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Training pedagogical competence for teachers: a bibliometric analysis using the Scopus database

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ABSTRACT

Pedagogical competence training for teachers is an intensive training process to improve teachers' knowledge, skills, and teaching ability. The change in teaching and research and the development of science and technology have affected the training of pedagogical competency for teachers in many countries. An analysis of the publications related to these paints a general picture of significant trends and contributions by scientists and has implications for policymakers and researchers alike. The study used bibliographic analysis to analyze 344 documents extracted from the Scopus database related to pedagogical competence training for teachers. The results show that the number of studies on this topic increased sharply, especially from 2015 to 2022 and mainly from studies in the United States and developed countries. In addition, the most concerning issues are higher education, professional development, and teacher training. Policymakers and researchers can find prominent authors, influential studies, and regularly published journals on teacher training to read and write about. Further studies based on a combination of bibliographic analysis and other methods may help paint a deeper picture of the research findings on this topic.

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1. INTRODUCTION

In the context of innovative education, administrators and researchers pay special attention to the issue of teachers. The professional competency of teachers is expressed mainly through pedagogical competency. Teachers must maintain substantive and appropriate teaching activities to achieve professional competence. As science and technology develop, especially the development of information and communication technology, teachers' teaching skills also need to change. For example, teaching skills in blended learning and e-learning models. Therefore, after graduating from university and participating in teaching, teachers still need to continue studying to improve and update their professional knowledge and skills. Teachers' learning to improve and update their knowledge and professional skills must be done before implementing innovative content in school education. Hence, it is necessary to conduct research on innovation trends in education to find out the content and methods that need to be trained for teachers.

According to Emilio and Nicholas [1], teacher training opportunities represent an essential factor influencing a nation's development and the opportunities of people. Acosta and Quiles [2] pointed the teaching of university professors without pedagogical training is an academic issue of concern in order to improve the quality of university education. To achieve the quality of university education, it is necessary to inspire lecturers to self-evaluate and reflect on their teaching and to continuously practice. Before the

COVID-19 pandemic, Pereira *et al*. [3] analyzed an online course for teacher training; Bentri *et al.* [4] also suggested factors that support digital pedagogical competence for teachers. Pedagogical competence is an important professional competence of all teaching staff, including teachers [5], teaching assistants [6], and lecturers at universities [7]. Channa and Sahito [8] affirmed that the teaching competence of teachers will affect how well students learn. In fact, teachers with good pedagogical competency are able to identify the unique characteristics and learning needs of each student, through which they will develop a teaching plan and effectively implement that plan. At the same time, they are also capable of creating a positive and safe learning environment for students. Pedagogical competence can be developed in many ways, such as short courses [9], long-term courses [10], self-study, and learning from colleagues [11]. This makes it easier to update the knowledge and pedagogical skills of teachers, even those who have not graduated from pedagogical universities.

The problem that teaching participants are not equipped with pedagogical knowledge and skills is also a matter of concern to many researchers. For example, Ritchey and Smith [12] developed an undergraduate teaching assistant training course. The course provides an effective method by which assistants learn how to support students and faculty in a wide range of university courses. This model is seen as having potential for other teaching assistant programs or a course to help university lecturers improve their pedagogical competency [13]. However, after graduating from university and entering the teaching profession, many teachers settle in places far from the university or from where pedagogical training courses are held. They are also busy with other jobs related to family and friends. Therefore, participating in courses on improving pedagogical competency will have many obstacles. Many measures have been put in place to increase the efficiency of the process of fostering pedagogical competency for teachers. Examples are the online courses for the improvement of basic instructional engineering skills [14], [15]. Also, use blended learning and find that blended learning has more positive effects on teacher achievement and long-term learning than traditional teaching methods [16]–[18]. In addition, organize teaching based on lesson research to improve the pedagogical competency of teachers, namely a small group of teachers working together to design a lesson study, open a class, observe, and reflect on some of the lessons learned. classroom lessons [11]. Therefore, participation in pedagogical competency-training courses can be identified as a factor affecting teachers' pedagogical competency in recent times.

The form of training is one of the factors affecting the choice of participation or not of the teaching staff. However, until now, there has not been any document systematically analyzing the bibliography on fostering pedagogical competency for teachers to get an overview of research trends in recent years, which country, which author, and which resource is ranked as the top research on this issue so that researchers and policymakers can learn from and refer to it? The most important topics about pedagogical competency need to focus on further research, for example, forms of organizing pedagogical competency training for teachers. Some previous bibliographic studies mainly focused on general professional competence training for university lecturers [19] or digital teaching competence for university lecturers [20].

To provide an overview of pedagogical competence training for teachers, in this study we analyze data obtained from the Scopus dataset using bibliometric analysis. The study points out current research trends on teacher pedagogical competency development, countries, authors, and sources that researchers and policymakers should learn about and refer to and potential research directions. As no similar review has been performed in the literature, this paper aims to fill this research gap. To accomplish this goal, the study addresses four research questions:

i) What are the volume, growth patterns, and geographic distribution of the world's training pedagogical competence publications? (RQ1)
ii) Which are the top sources (journals, book series, and conferences) on training pedagogical competence regarding the volume of publications and citations? (RQ2)
iii) Who are the top authors and research groups on training pedagogical competence regarding publications and citations? (RQ3)
iv) What are the most important research topics in training pedagogical competence? (RQ4)

This study analyses and points out research trends in scientific documents related to fostering pedagogical competence for teachers using bibliometric analysis in the Scopus database. Thereby, we recognize a number of issues that can be further researched in the future related to teachers' pedagogical competence. This includes research on the pedagogical competencies of teachers in developing countries and building models for fostering pedagogical competencies for teachers in these countries. These results help policymakers and managers at universities devise appropriate policies to improve teachers' pedagogical capacity. At the same time, it helps lecturers find trends to foster and develop their own expertise. Researchers can find research gaps to find future research directions.

2. METHOD

This study uses the Scopus database as the primary search engine due to its broader coverage and more detailed indexing capabilities in social science research [21] compared to other databases such as the Web of Science (WOS), Google Scholar [22], [23]. The study was carried out according to the preferred reporting items for systematic review and meta-analysis (PRISMA) model [24]. In recent years, the PRISMA model has been increasingly used by scholars from different fields to conduct systematic assessments, such as tourism and hospitality [25], operational research and management science [26], culture [27], economics [28], computers, and industrial engineering [29]. In particular, in the field of education, there have been some previous works using PRISMA to perform systematic assessments [30]–[33].

The keywords used in this article were collected based on the results of a combination of searches related to pedagogical competence and pedagogical competence training. We explore the issue of fostering pedagogical competency for all teachers working in the teaching profession, regardless of the type of school or the type of students they teach. The reason is because we believe that, in addition to the specific skills needed when teaching students of different ages and different subjects, there are still many common and similar skills among these teachers. At the same time, we want to overview all content related to fostering pedagogical competency in general. Geographic distribution is not restricted. There is no time limit on the publication of studies. The first raw data retrieved was 1,811 documents, which were obtained using a search query on Scopus's website on April 12, 2023.

