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# A Bibliometric Analysis of the Literature on Postgraduate Teaching

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**Abstract:** The sustainable development of human society and economy needs the support of senior talents. Postgraduate teaching is one of the crucial components of higher education, and the priority method to cultivate senior talents. The 7th United Nations STI Forum in 2022 will focus on open science and postgraduate teaching; the theme of the forum is "While comprehensively implementing the 2030 Agenda for Sustainable Development, strengthen science, technology, and innovation, and promote the world's recovery from the COVID-19 pandemic". Therefore, the analysis of the field of postgraduate teaching is of great theoretical and practical significance to the cultivation of postgraduate students, the research of researchers, and the management of postgraduate teaching by the education sector. This research has carried out a bibliometric analysis to better obtain the knowledge structure in the field of postgraduate teaching and research, and help other researchers obtain the characteristics of the field of postgraduate teaching and research. VOSviewer and CiteSpace are used to analyze 4816 scientific core collection articles related to postgraduate teaching. These publications are from the Web of Science database. The dates of the articles range from 1995–2022. This research intuitively introduces a systematic overview of postgraduate teaching literature research, covering a number of publications, major categories, the most significant nations, groups, publications, writers, significant literature, and academic trends. The goal of this article is to create a map of the postgraduate teaching knowledge structure, while also examining the research collaboration across organizations, authors, nations, and areas. For scholars and practitioners in the field of graduate education, objective advice and helpful ideas are given through the analysis and discussion of the data acquired.

**Keywords:** sustainable development; postgraduate teaching; bibliometric analysis; VOSviewer; CiteSpace

**Citation:** Fan, S.; Jiang, J.; Li, F.; Zeng, G.; Gu, Y.; Guo, W. A Bibliometric Analysis of the Literature on Postgraduate Teaching. *Sustainability* **2022**, *14*, 17047. https://doi.org/10.3390/su142417047

Academic Editor: Diego Monferrer

Received: 18 November 2022
Accepted: 14 December 2022
Published: 19 December 2022



## 1. Introduction

Several significant sustainable development goals were proposed in the UN Sustainable Development Plan 2015–2030 (SDG). Among them, in (Goal 4) it is emphasized that "quality education, access to high-quality education, is the basis for improving people's lives and achieving sustainable development" [1]. As a key part of modern education, postgraduate education has a growing share in the field of education, which has a stronger and stronger role in promoting sustainable development in Goal 4.

Postgraduate teaching and the quality across different of education in the higher education system, has produced an enormous number of valuable talents for social and economic development, which is a powerful guarantee for the advancement of technology

and industry for all of humanity [2]. In recent years, the enrollment rate and teaching quality of postgraduate students around the world are steadily improving [3,4]. With the rapid expansion of the scale of graduate students, graduate teaching at home and abroad has also developed rapidly. Postgraduate teaching is an important way for society to cultivate high-quality talents, and building a quality assurance system of internal and external cooperation is an important means to cultivate postgraduates. Establishing a reasonable and effective postgraduate teaching quality assurance system is a complex and systematic project, which depends not only on the external cooperation of the government and society but also on the improvement of the internal quality culture and quality system of colleges and universities [5]. Reasonable postgraduate teaching should not only conform to the development law of teaching itself, but also promote the sustainable development of society [6–8].

In terms of the global environment, comprehensive research has already been performed on postgraduate teaching in European instructionally developed nations. 1993 saw the release of Conrad Fetal's book Silent Success: Master's Education in the United States [9], which summarized the factors that contribute to the success of graduate education in this country through interviews. Since then, the Scientific Research Basis of Postgraduate Education [10] and the Place of Inquiry—Scientific Research and Postgraduate Education in Modern Universities [11], edited by American scholars, have conducted a comprehensive and in-depth analysis of the history, current situation and problems of postgraduate teaching in the five major countries with developed education, namely, the United States, Britain, France, Germany, and Japan. In 2018, the UK Education Quality Assurance Agency (QAA) revised the UK Higher Education Quality Specification, defining the competency framework of graduate students as academic research ability, cooperation and communication ability, lifelong learning ability, professional access ability, and professional ethics ability [12]. The Master of Teaching Program of the University of Melbourne in Australia (2008) divides the teacher standard of master of education into three dimensions: professional knowledge, professional practice, and professional responsibility [13]. The University of Melbourne has launched the "Master of Teaching Program", which aims to cultivate "reflective practitioners" in the field of teacher education, emphasizing that the trained learners should have a solid foundation of discipline knowledge, strong critical reflection ability and rich teaching experience [14]. The actions and shared consensus of all nations worldwide to strongly enhance postgraduate teaching are evident from the experience of industrialized nations worldwide; to ensure the quality of postgraduate teaching, achieve the reserve and gathering of high-level talents in advance, and occupy the strategic commanding heights of the talent competition in the knowledge age [15].

In the process of writing literature reviews with traditional methods, the amount of literature collected is small, because it is extracted through manual reading. However, there is a large amount of literature in the field of review research. It is difficult to collect literature comprehensively and systematically, especially to correctly collect and understand the literature in different languages. However, the insufficient references collected will inevitably lead to the limitations of the content of the review. The goal of the bibliometric analysis approach is to evaluate the direction of research in a wide range of literary genres by applying statistical concepts and numerous indicators found in academic publications. Its research content is mainly about the mechanism of document information flow. The multi-knowledge map of the target field can be drawn specifically through, for example, the author index of the paper, the cited literature and the cited literature, their relationship, the utilization of the literature, the bibliography, the literature, and the index [16–18].

Since higher education enrollment has increased significantly, people from all walks of life have become much more interested in the quality of this sector of the economy. Academics research the healthy and sustainable development of postgraduate teaching.

However, of the existing literature, most of them make a conclusive summary of postgraduate teaching from a qualitative perspective. From a quantitative point of view, few articles can directly show the development and current situation of postgraduate teaching through the comparison of a large number of data. Based on this research situation, through bibliometric analysis (including the number of publications, main categories, countries, organizations, journals and authors from which publications come, important literature, research academic trends, research cooperation between countries and regions, and research cooperation between organizations and authors), we can achieve quantitative and visual research in the field of postgraduate teaching, which is the direction and focus of this research. Our study may provide a comprehensive understanding of the developments in the research on sustainable development of postgraduate teaching. This paper analyzes from four major categories, including research hotspot, cooperation analysis, source analysis and trend analysis.

## 2. Method

### *2.1. Bibliometric Analysis*

The key to bibliometric analysis is quantification. The qualities of the literature are examined and processed using the quantitative technique. Data from bibliographic sources are analyzed using the quantitative technique, such as publication year, publication number, reference number, author, journal, country, organization and keywords [19–22]. Bibliometric analysis can classify indicator elements and provide a descriptive overview [19]. It uses the research methods of information science, mathematics and statistics. It can deeply and accurately observe and describe various phenomena and laws by collecting and processing data. Based on several basic laws and regulations, research on literature distribution is carried out. At the same time, the establishment of Bradford's Law, Lotka's Law, and Zipf's Law has laid a solid foundation for bibliometric. The information capacity is not limited by the literature method. As long as the literature can be collected, it can be used as the research object [22–24].

### *2.2. Data Source and Tools*

The research achievements in the field of postgraduate teaching are very rich. To better and more comprehensively analyze its development law, this study selected the WoS core set. To avoid incorrect collection or missing statistics, this study collected articles with "Postgraduate teaching", "Postgraduate", "teaching for graduates" and "graduate teaching" in the title, abstract, or keyword. Through the search, we can find that the number of relevant articles published before 1995 is very small, and the number of documents published in 1995 and after gradually began to increase. Therefore, the implementation of bibliometric experiments will last from 1995 to 2022. After further comparison, 4816 documents were finally selected. There are 3954 publications on SCIE index, 1782 on SSCI index, 192 on CPCI-S index and 97 in A&HCI index.

In bibliometric analysis, CiteSpace and VOSviewer are commonly used tools. CiteSpace is a software for tracking and analyzing international cutting-edge research. It takes the literature system and bibliometric characteristics as the research object. It can not only quantitatively measure the profile distribution and a relationship and cluster between studies, describe and predict the development of specific research fields, but also analyze the information of different countries, institutions, journals and scholars, and compare their contributions [25,26]. VOSviewer is most suitable for a co-occurrence network. It is also a kind of knowledge map visualization software, which can use the basic classification and clustering methods and can cluster the keywords of literature, so as to find the research hotspots. The core idea of its design is "co-occurrence clustering", that is, the simultaneous appearance of two things means that they are related; There are many

types of correlation, and their intensity and direction are different; The measurement index clustering based on relationship strength and direction can find different types of groups.

### *2.3. Research Process*

The goal of this research is to realize the visualization of the development status and prediction of the development trend of the field of postgraduate teaching based on the bibliometric method and to conduct an in-depth discussion on the following five research issues. The five questions are based on previous studies [27]. The technical route is shown in Figure 1.

Q1. For the field of postgraduate teaching, how about the number of relevant publications and citation trends so far?

Q2. What are the categories of publications in the field of postgraduate teaching and how are they distributed?

Q3. What is the nature of the collaboration between many nations, communities, organizations, and writers?

Q4. What is the distribution of literature sources in the field of postgraduate teaching?

Q5. What is the research trend and evolution process in the field of postgraduate teaching?

