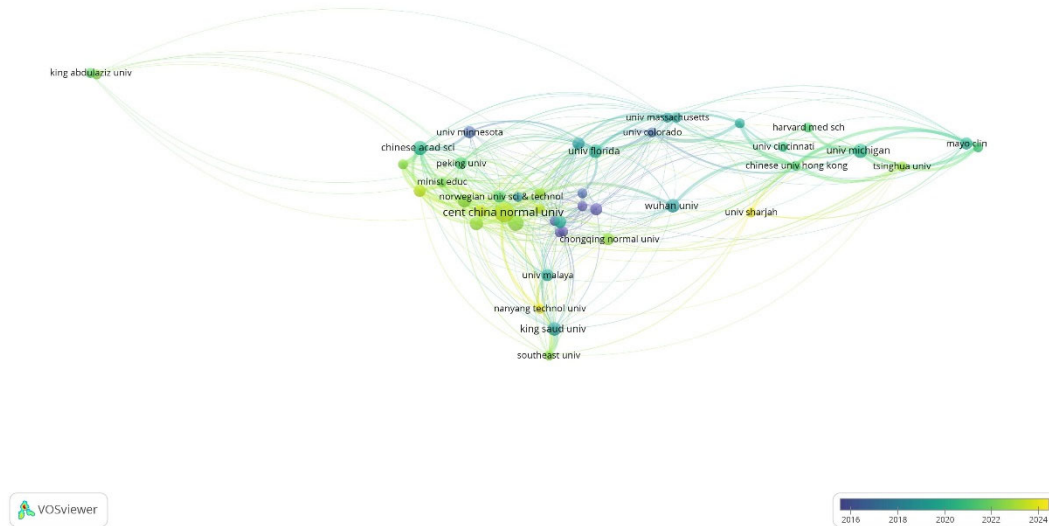


Figure 5. Research cooperation network among institutions

Figure 4 presents a total of 1,173 academic institutions from various countries have engaged in research on personalized teaching. In this study, we selected 44 institutions for detailed analysis. Among them, the Chinese institutions included Tsinghua University, Peking University, Wuhan University, Chongqing University, and the University of Hong Kong. International institutions featured Harvard University, Nanyang Technological University, among others. Another remarkable finding emerged from this analysis. These selected institutions demonstrated a high level of contribution to the field of personalized teaching^[7]. This information provides crucial insights for a new layer of research at the institutional level and offers a foundation for a deeper understanding of the impact and collaborative patterns of these institutions.

3.4. The analys of journals

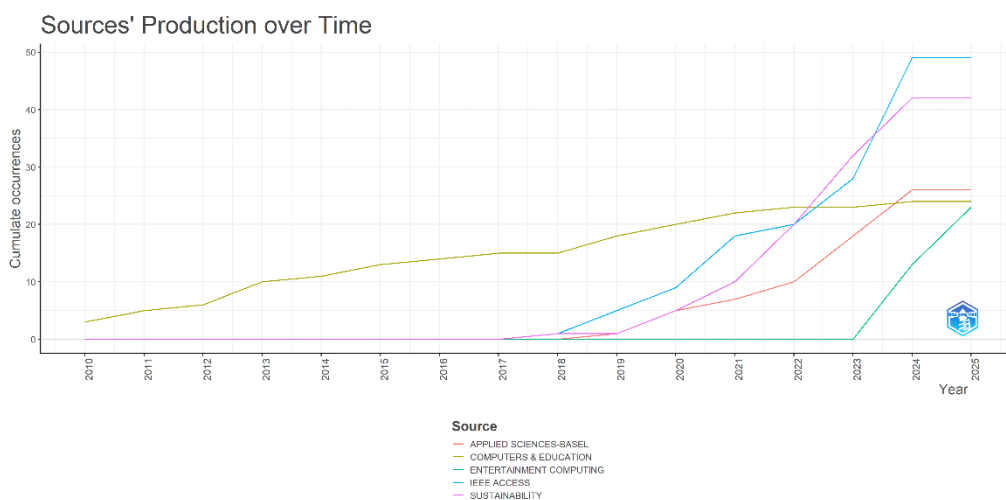


Figure 6. Sources' production over time.

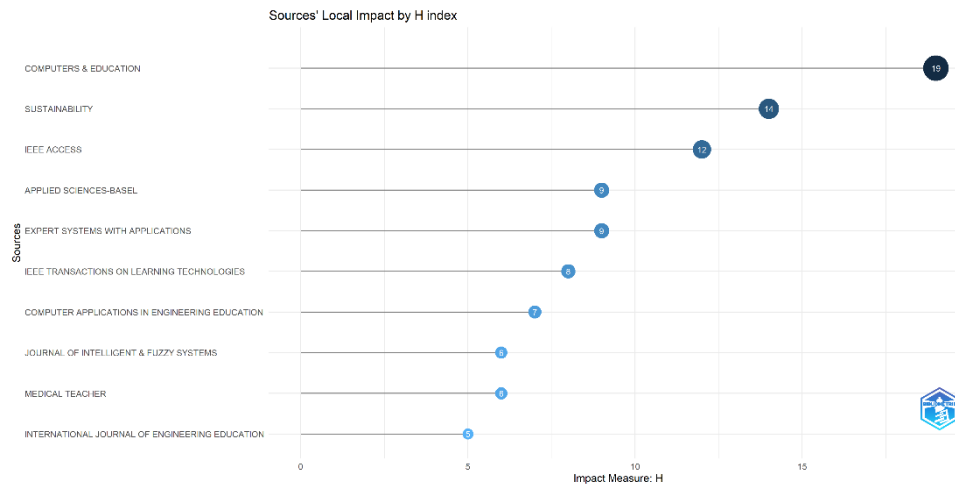


Figure 7. Sources’ production over time.