In the next step (screening), on Scopus's website, the documents are limited to the fields: social sciences, arts and humanities, decision sciences, psychology, business, economics, multidisciplinary; limited by articles, conference papers, and book chapters; and the search language is set to "English". So, there are 751 rejected documents, leaving 1,060 remaining. This data was obtained using a search query on Scopus's website on April 12, 2023, as the following: TITLE-ABS-KEY (("pedagogical competence" OR "pedagogical skill")) OR (TITLE-ABS-KEY ("pedagogical training" OR "pedagogical mentoring" OR "pedagogical coaching" OR "pedagogical instruction" OR "pedagogical tutoring")) AND (LIMIT-TO (PUBSTAGE , "final")) AND (LIMIT-TO (SUBJAREA , "SOCI") OR LIMIT-TO (SUBJAREA , "ARTS") OR LIMIT-TO (SUBJAREA , "DECI") OR LIMIT-TO (SUBJAREA , "PSYC") OR LIMIT-TO (SUBJAREA , "BUSI") OR LIMIT-TO (SUBJAREA , "ECON") OR LIMIT-TO (SUBJAREA , "MULT")) AND (LIMIT-TO (DOCTYPE , "ar") OR LIMIT-TO (DOCTYPE , "cp") OR LIMIT-TO (DOCTYPE , "ch")) AND (EXCLUDE (PUBYEAR , 2023)) AND (LIMIT-TO (LANGUAGE , "English")). Figure 1 shows the flowchart of the document selection process.

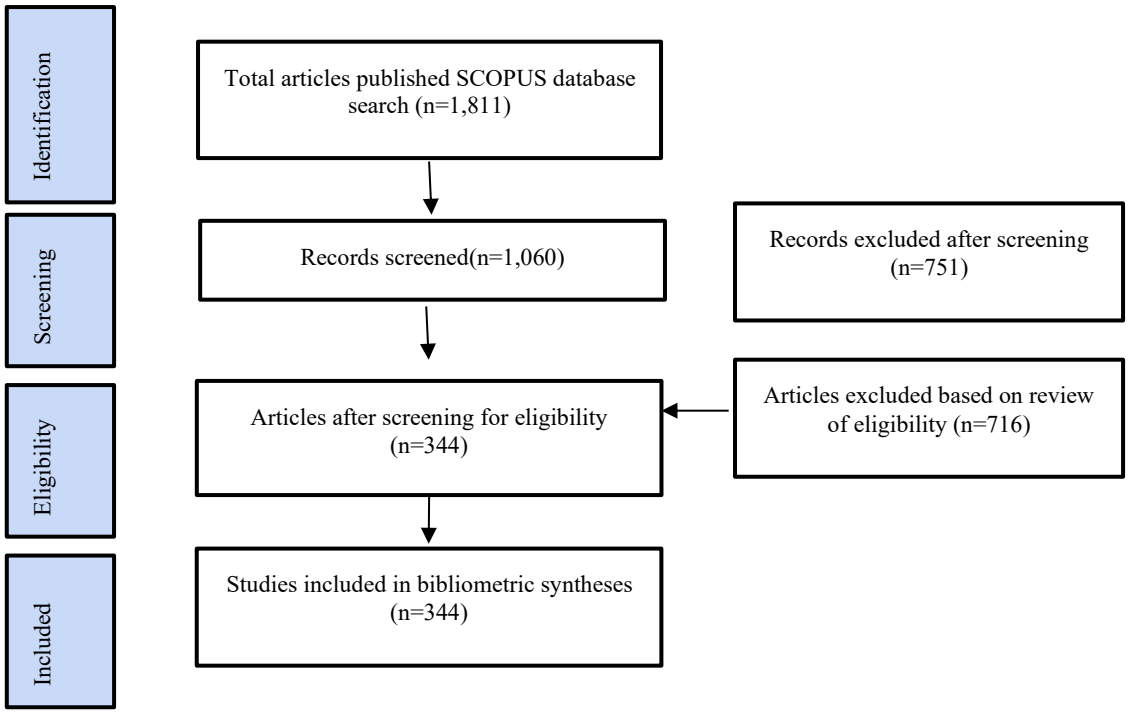

Figure 1. PRISMA-based document selection process flow chart

Next, the document's titles and summaries were examined to determine eligibility based on thematic relevance, often referred to as direct subject or direct match. between the overall topic of the relevant document and the entire topic of the user's needs. For example, many articles were removed due to irrelevant content (e.g., [34]–[37]) or because they focused only on the role and importance of pedagogical competence and did not study how to develop that competency (e.g., [38]–[41]). All researchers in the study group participated in the selection of documents and followed the guidelines established in the search protocol. This resulted in the exclusion of an additional 716 documents. Thus, the final database included 344 articles for final review.

Bibliographic data (authors, link titles, and citations) related to 344 documents was exported and saved for subsequent data analysis. Data analytics include descriptive statistics (e.g., number of articles by country and author) as well as advanced bibliographic analysis, including citation and co-citation analysis using co-authorship and keyword analysis [42], [43]. VOSviewer software [44] was used for data processing and visualization because it is the most popular and effective software for bibliographic analysis [45].

3. RESULTS

3.1. General statistical information

Figure 2 depicts the number of documents on pedagogical competence training by year from 1981 to 2022. The values on the vertical axis in Figure 1 show that before 1998, there were only 1-3 per year. Publications on the topic of fostering pedagogical competence were published; this number increased to 4 in 1999 and then returned to the old trend. In 2006, it gradually increased to nearly 10 publications by 2015. At that time, 2012 was marked by a spike in the number of publications on the topic of fostering pedagogical competence. Specifically, from 2015 onwards, the number of research papers on pedagogical competence training for teachers increased significantly, especially in 2021 with 46 evaluation documents. In 2016 and 2017 also had a fairly high number of documents, with 37 and 24 documents, respectively. Meanwhile, in previous years, not many review papers were published. However, in 1984 and 2007, there were a higher number of published documents than in previous and subsequent years (3 and 6 documents, respectively). However, this growth rate is unstable, as it continues to increase and then decline sharply until 2022. Overall, Figure 2 shows that the number of documents on pedagogical competence training has increased significantly in recent years. recent years, showing the interest and efforts of researchers and teachers in improving the quality of pedagogical training.