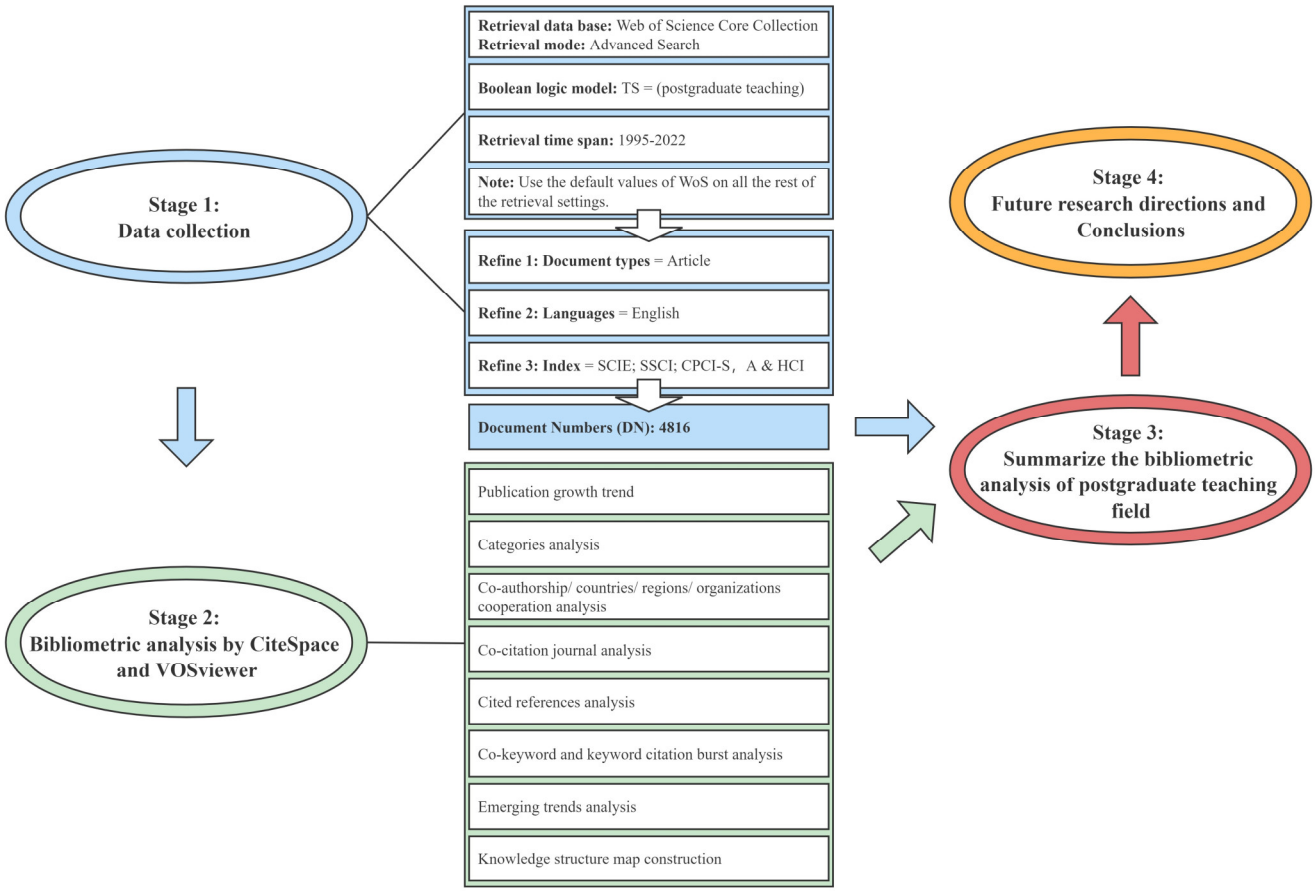



**Figure 1.** Technical roadmap of this study. Note: Data collection time in WoS on 19 October 2022.

The first step of this research is the data collection of literature. In the advanced search of Web of Science, the search format is as follows: (ALL = (postgraduate teaching)) AND DOP= (1995/2022) and Science Citation Index Expanded (SCI-Expanded) or Social

Sciences Citation Index (SSCI) or Conference Proceedings Citation Index—Science (CPCI-S) or Arts & Humanities Citation Index (A&HCI). At the same time, the set language is English, and finally, 4816 documents were obtained. The SCIE index has 3954 publications, the SSCI index has 1782, the CPCI-S index has 192, and the A&HCI index has 97. Not all of these publications can be found in one index, it should be noted.

In the second stage, according to the user's habits, this study selected CiteSpace (refer to the use method of CiteSpace for bibliometric analysis of carbon neutralization) [28] and VOSviewer [29], two bibliometric tools, to analyze the 4816 publications mentioned above. By using keyword analysis, cooperation analysis between authors, cooperation analysis between countries and regions, cooperation analysis between organizations, source analysis and keyword evolution analysis, a map of cutting-edge scientific knowledge for postgraduate teaching is constructed.

The third stage discusses and summarizes the development status of the field of postgraduate education based on bibliometric.

In the fourth stage, we summarize the current achievements in the field of postgraduate education research and made suggestions, and propose potential research and development directions.

## 3. Results

### *3.1. Research Status and Hotspot Analysis*

#### 3.1.1. Publication Growth Trend and Category Analysis

In the information collected, the primary consideration is quantity. Therefore, the first step of this study should be to make a statistical analysis of the number of publications and citations. It reveals the development trend of the study in years. Citation frequency should also be considered when considering the number of publications. The criteria by which academic communities judge the caliber of publications is crucial. The progression of the number of publications and papers mentioned in postgraduate instruction is seen in Figure 2.

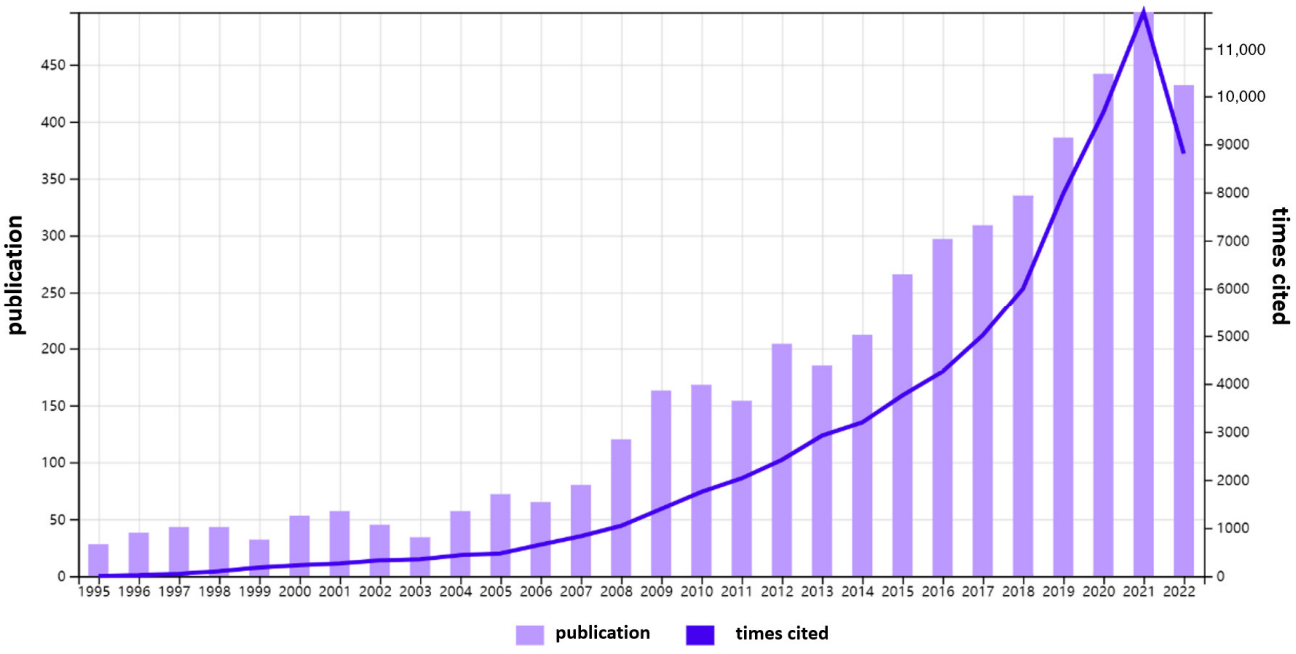



**Figure 2.** Between 1995 and 2022, the number of yearly publications and citations pertaining to postgraduate teaching research (downloaded from WoS).

The annual trend of publications on the topic of "postgraduate teaching" is seen in Figure 2. The chart makes it clear that this scientific discipline is experiencing an increase in overall yearly publications and citations. According to literature statistics, there are 4816 publications and 66,163 articles cited here. In addition to the self-cited articles, there are 65,044 articles.

In terms of productivity each year, less than 100 articles were published from 1995 to 2007, and 163 publications were published in 2009. Similarly, 168 in 2010, 154 in 2011, 204 in 2012, 185 in 2013, 212 in 2014, 266 in 2015, 297 in 2016, 309 in 2017, 335 in 2018, 386 in 2019, 442 in 2020, 496 in 2021, 432 in 2022. It can be seen from the statistical data that from 1995 to 2021, the number of articles published showed an overall increasing trend. These trends indicate that the research on "postgraduate teaching" has been continuously strengthened, and the field of postgraduate teaching has gradually set off a wave of research. It is expected that more papers will be published in 2022 than in 2021. At the same time, the "cited frequency" curve in the above Figure 2 also supports this conclusion.

In the past 28 years, the number of articles related to postgraduate teaching has grown rapidly. One of the reasons is that various countries are paying attention to the issue of postgraduate teaching and the upsurge of postgraduate study among students.

In terms of categories of publications, 219 categories include 4816 articles. The Table 1 lists the top 10 categories.

**Table 1.** The top 10 categories.

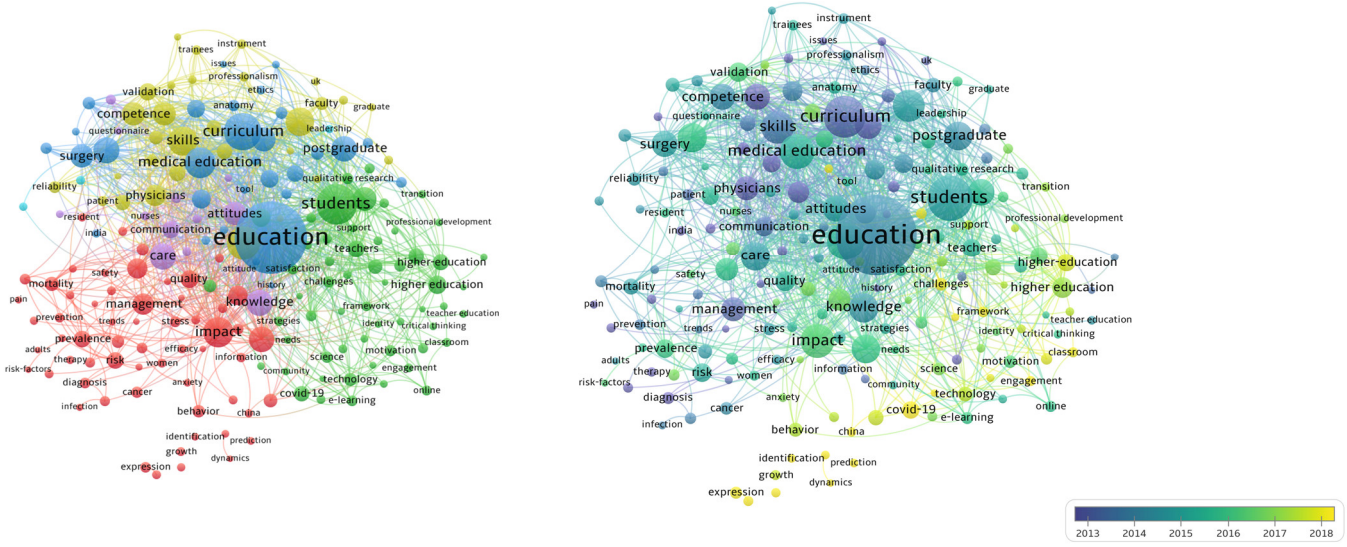
| Rank | WoS Categories | Number | Proportions (%) |
|---|---|---|---|
| 1 | Education Scientific Disciplines | 780 | 16.196 |
| 2 | Education Educational Research | 766 | 15.905 |
| 3 | Medicine General Internal | 561 | 11.649 |
| 4 | Health Care Sciences Services | 437 | 9.074 |
| 5 | Surgery | 337 | 6.998 |
| 6 | Public Environmental Occupational Health | 148 | 3.073 |
| 7 | Dentistry Oral Surgery Medicine | 136 | 2.824 |
| 8 | Pharmacology Pharmacy | 127 | 2.637 |
| 9 | Nursing | 119 | 2.471 |
| 10 | Engineering Electrical Electronic | 113 | 2.346 |