Figure 6 presents the annual number of papers published in the top five journals in the field of personalized teaching from 2010 to 2024. The number of articles in these journals generally follows an overall trend. From 2010 to 2018, the publication numbers were relatively low. However, from 2019 to 2024, there was a continuous increase in the number of publications. Among them, 《IEEE Access》 ranked first with nearly 50 published articles, followed by 《Sustainability》 with 44 articles.

Figure 7 displays the top 10 scientific journals in terms of publication count, which provides insights into the journals that are most interested in this topic. The H-index is a comprehensive indicator used to evaluate the quantity and quality of academic output of journals in a specific field. A higher H-index indicates that the journal’s articles are more relevant to the research area.

3.5. Keywords Clustering Analysis

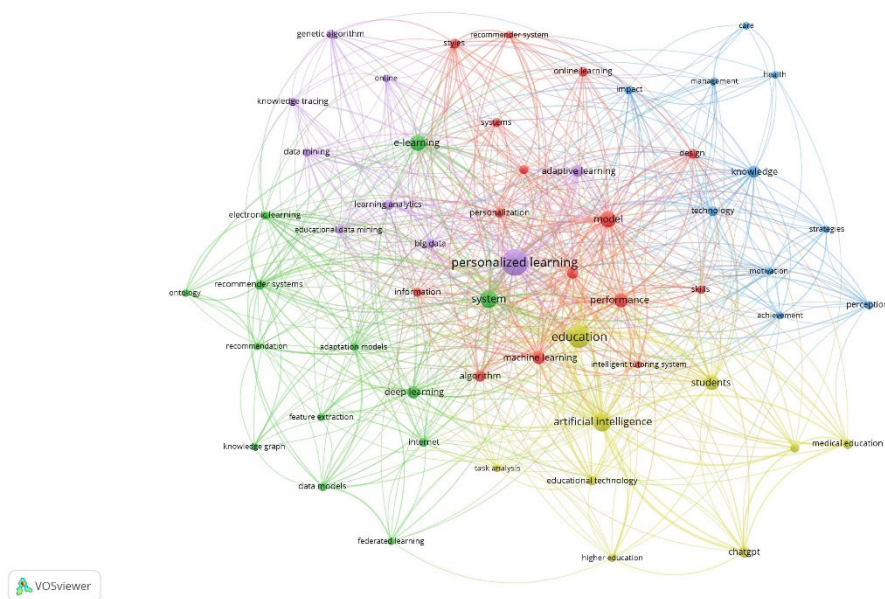


Figure 8. Keywords Analysis

Keywords in scientific journals play a significant role in understanding research trends and directions, aiding in the identification of research gaps. High-frequency keywords indicate research hotspots. In this section, a co-occurrence analysis of keywords was conducted to systematically identify connections between different themes across three defined periods. The results of the keyword analysis demonstrate that the conceptual evolution of research themes is interconnected through clusters of keyword nodes. A total of 2,908 keywords met the criteria, and 56 were selected for detailed analysis. As shown in Figure 8, the keyword “personalized learning” has a very strong association (50 links, total link strength of 199), followed by “education” (52 links, total link strength of 187).

In this study, the frequent appearance of keywords is crucial for ensuring the visibility of the research in both current and past research issues. Thick connecting lines indicate a close relationship between two items, while the large size of the nodes represents a high frequency of occurrence.

4. Summary

In recent years, with the increasing attention to personalized teaching, the use of bibliometric analysis methods to conduct systematic and comprehensive analyses of this field can provide valuable insights for future research. This paper employs bibliometric methods to analyze 714 documents indexed in the Web of Science Core Collection, aiming to provide a comprehensive and in-depth understanding of the current state of personalized teaching in higher education and to explore its developmental trends.

This study utilized bibliometric tools to tally articles on personalized teaching in higher education published between 2010 and 2024, and analyzed the number of publications, journals, institutions, and countries involved. The following conclusions were drawn:

1. Personalized teaching in higher education has garnered significant attention from numerous scholars in the scientific community.
2. Since 2019, China has been in a phase of rapid development in terms of the number of publications in this field, with an annual increase in the number of papers published, taking a leading position.
3. China has played a pivotal role in this domain, closely collaborating with various countries. It has the largest node and the most connections on the co-authorship map, indicating that there is still considerable potential for exploration in this field and that international cooperation is a trend for in-depth research.
4. The number of publications in the field of personalized teaching has continued to grow from 2019 to 2024.
5. This paper conducted a co-occurrence analysis of keywords, revealing that the term “personalized learning” has a very strong association, followed by education.

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