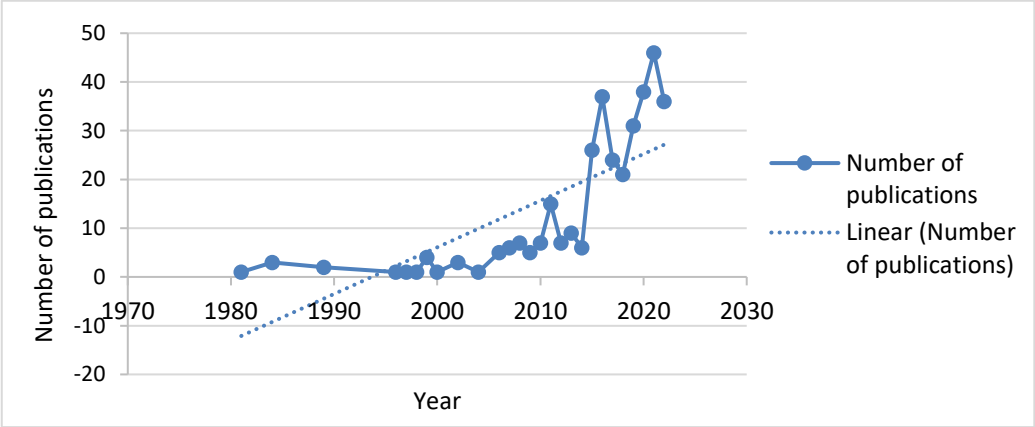

Figure 2. Number of documents on pedagogical competence training by year

3.2. Comparisons between countries

Figures 3-5 show the geographical distribution of countries with research related to pedagogical competence training around the world. Researchers from 74 countries have published at least one publication on the subject. Three countries, including the United States (81 works), Indonesia (28 works), and the Russian Federation (26 works), are considered to be the countries that publish the most research on pedagogical competence training. Besides three other countries, the United Kingdom (21 works), Finland (18 works), and Kazakhstan (15 works) also have a relatively large number of research works on this topic. These six countries have contributed more than half of all relevant published works.

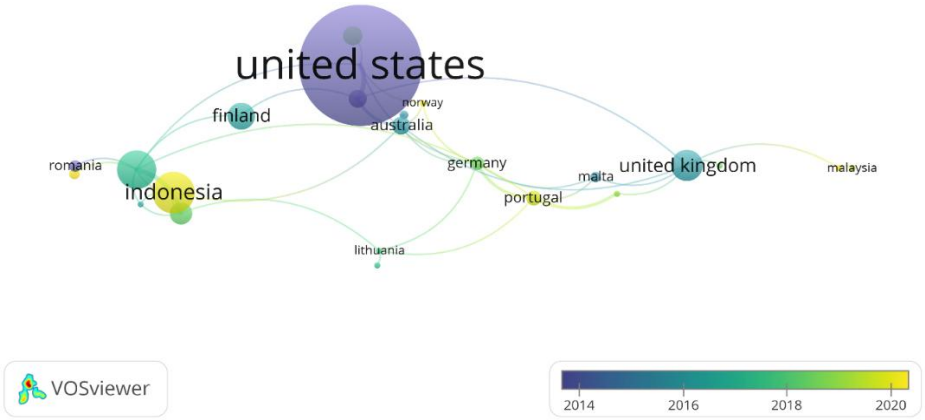

Figure 3. Distribution of the number of scientific publications on pedagogical competence training in the world by countries in the period from 2014 to 2022 (of the 74 countries, 35 meet the thresholds)

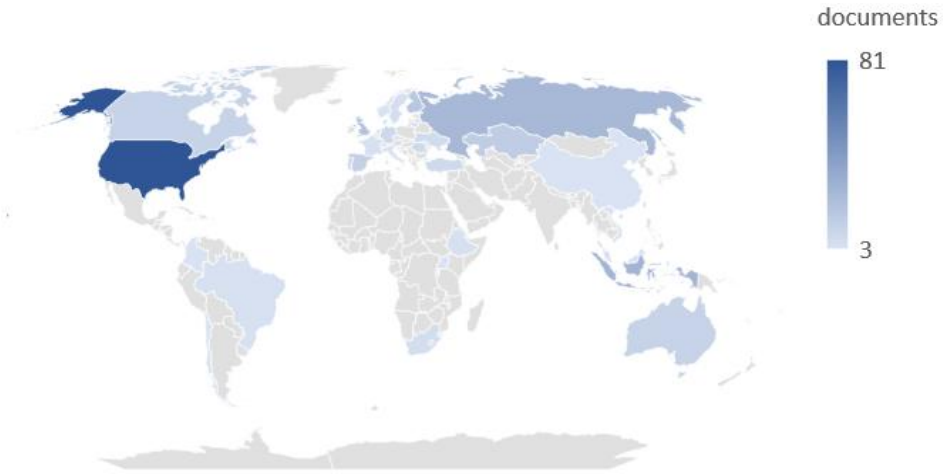

Figure 4. Publications of countries on fostering pedagogical competence in the world

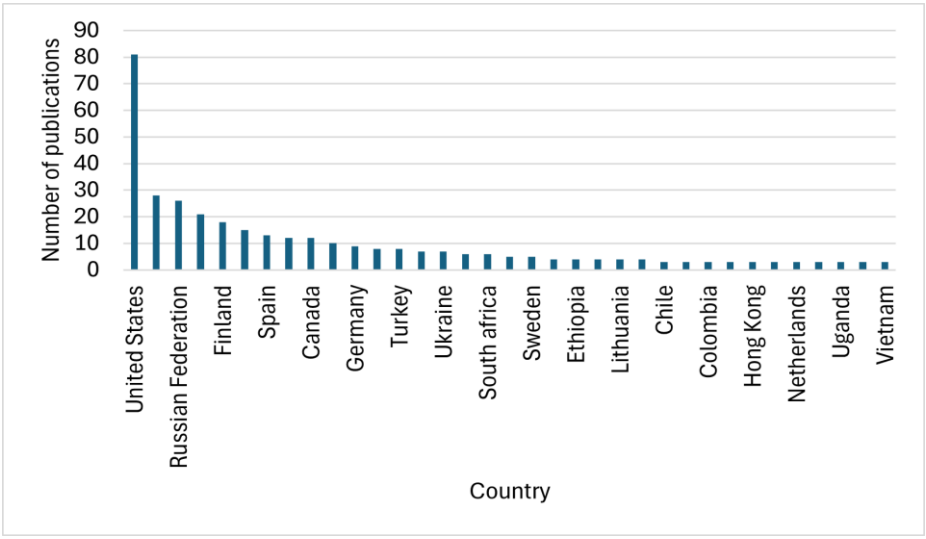

Figure 5. Countries with the highest number of publications on pedagogical competence training in the world from 2014 to 2022

3.3. Cooperation between countries

Regarding international cooperation networks, a co-authored analysis was carried out to identify research collaborations between countries on the topic of pedagogical competence training during the period in question. After selecting authors with more than three publications on pedagogical competence training, a co-author analysis was conducted, yielding an intuitive result. The representation of countries with significant co-authorship relative to other countries is shown in Figure 6. Specifically, the United States (US) has the largest number of co-authored works (81), but ranks third only in terms of co-authoring total link strength (7). Meanwhile, the Russian Federation is the country with the highest total link strength (10) but is third in the document (26). The next countries in the Russian Federation in total link strength are Australia (8), the US (7), Canada (7), Portugal (7), and Germany (7). Another notable point is that the co-authoring research cooperation between the Russian Federation and Kazakhstan and between the US and Canada is said to be the strongest, with three co-authored publications.