From the above table, we can find that there are 780 publications in the intuitive category of "Education Scientific Disciplines", which accounts for a high proportion, reaching 16.196% of the total number of 4816 publications. The second category is "Education Educational Research", with 766 papers, which is only 14 publications different from the first category, accounting for 15.905%. Then there is "Medicine General Internal", with 561 papers. Of course, some publications may fall into different categories, which will also have more or less an impact on the statistical data. It can be seen from the above table that in the past 28 years, research on postgraduate teaching in the medical field has accounted for a high proportion, and the study of medical discipline has become a trend of scientific research on postgraduate teaching.

#### 3.1.2. Co-Keyword and Keyword Citation Burst Analysis

The keywords can show the current situation and hot spots in the research field. They are important indicators in bibliometric research. Academically, they refer to words or terms selected from reports and papers to represent the full-text subject content information for document indexing. The word refers to the word that can contain a morpheme (the smallest meaningful unit in the language) or the smallest freely usable unit in the language, and the term refers to the professional terms in a certain discipline. To sum up, keywords are words that express the subject content of the text, including words, terms

and phrases, which are independent and non-compound in meaning. It contains a certain amount of information and plays a role in understanding the text content [30–36]. In order to analyze frequent keywords, one must choose terms from the article's title, abstract, and body [32]. Calculating the frequency of a collection of words in a piece of literature is comparable to the analysis of popular keyphrases. Through the experiment, the bibliometric data in the field of postgraduate teaching showed 17,281 keywords. This part uses VOSviewer to create a network map of common keywords to identify research hotspots in the field of postgraduate teaching and research. The visual map has 193 elements when the minimum number of keyword occurrences is set to 20. The visualization of the co-keyword network from post-graduate teaching research is shown in Figure 3.




(**a**) (**b**)

**Figure 3.** Network visualization for keywords. (**a**) Map of co-keyword analysis (occurrence weight). (**b**) A visualization map with co-keywords (occurrence weight).

The node size in Figure 3a represents the frequency of the keyword. The frequency of occurrence increases with node size. The three largest nodes are "education", "students" and "curriculum", which are the strongest. The same nodes are grouped together and display relevant and most closely linked subjects. Five clusters of five colors make up the keywords in Figure 3a. Each cluster is a sub-field of postgraduate teaching research. By analyzing the five main cluster nodes, you can label these clusters appropriately.

There are 60 keywords in the first cluster, and they are displayed in red in the Figure 3. The keywords of the big nodes in this cluster related to postgraduate teaching are impact, model, management, outcomes, health, quality, validity, and risk. The teaching environment for graduate students is significantly impacted by the new management model of the new generation. By integrating and using creative solutions, researchers can improve the standard of graduate teaching.

There are 57 projects in the second cluster (the green one). The following are the main terms of the principal nodes in Cluster 2 that pertain to postgraduate teaching: students, perceptions, higher education, program, teachers, higher education, university, COVID-19, and experiences [37]. Researchers should pay attention to student-centered research in postgraduate teaching, and should also pay attention to the resource allocation of teachers and schools in higher education and make reasonable plans to deal with COVID-19.

There are 30 projects in the third cluster (blue). The major nodes related to postgraduate teaching in Cluster 3 are education, curriculum, medical education, simulation, postgraduate, teaching, tourism, training, experience, and medical students ". The foundation

and base for the successful execution of postgraduate teaching is the creation of curricular teaching. The key point that should not be ignored in postgraduate teaching is curriculum design. At the same time, through Cluster 3, we can see that medical education is also a key point of postgraduate teaching, which may be related to more and more people applying for medical postgraduates, and other deep-seated issues arising from it need to be supplemented.

The fourth cluster has 30 projects. The keywords of the large node cluster are performance, skills, medical education, competence, residents, physics, and validation. Postgraduate teaching skills and performance gradually occupy the key position in this field.

There are 13 projects in the fifth cluster (purple). Keywords include care, knowledge, attributes, communication, patient safety, survey, and health care. As a result, in order for postgraduate teaching research to advance, it will also be necessary to pay attention to and expand the application of knowledge theory in postgraduate teaching practice, in addition to strengthening the development of theoretical techniques and systems. The theory can only successfully enhance the sustained growth of postgraduate teaching practice when it is properly utilized in practice.

In Figure 3b, 2013 (dark purple), 2018 (yellow), the change of keyword color indicates the change of keyword over time. The overlapping visualization of keywords shows that physicians, training, residents, teaching, curriculum, and management occur earlier than other keywords, and these keywords are purple. Since 2018, keywords related to postgraduate teaching have been widely concerned. The biggest challenge facing universities and graduate schools in light of the widespread use of COVID-19 is making it possible for professors and students to engage in online teaching and learning [38]. The details of the top 10 keywords and the overall link strength are shown in Table 2 below.

**Table 2.** The top 10 occurrence keywords.

| Keywords | Cluster | Links | Total Link Strength | Occurrences | Avg. Pub. Year |
|---|---|---|---|---|---|
| education | 3 | 186 | 1812 | 652 | 2014. |
| students | 2 | 160 | 954 | 272 | 2015 |
| curriculum | 3 | 154 | 829 | 244 | 2013 |
| performance | 4 | 148 | 670 | 206 | 2015 |
| medical education | 3 | 146 | 593 | 185 | 2015 |
| impact | 1 | 148 | 525 | 178 | 2016 |
| skills | 4 | 139 | 608 | 167 | 2014 |
| medical-education | 4 | 127 | 550 | 161 | 2015 |
| care | 5 | 137 | 456 | 144 | 2015 |
| knowledge | 5 | 148 | 512 | 144 | 2014 |

Link and total link strength are important attributes in the knowledge map [37]. According to the VOSviewer manual, "A link is a connection or relationship between two items" [37]. The total link strength represents "the total strength of links between one project and other projects" [37]. For instance, the "link" in a keyword co-occurrence link refers to the number of co-occurrence linkages between the two terms. The overall strength of links between a keyword and other keywords is referred to as a keyword's total link strength. After understanding this concept, the analysis of this part is well understood.

Another important thing in the field of keyword analysis is keyword reference burst analysis, which refers to the analysis of keywords whose citations have increased dramatically. Burst detection, a useful analytical method, is utilized to find keywords that have accrued a lot of interest in relevant scientific domains over time [34]. In the analysis of keyword reference bursts, one of the important indicators for determining growing or declining research trends [39]. Therefore, keyword reference burst analysis can uncover a number of intriguing themes. CiteSpace is used to detect unexpected keywords in order

to examine in-depth research orientations and analyze the dynamics of post-graduate education. 28 keywords were identified by CiteSpace as having the strongest reference explosion. (parameter settings of years per piece: 1; node type: keyword; top N of each slice: 50; and top N%: 10%). The results are shown in the following Figure 4. The publishing date is shown by the blue line. The period shown by the red line is when the keywords received the most citations.

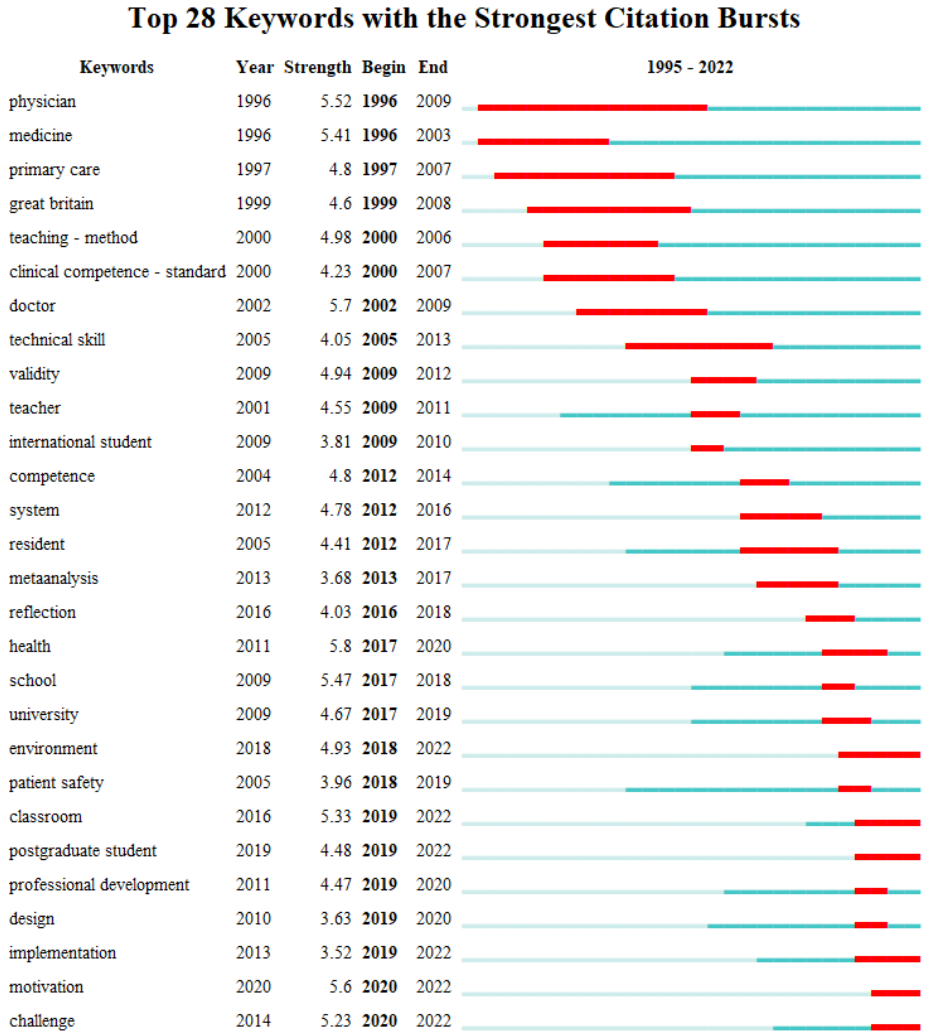



**Figure 4.** The top 28 terms with the biggest citation bursts, listed in order of when they first appeared in citations.

Through the analysis of the above Figure 4, it is not difficult to see that in the field of postgraduate teaching, there are strong keywords cited from 1996 to 2022. These highly cited keywords mean that these words have received great attention in a short period of time, which can reflect the evolution of research trends in this field and more cutting-edge research directions. The ranking in the above Figure 4 is based on the starting year of the citation of keywords with the sudden citation in the field of postgraduate teaching. At the initial stage, the research frontier of postgraduate teaching is mainly in the medical field. For example, the early keywords in the field of postgraduate teaching are as follows: physician (1996), medical (1996), primary care (1997), Great Britain (1999), teaching—method (2000), clinical competence—standard (2000), doctor (2002), technical skill (2005), validity (2009), teacher (2009), international student (2009), competence (2012) In the near future,

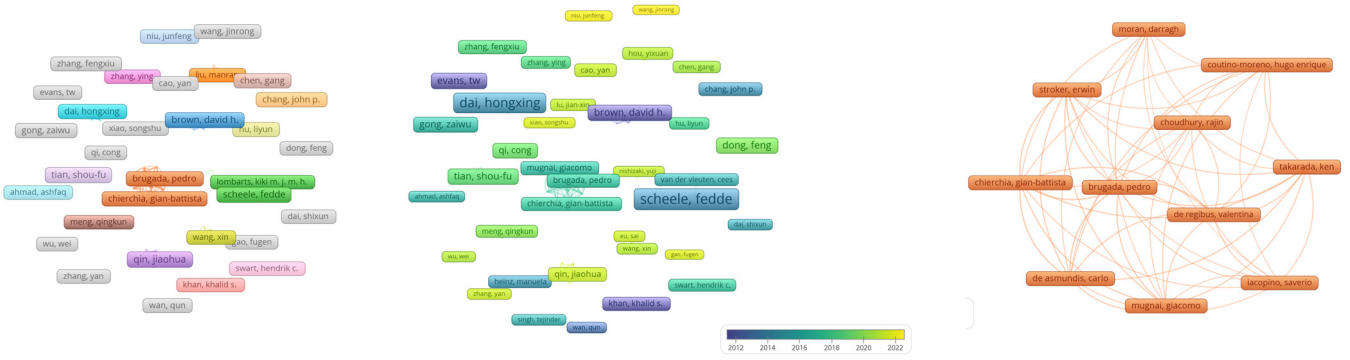
reflection (2016), health (2017), school (2017), university (2017), environment (2018), patient safety (2018), classroom (2019), post-graduate student (2019), professional development (2019), design (2019), implementation (2019), motivation (2020), challenge (2020) have become new research topics.

### *3.2. Cooperative Analysis*

#### 3.2.1. Co-Authorship Analysis

The analysis of co-authors can provide a powerful tool for the research of academic network structure. These authors may come from different countries and fields [31]. The researchers conducted scientific cooperation for the common purpose of generating new scientific knowledge. Many scholars have used VOSviewer to analyze the cooperation among countries, institutions, and authors [29]. As an important indicator of cooperation, the analysis of co-authors is indispensable in the bibliometric analysis [32]. In this section, the VOSviewer tool is used to analyze the co-authors and understand the cooperation between the authors. The results of software processing show that 18,595 authors have contributed to 4816 publications related to postgraduate teaching. The following Figure 5 shows the cooperative relationship between the collaborators in the field of postgraduate teaching and research. If individual authors use different names in their papers, they will be merged only when the ORCID is the same [30,33,34].

In order to analyze the contribution of co-authors more reasonably and effectively, the statistical threshold is set to 6, and 94 authors reach the threshold, that is, the total strength of the relationship between 94 authors and other authors is calculated. Some of the network's 94 projects are not linked to one another. The greatest group of linked things has 11 components. The aforementioned conditions produce the co-author network map. There are 94 projects in the network (Figure 5a below). Figure 5b displays the overlay visualization network. There are 11 individuals inside the network's biggest intellectual circles (c below). The total strength of the relationship between 94 authors and other authors was calculated.




(**a**) (**b**) (**c**)

**Figure 5.** Network for co-authorship visualization. (**a**) A map of network visualization (document weights). (**b**) Overlay a network map visualization (citation weights). (**c**) A visualization of the biggest academic network (document weights).

In the Figure 5, above, collaboration clusters between authors appear in different colors. 94 projects generated 145 links, with a total link strength of 1042. These clusters allow for the observation of the principal academic linkages and researchers. The size of an author's name in the cooperative network indicates how many papers they have published. The main researchers are Brown, David H; Qin, Jianhua; Scheele, Fedde; Scherpbier, Albert J. J. A.; Tan, Yun; Tian, Shou-Fu; Xiang, Xuyu; Zhang, Tian-Tian.

In the above Figure 5b, the author's information is superimposed into a visual network to display different reference colors over time. It can be found some authors appear

more frequently, such as Scheele and Fedde; Dai, and Hongxing. There are also many researchers who have recently published new works on postgraduate teachings, such as Cao, Yan; Chen, Gang; Gao, Fugen; Hou, Yixuan; Huang, Zhi-Guang; Li, Xiangping; Lu, Chan; Niu, Junfeng; Zhu, Hui. Interestingly, most of the authors of the new works are Chinese, which shows that Chinese people are increasingly interested in research in the field of postgraduate teaching, which is closely related to the development of China's higher education.

The biggest academic community on this topic, which consists of 11 writers, is seen in Figure 5c above. The cooperation between 11 authors shows that collaborative research among researchers can effectively promote knowledge development in the field of postgraduate teaching. Among the 11 authors of the largest group of co-authors, each author has about 10 papers. The most important year of publication is 2017, including Brugada and Pedro; Chierchia, Gian-Battista; Choudhury, Rajin; Coutino-Moreno, Hugo Enrique; De Asmundis, Carlo; De Regibus, Valentina; Iacopino, Saverio; Moran, Darragh; Mugnai, Giacomo; Stroker, Erwin; Takarada, Ken.

The writers with the most publications and their co-authors have greatly advanced the fields of postgraduate teaching and research, as well as worked together to advance this area. The top 10 writers with the most papers published are shown in Table 3 below (the table data comes from the generation of VOSviewer).

**Table 3.** The top 10 most prolific authors.

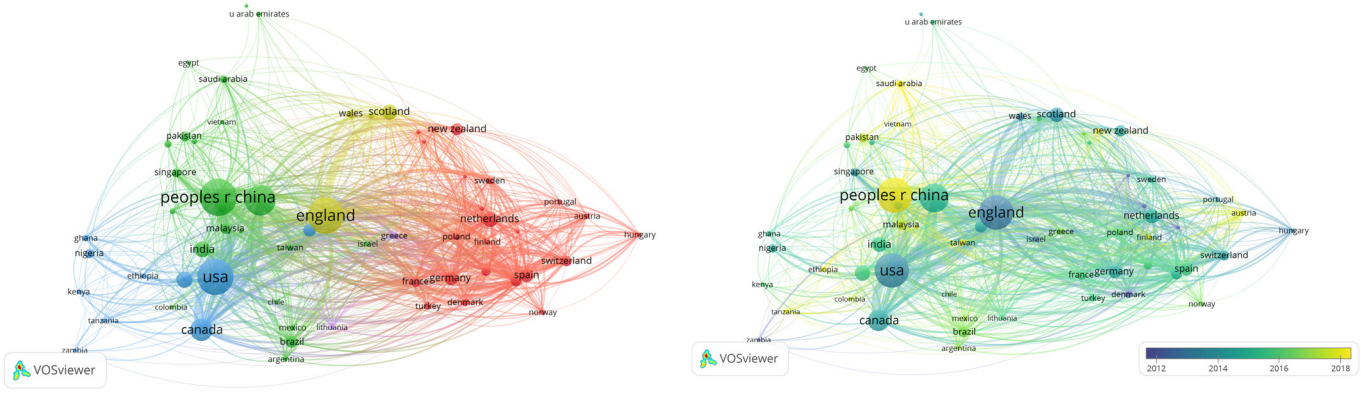
| Rank | Author | Links | TS a | Documents | Citations | APY b |
|---|---|---|---|---|---|---|
| 1 | Qin, Jiaohua | 4 | 67 | 28 | 257 | 2021 |
| 2 | Xiang, Xuyu | 4 | 65 | 26 | 253 | 2021 |
| 3 | Tan, Yun | 4 | 64 | 25 | 241 | 2021 |
| 4 | Tian, Shou-Fu | 2 | 21 | 20 | 441 | 2019 |
| 5 | Brown, David H. | 5 | 50 | 19 | 426 | 2011 |
| 6 | Scheele, Fedde | 5 | 20 | 19 | 1136 | 2014 |
| 7 | Baker, Murray V. | 5 | 49 | 17 | 395 | 2011 |
| 8 | Scherpbier, Albert J. J. A. | 5 | 23 | 16 | 335 | 2014 |
| 9 | Zhang, Tian-Tian | 2 | 21 | 15 | 357 | 2019 |
| 10 | Chen, Gang | 1 | 7 | 14 | 69 | 2020 |

Note: a TS = total link strength; b APY = average publication year.

According to the above Table 3, the author Qin, Jiaohua; Xiang, Xuyu; Tan, Yun; Tian, and Shou Fu have published 20 or more articles related to postgraduate teaching. Among them, the articles of Scheele and Fedde have even been cited 1136 times. At the same time, it can be seen that in the past few years, the top 10 prolific authors have worked closely together, and the average year of publication of the top three authors is 2021. This demonstrates the growth of postgraduate teaching research to some extent.

#### 3.2.2. Country and Region Cooperation Analysis

Similar to the previous section, the network visualization map of countries and regions based on co-authors is also generated by VOSviewer. With reference to the user manual of VOSviewer, this paper reasonably sets the "minimum number of documents in a country" as 10. Out of 131 countries, 62 have reached the threshold and are shown on the visual map (see Figure 6 below).