In addition, the button color represents the average publication year (of all selected publications) for a country. The more recent the publications on fostering pedagogy, the lighter the color of the button. Thus, it can be seen that Indonesia (28 publications, average publication year: 2019.75), China (3 publications, average publication year: 2021.00), Portugal (with 10 publications, average publication: 2019.50), Ukraine (7 publications, average publication year: 2020.57), and Norway (3 publications, average publication: 2020.00) are relatively new countries in the field of pedagogical research and pedagogical competence training. In contrast, the countries highlighted in dark blue include the US (81 publications, average publication year: 2013.20), Canada (12 publications, average publication year: 2012.50), and Romania (8 publications, average publication year: 2012.88). In particular, the US is the country with the most co-authored publications on the topic of pedagogical competence training (81) with an average publication year of 2013.20, indicating that the issue of fostering pedagogical competence is recognized by the scientific community. Studying in this country has interested me for a long time.

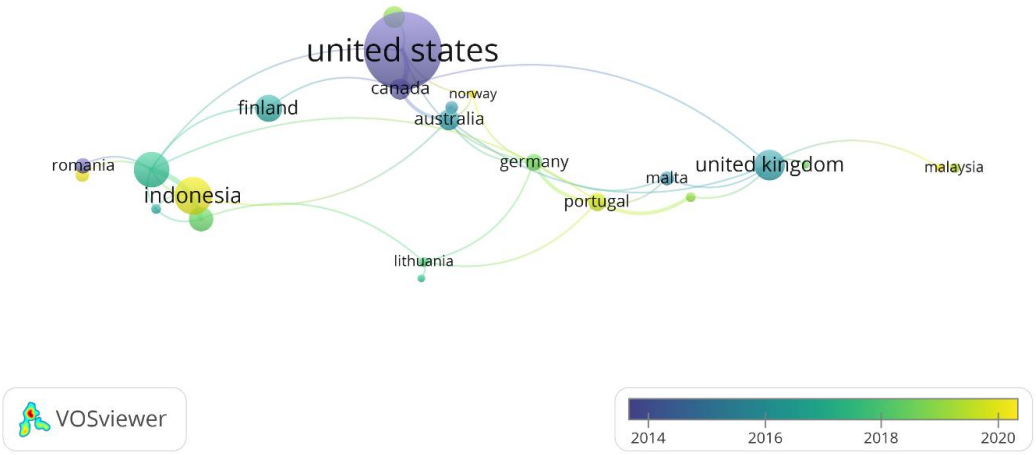

Figure 6. Map of co-authorship between countries (filter by total link strength, N=74 countries, minimum number of documents of an author: 3, 19 meet the thresholds)

3.4. Notable authors

As noted in the Scopus database, there are 336 authors from many different countries who have published research on fostering pedagogical competencies. Of these, 319 authors were cited less than 30 times, representing approximately 94.9% of all identified authors. Only 10 authors are cited in more than 40 other studies, as shown in Table 1. It shows that the number of citations with the same surname is over 40 times with only 1 or 2 public publications.

Meanwhile, the number of works by the authors on the topic of fostering pedagogical competency is also measured. Table 2 shows the 10 authors with the most works on the topic of pedagogical competence training. Combining these two tables, it can be seen that there is only one author appearing in both tables, and that is the author Liisa Postareff, which means that he is also one of the authors with many works on the topic. The most published article on pedagogical competence training and the most cited author on the subject are from Häme University of Applied Sciences, where Liisa Postareff works as its lead research scientist and Adjunct Professor of Pedagogy at the University of Helsinki.

Table 1. Top 10 authors with most number of citations on the topic of pedagogical competence improvement

Rank	Author	Affiliation	Nationality	TC	NP
1	Postareff L.	Häme University of Applied Sciences	Finland	427	2
2	Chai C. S.	The Chinese University of Hong Kong	Hong Kong	266	1
3	Develotte C.	ENS-IFÉ	France	73	1
4	Boe E. E.	University of Pennsylvania	United States	68	1
5	Howard M. O.	The University of North Carolina at Chapel Hill	United States	66	1
6	Starčič A. I.	University of Primorska	Slovenia	54	1
7	Irby D. M.	University of Washington	United States	53	1
8	Brand B. R.	Virginia Polytechnic Institute and State University	United States	48	1
9	Dewaele J. M	University of London	United Kingdom	44	1
10	Ödalen J.	Mälardalen University	Sweden	44	1

(TC: number of times cited, NP: number of published works on the topic of pedagogical competence training)

Table 2. Top 10 authors with the most works on the topic of pedagogical competence training

Rank	Author	Affiliation	Nationality	NP	TC
1	Xerri D.	L-Università ta' Malta	Malta	6	10
2	Postareff L.	Häme University of Applied Sciences	Finland	2	427
3	Saalman E.	Chalmers University of Technology	Sweden	2	0
4	Suhirman L.	Universitas Cenderawasih	Indonesia	2	5
5	Abdullah I.	Robert Morris University	United States	1	4
6	Adams A.	University of Cambridge	United Kingdom	1	0
7	Adey P.	King's College London	United Kingdom	1	20
8	Adjei-boateng E.	University of Ghana	Ghana	1	1
9	Agarwal J.	University of Cincinnati	United States	1	2
10	Ahtarieva R. F.	Kazan Federal University	Russian Federation	1	4

(TC: number of times cited, NP: number of works published on the topic of pedagogical competence training)

3.5. Magazines with the most articles (most popular)

Table 3 presents the top sources (scientific journals) regarding the number of works and citations on the topic of pedagogical competence training, most of which are in the field of education. From Tables 1-2, it can be seen that there are six sources with both the highest publishing productivity and the highest number of citations, namely Teaching and Teacher Education, Action in Teacher Education, Education and Information Technologies, Journal of Science Teacher Education, European Journal of Contemporary Education, and International Education Studies. Among them, the most prominent is Teaching and Teacher Education, with the highest number of citations and ranking 4th in the number of published works on the topic of fostering pedagogical competence. This is an international journal primarily concerned with teachers, teaching, and/or teacher training in an international context. The journal focuses on early childhood through high school (including secondary education), teacher preparation, and higher education in relation to teacher professional development and/or teacher training. In addition, from the two lists in Table 3, it is interesting to see that some journals receive many citations despite their limited number of publications. From there, reader can see the importance and reputation of such journals as the International Journal of Higher Education and Professional Development in Education.

In Figure 7, it can be seen that, from the cross-citation linkage between sources, five groups have been formed, with the same color of buttons; each group includes the most cross-referenced sources. The size of the nodes represents the number of quotes. There is a prominent group of sources that are all highly cited, as shown in Figure 7, including Teaching and Teacher Education, Journal of Science Teacher Education, Action in Teacher Education, and Education and Information Technologies. The special thing is that all four journals are present in both lists of outstanding sources in terms of publication productivity and number of citations, as in Table 3. When compared to the publication year of research on pedagogical competence, as shown in Figure 8, 3 out of 4 journals in this group are the oldest journals in terms of publishing articles on the subject. The topic of pedagogical competence training, from about 2012, only one journal in the group has published research on this topic, and that is Education and Information Technologies, which just published research on competence training. pedagogical force since about 2018.