(**a**) (**b**)

**Figure 6.** co-author regional and national network maps. (**a**) A map of network visualization (document weights). (**b**) Map overlay with visualization (document weights).

In the above Figure 6a, the larger the circular node, the more publications representing that country. On the contrary, the smaller the circular node, the fewer publications representing that country. These 62 countries are divided into five clusters, which shows that there is close cooperation between countries. In the first group, Germany, The Netherlands, New Zealand, and Spain have cooperated with many works. Their number of publications is more than 100. Germany has the largest total link strength, reaching 399. In the second group, Australia, India and People r China have a high level of cooperation, and their total link strength is 431, 452, 160 respectively. In the third group, the USA, Canada, Ireland, South Africa and other countries have a lot of cooperation, and their total link strength is 596, 313, 138, 113 respectively. In group 4, England and Scotland have conducted friendly cooperation, and the total link strength between them is 807 and 202 respectively. Other countries have also contributed to Group 5, such as Greece and Lithuania. The total link strength between them is 139 and 86 respectively.

A purple to yellow color bar appears at the bottom of Figure 6b, which is generated according to the release date of the file provided by the country or region. The visual network (Figure 6b) shows that in 2012, England, USA, and Scotland (purple nodes) released many documents related to postgraduate teaching. Their total documents were 877,889,159. In 2012, many countries or regions, such as Croatia, Czech Republic, Zambia, Denmark, Slovenia and Israel, published a small number of works on postgraduate teaching. In 2014, Canada, New Zealand, Germany, Ireland, Japan, The Netherlands, Nigeria, Sweden, Italy, Australia and other countries (dark green nodes) published some articles on postgraduate teaching, with a total of 340 articles published by Canada. In 2016, a large number of nations or areas (light green nodes) started taking part in the study of postgraduate teachings, such as Poland, Egypt, Norway, Thailand, Greece, Brazil, Serbia and Argentina. Since 2018, the growth and administration of postgraduate teaching have received increased attention from various nations. Figure 6b's yellow countries, for instance, include Romania, Saudi Arabia, Ethiopia, Vietnam, South Korea and People R China. Large nodes such as Peoples' Republic of China, the United States, England, Australia, and Canada reflect nations that have engaged in extensive international collaboration. Peoples' Republic of China has even produced 940 papers in the recent period. They oversaw collaborative projects in the postgraduate teaching and research fields.

The Table 4 below demonstrates that England was the first country to conduct pertinent research in the area of postgraduate teaching research. The top three countries in terms of articles published are People's Republic of China, USA and England. The number of published articles ranked top, which is interesting because postgraduate teaching research just recently began in China, despite the fact that postgraduate teaching research has garnered considerable interest there.

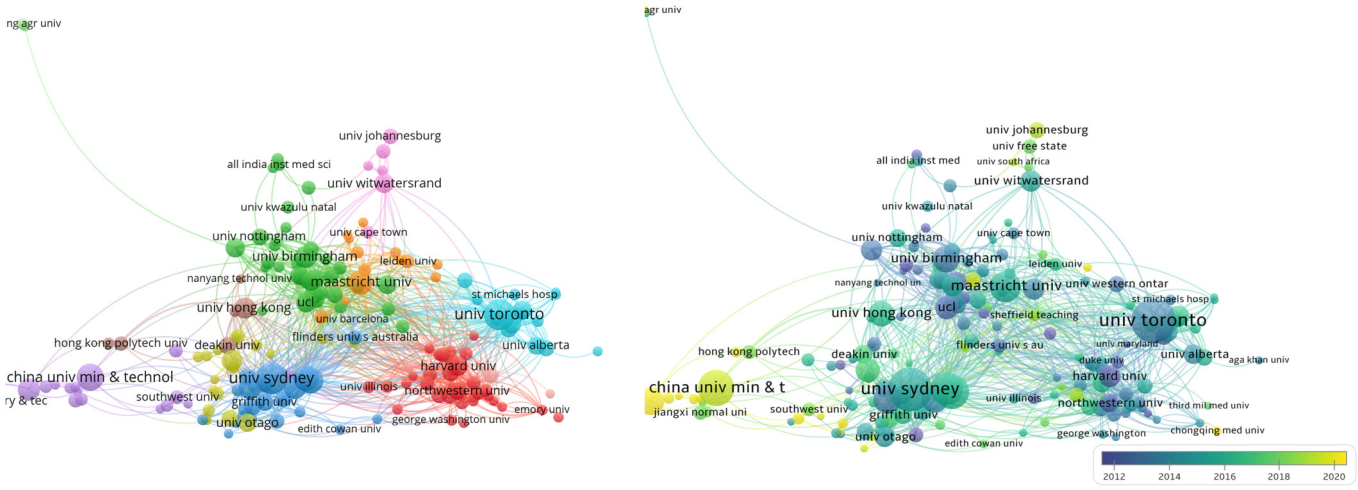
**Table 4.** Top 10 countries with the largest number of documents.

| Rank | Country or Region | Cluster-ID | Links | TS a | Documents | Citations | APY b |
|---|---|---|---|---|---|---|---|
| 1 | Peoples R China | 2 | 52 | 431 | 940 | 9373 | 2019 |
| 2 | USA | 3 | 56 | 596 | 889 | 17,740 | 2013 |
| 3 | England | 4 | 59 | 807 | 877 | 16,614 | 2013 |
| 4 | Australia | 2 | 55 | 452 | 621 | 10,562 | 2015 |
| 5 | Canada | 3 | 48 | 313 | 340 | 7301 | 2014 |
| 6 | South Africa | 3 | 46 | 138 | 177 | 1776 | 2016 |
| 7 | India | 2 | 39 | 158 | 172 | 2044 | 2015 |
| 8 | Scotland | 4 | 46 | 202 | 159 | 3198 | 2014 |
| 9 | The Netherlands | 1 | 48 | 306 | 157 | 4291 | 2015 |
| 10 | Germany | 1 | 52 | 399 | 120 | 3365 | 2014 |

Notes: a TS = total link strength; b APY = average publication year.

### 3.2.3. Organization Cooperation Analysis

The research covers the collaboration of organizations in post-graduate teaching in this part. There are 4517 organizations. When an organization's Minimum Number of Documents is set to 10, (meaning that only organizations whose cumulative number of documents exceeds 10 are displayed on the knowledge map), The required number of organizations—180—has been met in 3.98 percent of cases. Calculate the 180 organizations' combined link strength. The following Figure 7 depicts the organization with the greatest total link strength.




(**a**) (**b**)

**Figure 7.** The networks of organizations' visualizations. (**a**) Map of the Organizational Network (document weights). (**b**) Map overlay with visualization (document weights).

These 180 organizations belong to 12 clusters, with 1227 links and 2100 total link strength (Figure 7a). The node size represents the number of publications in the organization, which is proportional to each other. The collaboration between the two organizations on academic matters is shown by the line connecting the nodes. The relationship will be closed the smaller the distance that separates the two organizations. The research on post-graduate teaching has been significantly influenced by numerous organizations and institutions. The ten most productive organizations are as follows: univ Sydney, Harvard univ, univ Toronto, china univ min&technol, Monash univ, brigham&women host, univ Washington, univ London imperial col sci technol&med, univ Dundee, Maastricht univ. It can

be seen that the main body of institutions in the field of postgraduate teaching is the university.

Many organizations (purple) first started to explore the theme of postgraduate teaching around 2012 (Figure 7b), such as Harvard univ, univ London imperial college sci technol&med, univ news walls, Curtin univ technol, McGill univ, and univ manchester. After 2020, people have greater demand for postgraduate teaching. Many research institutes start looking at ways to effectively teach postgraduate students in order to meet more ambitious teaching goals., such as the yellow institutions: Nanjing agr univ, Chinese acad sci, Chongqing med univ, xian technol univ, center south univ forestry&technol, center south univ. It is worth mentioning that these yellow institutions are Chinese universities.

Since 2020, more Chinese institutions have entered the research field of postgraduate teaching. Perhaps this is a consequence of the new higher education's unavoidable tendency toward postgraduate teaching, which has caught the interest of many academics and universities. Geographically distributed graduate teaching and research institutes. Universities all throughout the world undertake research at the top 10 high-impact institutes. A significant regional research base has not yet been established by graduate teaching and research institutes. To ensure the best use of resources and the formation of discipline groups, regional research bases for postgraduate teaching must be built. To create a regional research base with graduate teaching features, research institutions should promote regional collaboration in accordance with their individual characteristics.

### *3.3. Source Analysis*

#### 3.3.1. Co-Citation Journal Analysis

Firstly, the journals from which the 4816 articles come are studied. The basic principle is that when two articles appear in the bibliography of the third article, the citation analysis will be carried out so that the two articles have a citation relationship. The analysis of journals from which publications come is also a key point to focus on [35]. By using the software, the threshold of "the minimum number of citations of sources" was set to 100, so 150 of 42,589 journals reached the threshold. The following Figure 8 shows the joint citation network of the journal.

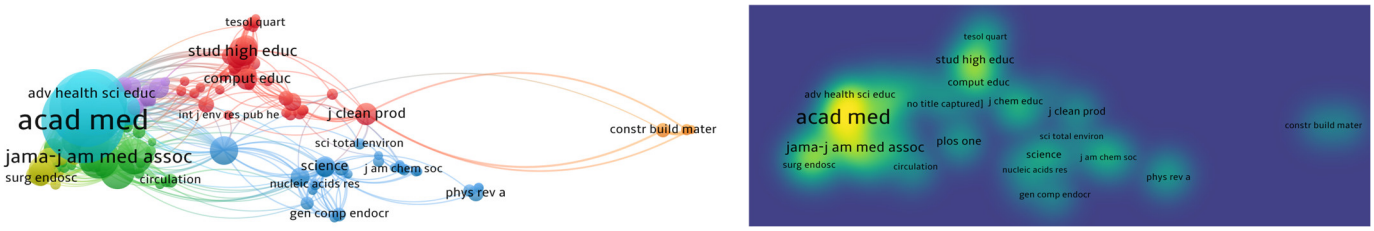



**Figure 8.** Journal co-citation network. (**a**) Journal network visualization map. (**b**) Journal density map.

The most frequently referenced journals in postgraduate teaching research are shown in the chart above. The number of magazines published and the node size are directly proportional to one another. There are 7 clusters. Acad med is the most cited journal, followed by med educ, med coach, jama j am med assoc, lancet, new engl j med, brick med j. The following Table 5 lists the top 10 journals most frequently cited in research on postgraduate teaching.

**Table 5.** Top ten journals cited most in postgraduate teaching research.

| Journals | Cluster ID | Links | TS a | Citations |
|---|---|---|---|---|
| Academy of Medicine | 6 | 118 | 43,967 | 2860 |
| Medical Education | 6 | 123 | 38,535 | 2439 |
| Medical Teach | 6 | 118 | 31,526 | 2006 |
| Journal of the American Medical Association | 2 | 124 | 14,412 | 990 |
| Lancet | 2 | 128 | 8458 | 805 |
| New England Journal of Medicine | 2 | 120 | 10,535 | 775 |
| British Medical Journal | 2 | 113 | 9250 | 765 |
| Bmc Medical Education | 6 | 117 | 11,102 | 751 |
| Journal of General Internal Medicine | 2 | 108 | 10,807 | 657 |
| Stud Higher Education | 1 | 100 | 5669 | 585 |

Note: a TS = total link strength.

From the above Table 5, it is not difficult to see that the source of articles in the field of postgraduate teaching and research in Chinese medicine journals, which account for a large part, of and is consistent with the conclusions drawn in the previous analysis of publication categories.

3.3.2. Cited Reference Analysis

This part does the reference burst detection analysis, which can identify fresh or significant information. The six strongest references discovered using CiteSpace are displayed in Figure 9 below. The basic settings are as follows: years per slice: 1; node type: reference; top N: 50; And top N%: 10.0%. Other parameters not mentioned are set by default. The analysis results show that 8 references were cited. The publishing date is shown by the blue line. When articles are referenced, the red line represents the strongest period.

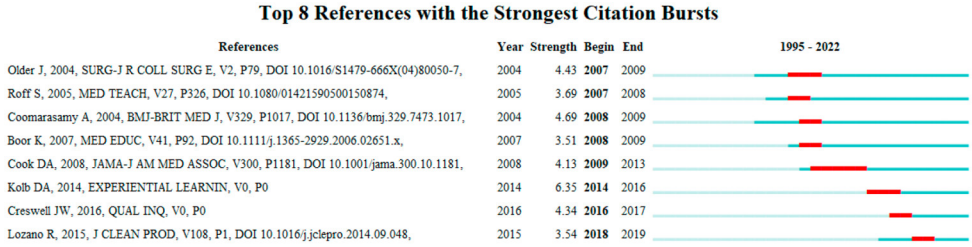



**Figure 9.** The top 8 references with the strongest citation outbreak [40–47].

The strength of these documents has reached more than 3.5, and the highest even reached 6.35. The longest citation period is 4 years and the shortest is 1 year. At the same time, it can be seen from the above Figure 9 that these highly cited papers were published after 2004, which is 10 years away from the starting time of our set time span from 1995 to 2022. This proves that the focus of topics related to postgraduate teaching was after 2004, which is basically in line with the actual situation of society.

*3.4. Trend and Evolution Analysis*

3.4.1. Research Trends

This section analyzes the research trend in the field of postgraduate teaching, since it is well known that the "timeliness of various papers" is not taken into consideration [18] and that merely the study of hot spots is insufficient to describe the research trend in an academic topic. This section makes use of CiteSpace to gather developing themes and cutting-edge keywords in the field of postgraduate education in order to address this deficit. Clustering techniques have been developed. These techniques and methods are used to

describe data, measure the similarity between different data sources, and classify data sources into different clusters [18]. The settings in CiteSpace were set as node types: keyword; top N: 10%; top N: 50; And years per slice: 1. Then, a keyword cluster network map was displayed (Figure 10), where modularity Q = 0.2759 > 0.25 and the weighted mean silhouette S = 0.6994 > 0.5. Q values meet the clustering conditions. Here, we use the log-likelihood ratio (LLR) function to name clusters. In the area of postgraduate teaching, CiteSpace produced seven clusters of articles. Some words could cross over into several clusters.

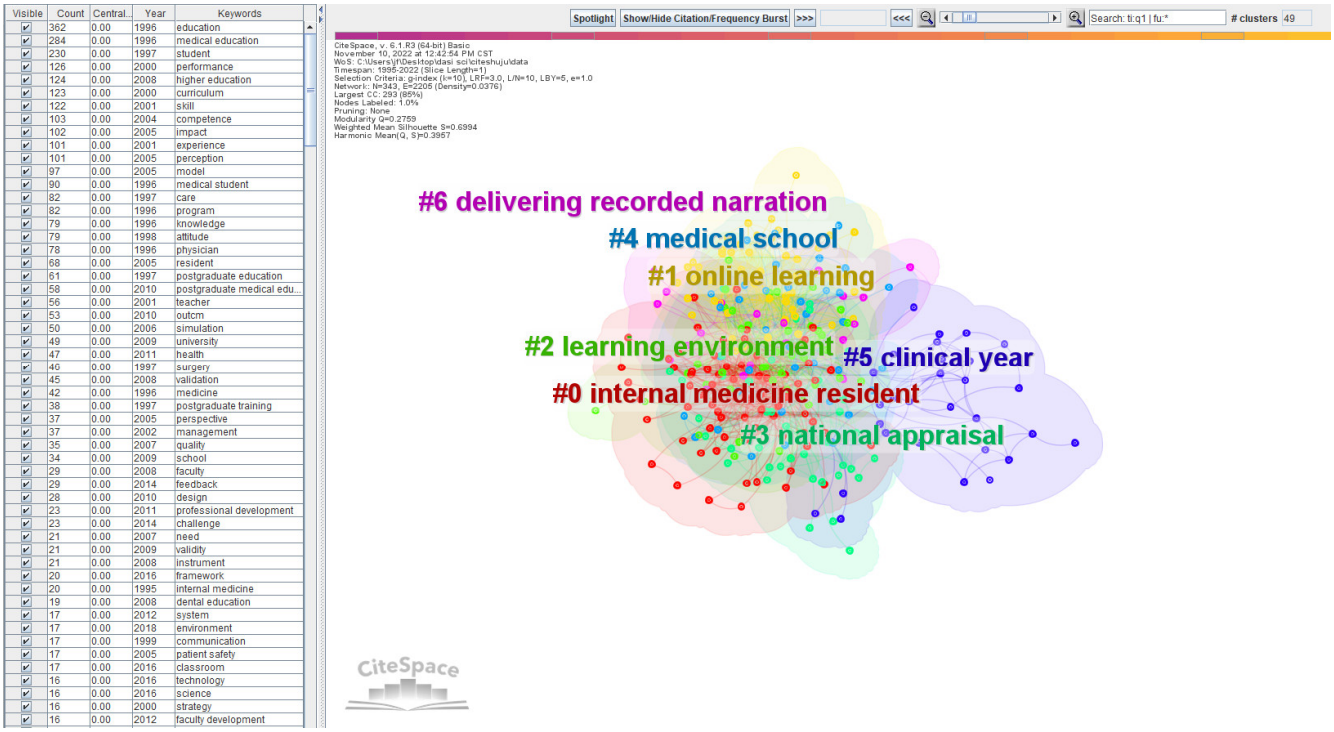



**Figure 10.** Cluster diagram with postgraduate teaching as the keyword.

There are 7 clusters in the Figure 10, which are represented by different colors. The following Table 6 lists the specific information of the keyword cluster.

**Table 6.** Key labels of postgraduate teaching research topics.

| Cluster-ID | Size | Silhouette | Mean (Year) | Top Terms (Log Likelihood Ratio) |
|---|---|---|---|---|
| 0 | 72 | 0.686 | 2008 | internal medicine resident (754.14, 1.0 × $10^{-4}$); non-technical skill (684.64, 1.0 × $10^{-4}$); teaching resident (552.22, 1.0 × $10^{-4}$); communication skill (543.53, 1.0 × $10^{-4}$); neurological surgeons boot camp courses (534.86, 1.0 × $10^{-4}$) |
| 1 | 50 | 0.617 | 2016 | online learning (689.41, 1.0 × $10^{-4}$); sustainable learning (680.61, 1.0 × $10^{-4}$); critical thinking (641, 1.0 × $10^{-4}$); covid-19 pandemic (534.92, 1.0 × $10^{-4}$); sustainable development (438.74, 1.0 × $10^{-4}$) |
| 2 | 44 | 0.654 | 2008 | learning environment (664.26, 1.0 × $10^{-4}$); psychometric properties (570.71, 1.0 × $10^{-4}$); blended learning (485.68, 1.0 × $10^{-4}$); junior doctors knowledge (432.9, 1.0 × $10^{-4}$); distant clinical microbiology specialization university course (429.38, 1.0 × $10^{-4}$) |
| 3 | 40 | 0.663 | 2005 | national appraisal (441.78, 1.0 × $10^{-4}$); dermatology residency training (441.78, 1.0 × $10^{-4}$); Tehran Iran (438.19, 1.0 × $10^{-4}$); questionnaire survey (438.19, 1.0 × $10^{-4}$); trainee physician (438.19, 1.0 × $10^{-4}$) |

| | | | | |
|---|---|---|---|---|
| 4 | 37 | 0.736 | 2009 | medical school (557.41, 1.0 × 10⁻⁴); current status (519.34, 1.0 × 10⁻⁴); anatomy knowledge (493.94, 1.0 × 10⁻⁴); student teachers competence (440.91, 1.0 × 10⁻⁴); video narrative (440.91, 1.0 × 10⁻⁴) |
| 5 | 30 | 0.889 | 2002 | clinical year (223.35, 1.0 × 10⁻⁴); task-based learning (223.35, 1.0 × 10⁻⁴); integration ladder (212.14, 1.0 × 10⁻⁴); curriculum planning (212.14, 1.0 × 10⁻⁴); general practice trainer (189.73, 1.0 × 10⁻⁴) |
| 6 | 20 | 0.772 | 2011 | delivering recorded narration (543.04, 1.0 × 10⁻⁴); nursing education (543.04, 1.0 × 10⁻⁴); creating teaching object (491.21, 1.0 × 10⁻⁴); postgraduate dental resident preference (356.66, 1.0 × 10⁻⁴); asynchronous learning (356.66, 1.0 × 10⁻⁴) |

The following Figure 11 is a keyword clustering diagram with a timeline:

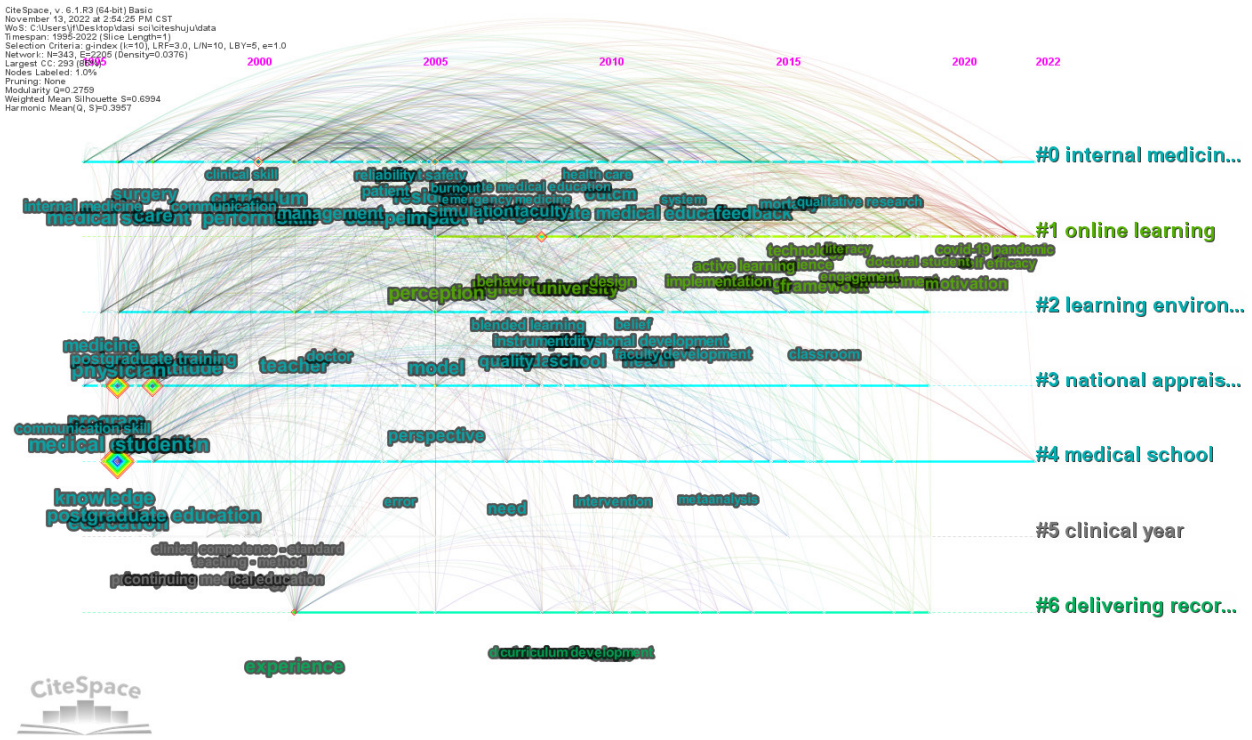



**Figure 11.** Clustering graph of keywords with the time axis.

Through the processing of CiteSpace software, Cluster 0 was labeled as an internal medicine resident. It is related to medical school and medical year. The exponential growth of information technology and the advancement of society have created countless opportunities for human learning, considerably enhancing the current social model of education and encouraging the growth of post-graduate teaching and education. The leaders and educators of some medical colleges and universities have realized that graduate education is one of the most important ways to cultivate high-level talents in human society, while high-level medical talents are generally lacking, so medical graduate education is of vital importance [48]. Medical postgraduate education should keep pace with the times. It is not easy to change the teaching and learning methods. Hidden from this, we must guide and cultivate the unique thinking method and innovation ability of postgraduates, and gradually improve medical postgraduate education in continuous practice [49].

The label of cluster 1 was online learning. During this pandemic period, in order to cope with the impact of the COVID-19 epidemic on the normal teaching of graduate students, colleges and universities launched online teaching. As a special teaching method during the epidemic period, online teaching ensures normal teaching work in colleges and

universities [50]. Although the epidemic has a certain impact on the normal teaching of university graduate students, it has greatly promoted the process of online teaching and ensured the smooth development of teaching. The study on the reform and development of higher education is focused on developing a scientific and effective online course operation method. The management of colleges and universities, teacher organization, and student learning must all meet greater standards as a result of the use of online teaching. At the same time, in the process of online learning, postgraduate teaching can improve the ability of independent learning, communication, mutual support and cooperation, expression, critical thinking and innovative thinking through group learning and discussion. The problem-oriented teacher system teaching combined with the PBL teaching method can inspire graduate students' interest in learning and scientific research thinking, so that students at the remote end of online courses can pay more attention to lectures. Teachers' explanations are conducive to systematically and completely mastering the whole knowledge system [51].

The second cluster is the learning environment. The traditional classroom teaching mode lacks attention to the academic inquiry, innovation, and knowledge construction of master's degree students. Students' classroom participation is low, and the learning atmosphere is not active, which often fails to meet the training objectives of master's degree students [52]. In order to broaden the academic vision of postgraduates, stimulate their interest in learning, enhance their confidence in clinical medical work and life science research, and constantly improve their diagnosis and treatment level and scientific literacy, researchers should pay more attention to the change of postgraduates' teaching mode, the teaching process should focus more on students' initiative, the teaching focus should focus more on stimulating students' endogenous motivation, and the teaching focus should focus more on students' learning, Finally, the goal of improving the teaching effect of graduate students is achieved. The change in teaching mode of postgraduate teaching is an inevitable trend [53]. It is suggested to take theoretical learning, clinical practice and research innovation as the teaching vertical line, intersperse cutting-edge scientific research achievements sharing, independent learning and other modes, and organically combine emerging media technologies to improve teaching.

#### 3.4.2. The Trend Evolution Structure of Postgraduate Teaching

In order to make a trend evolution structure chart of the postgraduate teaching field, this paper follows the method of building a knowledge map in the previous publication [54,55]. This part combines the knowledge field (important research points), knowledge base (keywords connected to research themes), and knowledge development produced by bibliometrics methods (keywords with sudden citations), and builds a knowledge structure chart of postgraduate teaching, as shown in the following Figure 12.

Through the keywords identified by CiteSpace, the postgraduate teaching knowledge base is constructed. Combined with the keyword analysis and the clustering analysis of the trend of the knowledge frontier. The knowledge evolution process of postgraduate teaching is obtained. The early research of postgraduate teaching is mainly in the medical field, such as a physician, medical, and primary care. The theory of postgraduate teaching must be put into reality, which is the biggest challenge. The practice of postgraduate teaching and professional development is a hotspot and frontier for study, and it is of utmost importance, such as professional development, design, implementation, motivation and challenge in recent keywords. With the rapid development of information technology, the field of postgraduate teaching will also be rapidly updated. Thus, the structure of the knowledge base, fields of knowledge, and future knowledge will also change. Theoretical research should be the main emphasis of future study, practical research, design and professional development as a whole to face more challenges in the future in the field of postgraduate teaching.

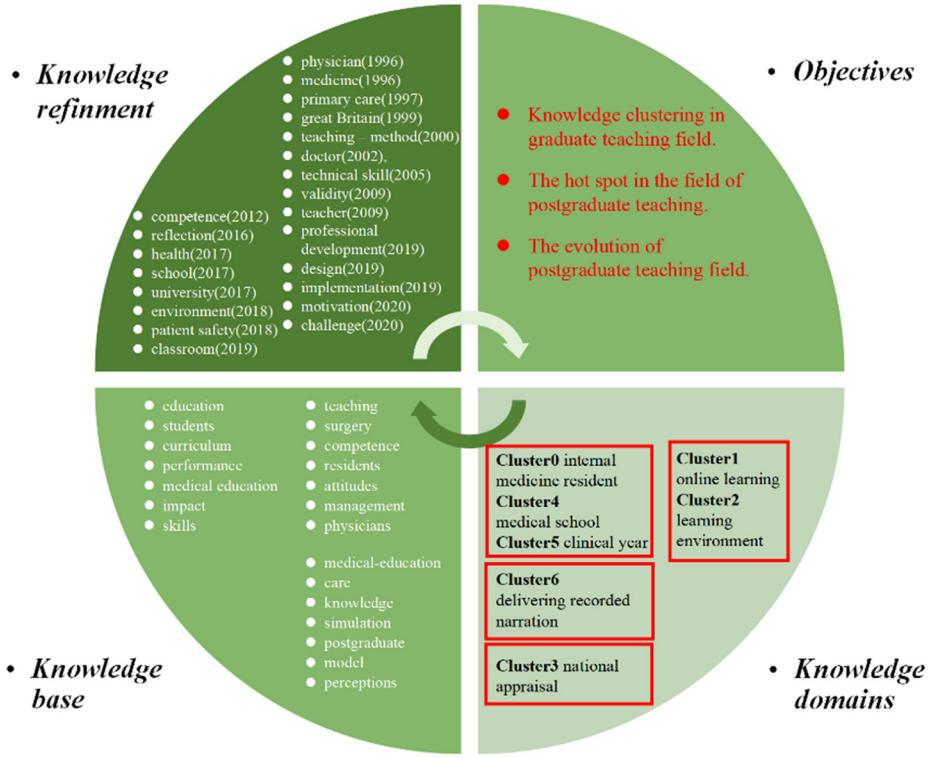



**Figure 12.** Postgraduate teaching integrated knowledge structure map.

## 4. Discussion

The general literature review is a style different from the research paper, which is formed by the researcher through understanding, sorting, comprehending, comprehensive analysis and evaluation after reading the selected literature. The writing of this paper avoids the main shortcomings of the traditional method of reviewing research topics (the subjectivity of the author in selecting literature may play a role, and the results may lead to some deviations and defects), mainly because the humanities selection of publications for research is not comprehensive [56,57]. An additional drawback is that traditional literature reviews make it challenging to identify the link between several core literature indicator parts and important literature [58]. Bibliometric analysis has the following advantages: 1. Research is not limited by time and space. 2. The study was not disturbed by the "reaction" of the subject. 3. Research reflects the combination of criticism and innovation. 4. The research is objective. 5. Large information capacity and low cost [22–24]. The problem of incomplete literature reading in traditional reviews can be avoided by searching and processing all relevant literature in a certain period. This paper makes a quantitative exploration of the research status, hot spots, cooperation, sources, evolution, etc. in the field of postgraduate teaching by using this method [59,60]. In order to offer more impartial findings for follow-up study, we used CiteSpace and VOSviewer to analyze the literature knowledge map of 4816 papers.