In addition, from Figure 8, it can be seen that there are a number of journals that have just started publishing publications on pedagogical competence training from 2020 onwards, as shown by brightly colored buttons. These are the Eurasia Journal of Mathematics, Science, and Technology Education; the International Journal of Higher Education; and Cogent Education. Among them are the Eurasia Journal of Mathematics, Science, and Technology Education and the Journal of Cogent Education. Even though they have only published publications on pedagogical competence since 2020, these journals are still on the list. journals with the highest publishing productivity on pedagogical competence training, as in Table 3.

Table 3. Most prominent sources by number of publications and number of citations

Rank	Source	TC	NP	SQ
Source with largest numbers of publications				
1	International Journal of Higher Education	11	5	Q4
2	Journal of Science Teacher Education	94	4	Q1
3	Mediterranean Journal of Social Sciences	5	4	Q4
4	Teaching and Teacher Education	359	4	Q1
5	Action in Teacher Education	25	3	Q2
6	Cogent Education	6	3	Q2
7	Cypriot Journal of Educational Sciences	0	3	Q3
8	Education and Information Technologies	58	3	Q1
9	Eurasia Journal of Mathematics, Science and Technology Education	14	3	Q2
10	European Journal of Contemporary Education	23	3	Q2
11	Indonesian Journal of Applied Linguistics	6	3	Q2
12	International Education Studies	15	3	Q3
Source with largest numbers of citations				
1	Teaching and Teacher Education	359	4	Q1
2	Journal of Science Teacher Education	94	4	Q1
3	Education and Information Technologies	58	3	Q1
4	Professional Development in Education	30	3	Q1
5	Australian Journal of Teacher Education	29	2	Q2
6	International Journal of Instruction	28	3	Q2
7	Technology, Knowledge and Learning	26	2	Q1
8	Thinking Skills and Creativity	26	2	Q1
9	Action in Teacher Education	25	3	Q2
10	European Journal of Contemporary Education	23	3	Q2
11	English for Specific Purposes	19	2	Q1
12	Asia-Pacific Journal of Teacher Education	17	2	Q1

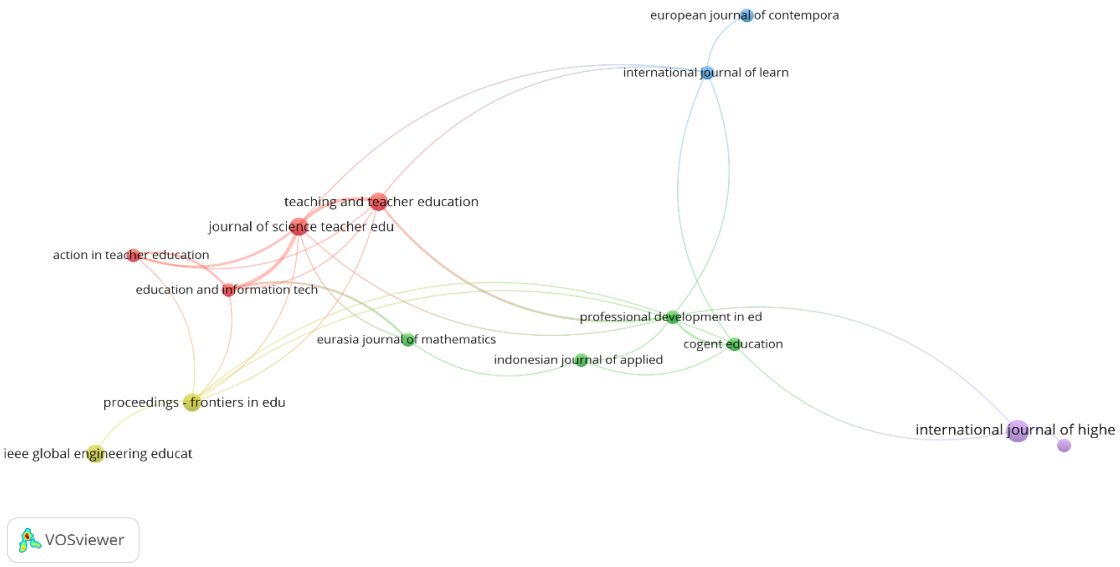

Figure 7. Cross-citation of sources in the field of pedagogical competence training research (minimum number of documents of a source: 3)

3.6. Most cited articles

The most cited publication, and also the one on the topic of fostering pedagogy, published the earliest among the 10 outstanding publications, is "those who understand: knowledge growth in teaching" [46]. The article challenges negative stereotypes about teaching and emphasizes the importance of gaining knowledge in the profession. Shulman [46] argues that teaching is a complex and specialized profession that requires a deep understanding of the subject, the pedagogy, and the unique needs of the learner. He suggests that teachers can continue to develop their knowledge and expertise over time through continuous professional development and collaboration with peers. Shulman [46] also argues that the traditional model of teacher training and professional development needs to be reimagined to better support knowledge development in the profession. Overall, the article emphasizes the importance of recognizing and evaluating teachers' knowledge and expertise. In addition, from Table 4, it can be seen that Teaching and Teacher Education magazine has many publications on the topic of fostering pedagogical competencies, most of

which are cited in the list of 10 outstanding publications. This is also the journal that is included in both the list of sources with the highest publishing productivity and the most cited journal on the topic of pedagogical competence training, as in Table 3.

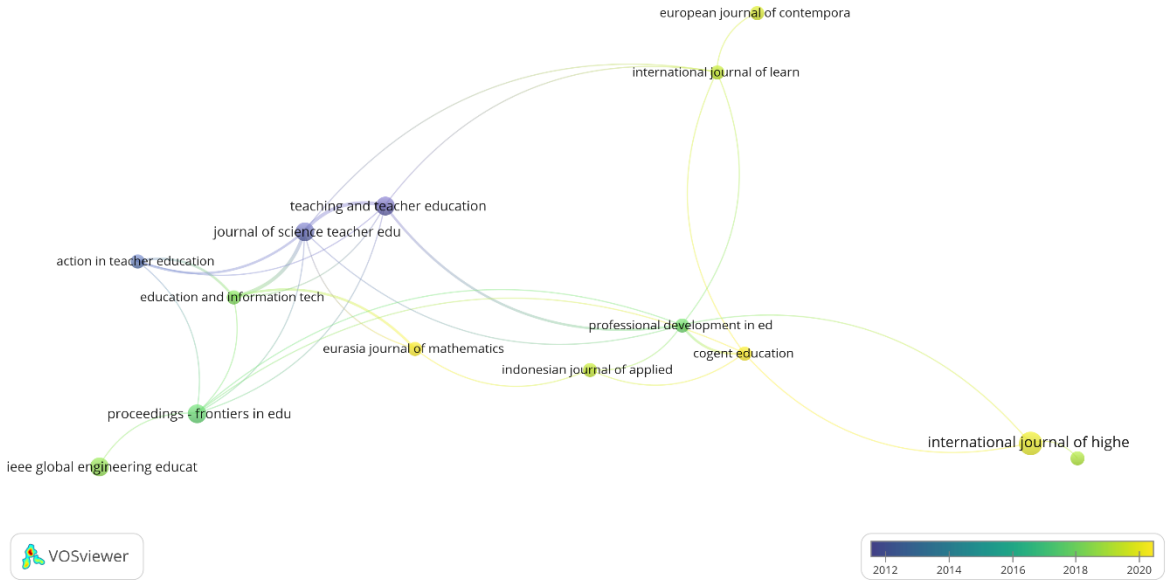

Figure 8. Cross-citation of sources in the field of pedagogical competence training research by the year (minimum number of documents of a source: 3)