For question 1, this paper aims to explore the current situation and development trend of research in the field of postgraduate teaching. In terms of the number of publications, there were fewer articles on postgraduate teaching published before 2006, and fewer articles published before 1995. Since 2006, there have been more articles on postgraduate teaching. Until 2009, more than 150 articles related to postgraduate teaching were published every year. After 2014, the number of articles began to increase significantly, showing a surge. With the change of the times and the demand of society for highly educated talents, people are becoming more and more interested in postgraduate teaching research. Particularly towards the start of 2020, due to the influence of COVID-19, many people are faced with the risk of unemployment, so many college students and social personages

choose to continue to pursue postgraduate studies. As far as China is concerned, the number of candidates for the master's degree examination is increasing year by year, including many candidates for the second or even the third time. At the same time, the number of postgraduate enrollments is also increasing. The provision of postgraduate dormitories is also insufficient. Now it is at the forefront of postgraduate teaching, and it is particularly important to pay attention to the research in this field.

For question 2, this item aims to discover the most active disciplines in the field of postgraduate teaching. The research of postgraduate teaching involves a wide range of subjects. However, based on the analysis of the categories of publications related to postgraduate teaching topics in the past 28 years, it is found that research on postgraduate teaching in the medical field accounts for a high proportion, and the study of medical disciplines has become a trend of scientific research on postgraduate teaching. In the future, research in this field can be strengthened.

For question 3, the research here aims to help researchers quickly identify collaborators in the field of postgraduate teaching from the perspective of spatial distribution. In the area of postgraduate teaching research, cooperative countries, regions, and organizations have been analyzed. England was the first to carry out relevant research. In terms of the number of published papers, the first three are followed by people r china, USA and England. The number of published articles rated top, which is interesting because postgraduate teaching research just recently began in China, suggesting that China has given it a lot of attention. The most citations are from the United States. Numerous institutions have significantly advanced the subject of postgraduate teaching research, such as univ Sydney, harvard univ, univ toronto, china univ min&technol, monash univ, brigham&women's host, univ washington, univ london imperial college sci technol&med, univ dundee, maastricht univ. In the research of this field, many authors and their co-authors have made great contributions. They have cooperated closely and jointly promoted this research field. In the recent period, some authors have published some new works on postgraduate teachings, such as Cao, Yan; Chen, Gang; Gao, Fugen; Hou, Yixuan; Huang, Zhi-Guang; Li, Xiangping; Lu, Chan; Niu, Junfeng; Zhu, Hui. Research in the field of postgraduate teaching is booming.

For question 4, this part of the study aims to help researchers identify important references and journals that are productive and influential. The analysis of cited journals shows that acad med is the most cited journal, followed by med educ, med coach, jama j am med assoc, lancet, new engl j med, and brick med j. Most journals are related to medicine, which shows that the field of postgraduate teaching has a great influence on the field of medicine, attracting many medical workers to explore the field of postgraduate teaching. It is an indispensable research direction in the medical field. The referenced literature may often be thought of as the literature that is important to a certain area of inquiry. The reference analysis cited shows that the focus of topics related to postgraduate teaching was after 2004, which is basically in line with the actual situation of society.

For question 5, researchers can gain a thorough understanding of this field's development patterns and research hotspots by doing a study on this topic. A keyword analysis reveals that "education," "students," and "curriculum" are the three primary study topics. It demonstrates the need for more focus on how education and curriculum are used in postgraduate instruction, and postgraduate teaching should be student-centered. The latest keyword is COVID-19. It can be seen that COVID-19 has a great impact on postgraduate teaching. How to achieve better postgraduate education in this context has become a development trend in the field of postgraduate teaching. The analysis of citation burst shows that the earliest keywords with citation burst are as follows: physical (1996), medical (1996), primary care (1997), Great Britain (1999), teaching—method (2000), clinical competence—standard (2000), doctor (2002), technical skill (2005), validity (2009), teacher (2009), international student (2009), and competence (2012). The latest cited key points are reflection (2016), health (2017), school (2017), university (2017), environment (2018), pa-

tient safety (2018), classroom (2019), post-graduate student (2019), professional development (2019), design (2019), implementation (2019), motivation (2020), challenge (2020). It is an effective way to better understand the trends and hotspots related to postgraduate teaching. The emerging trends and research directions of CiteSpace provide a new perspective on how to deeply understand the theme of postgraduate teaching in the future. After analyzing the field of postgraduate teaching with CiteSpace, it is suggested that future research should focus on medicine and online learning, which may be a promising field of postgraduate teaching. In addition, in order to achieve sustainable goals, it is necessary to strengthen multidisciplinary development. [61]

Based on the results of these five questions, it is not difficult to find that the relationship is that publications in the field of postgraduate teaching are growing rapidly, and Chinese universities are the main source of new publications after 2020. China's research efforts and influence in this field are increasing step by step. At the same time, from the perspective of cluster analysis and burst analysis of keywords, they both show that the medical field occupies the most important part of the field of postgraduate teaching and research, which also belongs to the mutual argument between problems.

## 5. Conclusions and Limitations

In light of the fact that there are few articles that can directly show the development and current situation of postgraduate teaching from a quantitative perspective, this study uses bibliometric analysis method to systematically and comprehensively analyze and summarize publications in the field of postgraduate teaching. The innovation of this paper is that the quantitative analysis of postgraduate teaching is realized by using bibliometric methods, and each quantity distribution is discussed and analyzed. It makes up for the fact that most of the existing literature summarizes graduate teaching from a qualitative perspective, while few articles can directly show the development of graduate teaching through a large number of data comparisons from a quantitative perspective. In this study, CiteSpace and VOSviewer were used to provide quantitative data in the field of postgraduate teaching research, and a map of postgraduate teaching knowledge was created. Based on the research results obtained, this paper proposes some topics in the field of future graduate teaching research to provide guidance and help for researchers on related topics. Through this research and the author's thinking, some useful findings and suggestions are summarized as follows.

First, as a social system, teaching is bound to be restricted by social and political systems. The educational policies and guidelines formulated by the state have strong guidance and influence on the postgraduate teaching structure. The government's education policy will guide the continuous adjustment and improvement of the postgraduate teaching model and structure. In order to ensure the steady development of postgraduate teaching, the government's educational policies (such as capital investment in postgraduate teaching, talent introduction, etc.) play a vital role. It is suggested that the scale of postgraduate teaching should be expanded to rationalize. Increasing the ratio of master to doctoral students requires improving the level of research and training, promoting the continuous development of science and technology, and constantly improving the knowledge level of talents in various professional fields. At the same time, in terms of the form and structure of graduate students, we should constantly expand the training scale of professional degree graduate students to meet the large demand for application-oriented and compound talents due to the upgrading of industrial structure, scientific and technological development and social production practice.

Second, in postgraduate teaching, we should pay attention to the cultivation of educational values. Educational values are people's ideas about the core values of the whole teaching, which directly or indirectly affect other teaching concepts and play an important role in regulating people's teaching behavior. It can affect the teaching purpose, teaching content, teaching methods, teaching planning, teaching structure and so on. It even relates

to the coordination between the teaching system and other social systems. Therefore, the shaping of educational values has a long-term influence on postgraduate teaching.

Third, from the perspective of research strength, graduate teaching research has formed a research team with highly influential scholars as the center and a core research institution with first-class universities as the main body, and the research strength has gradually grown. These research teams mainly focus on highly influential researchers and carry out postgraduate teaching research based on the research platform built by colleges and universities, so as to promote the strength of postgraduate teaching research of corresponding research institutions. However, the distribution of research power is uneven, and the main research comes from universities. This problem has affected the cohesion of postgraduate teaching and research power to a certain extent and hindered the healthy development of postgraduate teaching and research. Therefore, postgraduate teaching research should attach importance to the cultivation of research teams and the gathering of research forces. While paying attention to the inheritance and development of academic pedigree, we should break the barriers between space and academic journal exchange platforms, strengthen the frequency and depth of cooperation, and promote the construction of the academic community of postgraduate teaching and research and the formation of schools. Therefore, it is suggested that researchers and institutions should strengthen cooperation, exchange and depth of cooperation and that academic journals undertaken by research institutions should be more open, so as to strengthen academic contention.

Fourth, at the moment of COVID-19 epidemic, some experts have indicated that COVID-19 may coexist with humans for a long time and become a seasonal epidemic, and humans will soon enter the "post-epidemic era". The future postgraduate teaching trend will change to online teaching. Therefore, we should vigorously develop online teaching. This paper suggests that first, we should solve the problem of network collapse, second, we should vigorously develop more high-quality online learning platforms, and third, we should ensure the hardware equipment for online teaching. For graduate students, they should improve their consciousness, regularly carry out mental health education, strengthen psychological counseling, and do a good job of humanistic care. At the same time, there are many medical-related subjects in postgraduate teaching, so it is suggested that researchers should strengthen the exploration of postgraduate teaching in other fields.

The Web of Science database was selected as the data source in this study. Data collection was limited to WoS core collection. The literature included in different databases is varied, so the data source in this study has certain limitations. First of all, although Web of Science is considered a reliable database source for bibliometric analysis, the data in this study may not be comprehensive, and other database resources (such as Embase, Medline and Scopus) will not be added. Second, we only selected articles published in English, thus causing language bias. Next, we can expand the scope to other databases and expand the data sources. In addition to the intuitive presentation of the knowledge map, research hotspots and research frontiers also need to be interpreted by researchers. Influenced by the author's academic level, the interpretation is subjective to some extent, and the interpretation is not deep enough. In future research processes, it needs to be further expanded. Finally, there are restrictions on the bibliometric software. As a result, it is advised to do a more thorough content analysis for additional study while performing bibliometric analysis.

**Author Contributions:** Investigation S.F.; validation J.J.; methodology F.L.; resources G.Z.; data curation Y.G.; writing—original draft preparation, W.G.; funding acquisition, G.Z. and Y.G. All authors have read and agreed to the published version of the manuscript.

**Funding:** This work was funded by Sichuan Province 2021–2023 Higher Education Talent Training Quality and Teaching Reform Project (No. JG2021-654), Sichuan Province 2021–2023 Higher Education Talent Training Quality and Teaching Reform Project (No. JG2021-674) and Graduate Quality Engineering Key Program of Chengdu University of Technology (No.2022YJG115).

**Institutional Review Board Statement:** Not applicable.

**Informed Consent Statement:** Not applicable.

**Data Availability Statement:** Not applicable.

**Acknowledgments:** We thank the assistance of Academic Affairs Office of Chengdu University of Technology.

**Conflicts of Interest:** We declare that we have no financial and personal relationships with other people or organizations that can inappropriately influence our work, there is no professional or other personal interest of any nature or kind in any product, service and/or company that could be construed as influencing the position presented in, or the review of the manuscript.

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