Table 4. Top 10 most cited publications (scientific articles) on the topic of pedagogical competence training based on the Scopus database

Rank	Author(s)	Title	YP	Source	TC	SQ
1	Shulman L.S.	Those who understand: knowledge growth in teaching	1986	Educational Researcher	11	Q1
2	Borko H.	Professional development and teacher learning: mapping the terrain	2004	Educational Researcher	9	Q1
3	Gibbs G.	The impact of training of university teachers on their teaching skills, their approach to teaching and the approach to learning of their students	2004	Active Learning in Higher Education	8	Q2
4	Marx R.W.	New technologies for teacher professional development	1998	Teaching and Teacher Education	7	Q1
5	Postareff L.	The effect of pedagogical training on teaching in higher education	2007	Teaching and Teacher Education	7	Q1
6	Rienties B., Brouwer N., Lygo-baker S.	The effects of online professional development on higher education teachers' beliefs and intentions towards learning facilitation and technology	2013	Teaching and Teacher Education	7	Q1
7	Alloway T.P. and Alloway R. G.	The impact of engagement with social networking sites (SNSs) on cognitive skills	2012	Computers in Human Behavior	6	Q1
8	Alloway T. P., Horton J., Alloway R. G., Dawson C.	Social networking sites and cognitive abilities: Do they make you smarter?	2013	Computers & Education	6	Q1
9	Arnold N., Paulus T.	Using a social networking site for experiential learning: Appropriating, lurking, modeling and community building	2010	Internet and Higher Education	6	Q1
10	Callaghan N., Bower M.	Learning through social networking sites: the critical role of the teacher	2012	Educational Media International	6	Q1

Most publications are published from sources that rank highly in the Scopus database.

3.7. Keyword analysis

Table 5 presents the keywords most mentioned in the publications on pedagogical competence training. It shows the differences in aspects of those publications, including pedagogical aspects and professional aspects. subject. In this section, we used co-occurrence analysis to determine the structure of studies on pedagogical competency building. Co-occurrence keywords play an important role in bibliometric analysis because this method helps quickly detect common research topics and allows for tracking research

trends in the scientific field according to the progress of time. With the data from Scopus publications on pedagogical competency building, we used VOSviewer software, and the results of the analysis showed the keywords, as shown in Figures 9 and 10. In this map, the size of the button represents the number of occurrences of a keyword in the database (if the node is large, the keyword appears more often), and the links between two nodes represent the relationship between them. Nodes of the same color can be displayed. They may now appear on the same research topic.

Table 5. Top 15 keywords with the most appearances in publications on pedagogical competence training

Rank	Keywords	n	TLS
1	Higher education	27	34
2	Professional development	27	33
3	Teacher training	21	16
4	Pedagogical training	18	22
5	Pedagogical competence	17	16
6	Teacher education	17	19
7	Pedagogy	16	24
8	Engineering education	11	13
9	Competence	8	9
10	Pedagogical skills	8	5
11	Teachers	8	9
12	E-learning	7	9
13	Professional competence	7	9
14	Training	7	12
15	Active learning	6	9

n=number of occurrences; TLS=total link strength

A total of 975 keywords appeared in all 336 publications analyzed. To establish a relationship between them, only keywords that appear at least three times are selected. Using this criterion, there are 61 keywords that meet our criteria and are shown in the results map. The most popular keywords are all the ones we used to find data for this study, and words close to them are as: teacher education (17), teacher training (21), higher education (27), professional development (27), pedagogy (16), pedagogical training (18), and pedagogical competence (17). What is interesting here is that we found that some of these keywords mean the same thing, such as teacher education, teacher training, and pedagogical training; or one keyword is the target of the action represented by the other keyword, for example, professional development, pedagogical competence, and teacher education, teacher training, and pedagogical training.

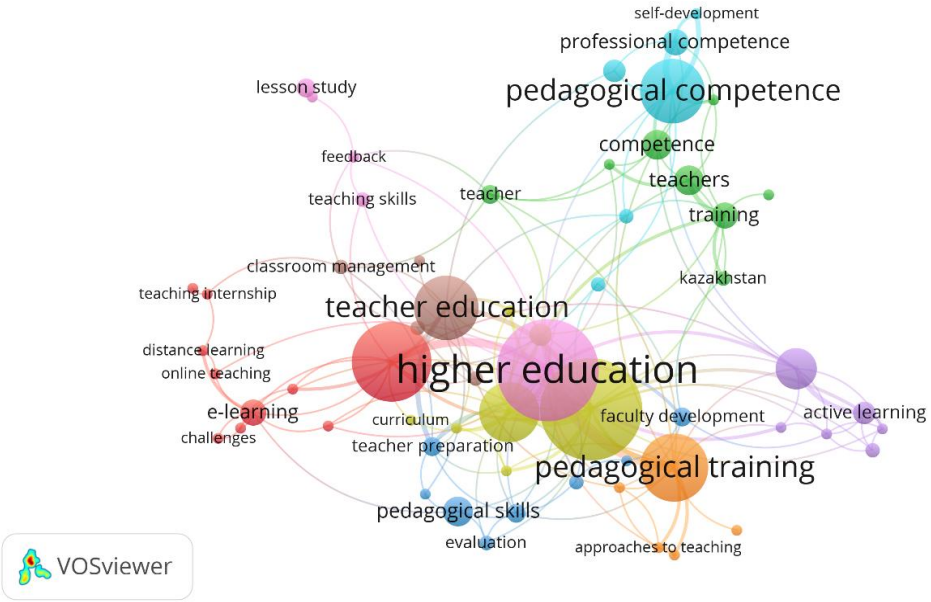

Figure 9. Distribution map of keywords on the topic of pedagogical competence training, using the co-occurrence analysis method (N=975 keywords, threshold 3 co-occurrences, display 61 keywords)

Different colors in Figure 10 indicate the frequency of keywords that have appeared over time and are associated with the topic of pedagogical competency building. It can be seen that the most recently mentioned keywords are science, technology, engineering and mathematics (STEM), teaching skills, online teaching, pedagogical skills, project-based learning, and primary education. It is surprising that the keywords distance learning and e-learning have been mentioned in publications since about 2014, but until about 2022, publications related to online teaching keywords have not been published.

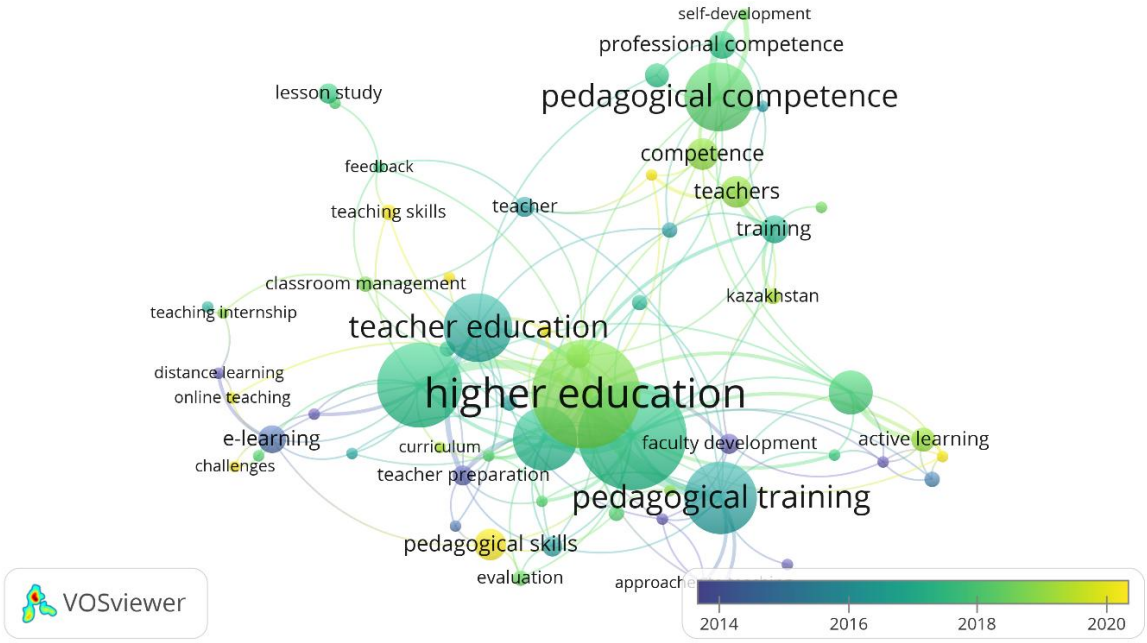

Figure 10. Time distribution map of keywords, using the co-occurrence analysis method (N=975 keywords, threshold 3 co-occurrences, display 61 keywords)

4. DISCUSSION

The number of publications related to research on teacher training was somewhat limited prior to 2015. However, in the past 10 years, there has been a significant increase in volume, with about 81.69% of the total articles, as in Figure 2. The increase in the number of studies on pedagogical competency building for teachers is due to the focus on the role of teachers in the teaching process [47], [48]. In order to promote education for sustainable development, UNESCO promoted this for many years, from 2005 to 2014 [49]. This is the driving force behind the research on fostering pedagogical competency for teachers. Notably, in 2021, the number of studies will have skyrocketed, focusing mainly on fostering teachers' digital competence when teaching. This result is similar to Alka *et al*. [50], which concluded that the number of research publications on pedagogical content knowledge increased from 2018 to 2020 and decreased in 2022. The COVID-19 pandemic had an impact on this, making it possible to conduct online teaching activities and significantly increasing the number of online courses [51]. Therefore, teachers also need to be strongly nurtured in their pedagogical competency in the digital environment.

Despite such an increase in the number of publications in recent years, there is an uneven development in science across countries, as in Figures 3-5. Countries with developed economies such as the United States, the Russian Federation, and the United Kingdom are the countries with the largest number of published publications, with the United States accounting for 23.55%. This result is similar to previous research by Alka *et al*. [50]. After the US, the country with the second largest number of scientific publications is Indonesia. However, Alka *et al*. [50] show that the 20 countries with the largest number of publications on pedagogical content knowledge do not include Indonesia but do include China, India, and Japan. This proves that in studies on fostering pedagogical competency for teachers in Indonesia, there are few studies focusing on pedagogical content knowledge. This may be because their pedagogical theoretical system is complete; they focus on training skills for teachers. Other countries in the Asian region have not really paid attention to developing pedagogical competency for teachers but only stopped at finding knowledge about pedagogical competency in general. The results show that seven out of the 10 most

productive academics, as in Table 2 come from these countries. As such, in order to keep up with the rapid development of this field of study, scholars from other countries must focus more on it, or else they risk falling behind. At the same time, countries need to refer to the teacher training models of countries with experience in this topic to find a model suitable for their own context [52].

International cooperation networks between different countries are considered weak, focusing on only a few countries in the last 10 years. In particular, the cooperation mainly focuses on the countries with the largest number of publications related to pedagogical competency building, as the United States and Canada, Australia; the United Kingdom group with Brazil, Portugal, and Germany; the Russian Federation group with Kazakhstan, Finland. As such, it is essential for researchers working in the field of educational science to strengthen national and international cooperation networks to enhance educational science publications and improve the quality of their research to produce good-quality publications.

Our analysis shows that, among the 12 most popular journals on research on fostering pedagogical competence for teachers, the Journal of Teaching and Teacher Education and the Journal of Science Teacher Education both belong to this group Q1 has a notable number of citations. Teaching and Teacher Education is an international journal concerned primarily with teachers, teaching, and/or teacher education situated in an international perspective and context. Teaching and Teacher Education does not publish unsolicited book reviews, validation studies, essays, constructive criticisms, and/or conceptual-type papers without empirical evidence such as reports, frameworks, or models. The Journal of Science Teacher Education serves as a forum for disseminating high-quality research and theoretical position papers concerning the preservice and in-service education of science teachers. The journal features pragmatic articles that offer ways to improve classroom teaching and learning, professional development, and teacher recruitment and retention at pre-K–16 levels. The other journals with the next highest number of publications and citations are also in the Q1 or Q2 group. Therefore, researchers should strive to improve the quality of their research so that they can accommodate high-quality journals and increase the citation rate of their research.

The keyword analysis in Figures 9 and 10 shows that the research topics are diverse. However, there are only a few keywords that are of significant interest, such as higher education and professional development, followed by teacher training, pedagogical training, pedagogical competence, and teacher education. That is why the five most cited articles in the publishing list are related to higher education and professional development [53]–[56]. Some important keywords have not been studied much or are still missing, such as teaching competence, online teaching, and high school. These are important research directions in educational science to help improve the pedagogical competency of teachers. These research gaps guide the research potential that researchers on the subject of teacher training can focus on in the future. In addition, recent keywords related to STEM, teaching skills, and project-based learning show that they are consistent with the teaching trend towards developing learners' competencies, helping learners to meet the requirements of students modern society [57], [58].

5. CONCLUSION

This study analyzes and visualizes research trends in scientific documents related to fostering pedagogical competence for teachers with bibliographic analysis and the Scopus database. The issue of fostering pedagogical competence for teachers is increasingly receiving the attention of researchers, with an increasing number of publications in the past 10 years. But mainly in developed countries, especially the United States, with the largest number of publications to date. Developing countries have a limited number of publications on the subject. The fact that organizations like UNESCO or the governments of some countries launch activities to promote education for sustainable development is a significant contributing factor to this increase. Most of the publications in the research data set are recommended by high-ranking educational journals such as Teaching and Teacher Education. These journals can be used as reference materials for researchers on the issue of fostering pedagogical competency for teachers. The leading research group with the highest number of citations on pedagogical competency training is Shulman's group. In addition, the visualisation results using VOSViewer provide 61 keyword clusters with a keyword-based network with content to foster pedagogical competence. From there, it helps researchers identify important research directions that have been studied by many researchers related to higher education, professional development, teacher training, pedagogical training, pedagogical competence, and teacher education. And research that receives little attention is teaching competence, online teaching, and high school.

This study provides a comprehensive quantitative analysis of the research on teacher training. However, like other bibliographic analyses, this work has some limitations, namely that it only uses Scopus data sources, because merging with other database sources can make them incompatible. These results help policymakers and managers at universities devise appropriate policies to improve teachers' pedagogical competence. At the same time, it helps lecturers find trends to foster and develop their own expertise. Researchers can find research gaps to find future research directions. The research results also highlight

a number of issues that can be further researched in the future related to the pedagogical competence of teachers, including the study of the pedagogical competence of teachers in developing countries and build a model for fostering pedagogical competency for teachers in these countries. In addition, focus on fostering teaching competency in the digital environment for teachers to adapt to the new trends in society. Future research can learn more deeply about the pedagogical competencies of specific groups of teachers such as teachers in high schools, colleges, and universities.

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AUTHOR CONTRIBUTIONS STATEMENT

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C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal analysis
I : **I**nvestigation
R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest

DATA AVAILABILITY

The data that support the findings of this study were retrieved from the Scopus database using a defined search string. Due to licensing restrictions, the dataset is not publicly available but can be obtained from the corresponding author [PLL], upon reasonable request.

REFERENCES

[1] R. P. Emilio and F. O. Nicholas, "Relevance of University Teaching Staff in Pedagogical Training," *Revista de Ciencias Sociales*, vol. 26, no. 4, pp. 419–432, 2020, doi: 10.31876/rcs.v26i4.34671.
[2] M. Z. Acosta and O. L. Quiles, "Perception of teaching competences in university professors of Health Sciences," (in Spanish), *Educación Médica*, vol. 22, pp. 420–423, Sep. 2021, doi: 10.1016/j.edumed.2021.02.002.
[3] I. Pereira *et al.*, "Teacher training as a starting point to support the initial challenges of emergency remote learning-case study," in *2021 International Symposium on Computers in Education (SIIE)*, 2021, pp. 1–6, doi: 10.1109/SIIE53363.2021.9583660.
[4] A. Bentri, A. Hidayati, and M. Kristiawan, "Factors supporting digital pedagogical competence of primary education teachers in Indonesia," *Frontiers in Education*, 2022, vol. 7, p. 929191, doi: 10.3389/feduc.2022.929191.
[5] M. Ukrop, V. Švábenský, and J. Nehyba, "Reflective diary for professional development of novice teachers," in *Proceedings of the 50th ACM Technical Symposium on Computer Science Education*, 2019, pp. 1088–1094, doi: 10.1145/3287324.3287448.
[6] H. A. Barron, L. C. Brown, and S. Cotner, "The culturally responsive science teaching practices of undergraduate biology teaching assistants," *Journal of Research in Science Teaching*, vol. 58, no. 9, pp. 1320–1358, 2021, doi: 10.1002/tea.21711.
[7] H. Vilppu, I. Södervik, L. Postareff, and M. Murtonen, "The effect of short online pedagogical training on university teachers' interpretations of teaching–learning situations," *Instructional Science*, vol. 47, no. 6, pp. 679–709, 2019, doi: 10.1007/s11251-019-09496-z.
[8] W. M. Channa and Z. Sahito, "Effect of Pedagogical Competences of English Language Teachers on Their Students' Academic Achievement: A Qualitative Study," *Theory and Practice in Language Studies*, vol. 12, no. 11, pp. 2274–2281, 2022, doi: 10.17507/tpls.1211.06.
[9] M. Murtonen *et al.*, "Creating a national digital learning environment for enhancing university teachers' pedagogical expertise: the Case UNIPS," *International Journal of Learning, Teaching and Educational Research*, vol. 18, no. 13, pp. 7–29, 2019,

doi: 10.26803/ijlter.18.13.2.
[10] M. Snoek, D. Knezic, E. van D. Berg, Y. Emmelot, A. Heyma, and H. Sligte, "Impact of in-service Master of Education programmes on teachers and their working environment," *European Journal of Teacher Education*, vol. 41, no. 5, pp. 620–637, Oct. 2018, doi: 10.1080/02619768.2018.1529755.
[11] L. Suhirman, "Lesson Study–Based Instruction for Enhancing EFL Teacher's Pedagogical Competence," *The Asian EFL Journal*, vol. 20, no. 5, pp. 154–174, 2018.
[12] K. A. Ritchey and S. Smith, "Developing a Training Course for Undergraduate Teaching Assistants," *College Teaching*, vol. 67, no. 1, pp. 50–57, 2019, doi: 10.1080/87567555.2018.1518891.
[13] J. Ödalen, D. Brommesson, G. Erlingsson, J. K. Schaffer, and M. Fogelgren, "Teaching university teachers to become better teachers: the effects of pedagogical training courses at six Swedish universities," *Higher Education Research and Development*, vol. 38, no. 2, pp. 339–353, 2019, doi: 10.1080/07294360.2018.1512955.
[14] K. Andajani, E. S. Andayani, E. T. Priyatni, A. Supriyanto, A. P. Putra, and S. Widyastuti, "Online Training Design to Improve Basic Teaching Skills Using Flipped Classroom," in *2020 6th International Conference on Education and Technology (ICET)*, 2020, pp. 148–151, doi: 10.1109/ICET51153.2020.9276595.
[15] M. Krátká, P. Eisenmann, and J. Přibyl, "Opportunities and boundaries of heuristic strategies through e-learning," in *European Conference on e-Learning*, 2016, pp. 383–390.
[16] C. Şentürk, "Effects of the blended learning model on preservice teachers' academic achievements and twenty-first century skills," *Education and Information Technologies*, vol. 26, no. 1, pp. 35–48, 2021.
[17] M. Fyfeild, "YouTube in the secondary classroom: how teachers use instructional videos in mainstream classrooms," *Technology, Pedagogy and Education*, vol. 31, no. 2, pp. 185–197, 2022.
[18] M. P. De-Luca, "ICT training strategies in a blended learning scenario," in *2021 XI International Conference on Virtual Campus (JICV)*, 2021, pp. 1–4, doi: 10.1109/JICV53222.2021.9600321.
[19] Y. Gao, S. L. Wong, M. N. Mas, and N. Noordin, "A bibliometric analysis of online faculty professional development in higher education," *Research and Practice in Technology Enhanced Learning*, vol. 17, no. 1, p. 17, 2022, doi: 10.1186/s41039-022-00196-w.
[20] F. M. Esteve-Mon, M. A. Llopis-Nebot, and J. Adell-Segura, "Digital Teaching Competence of University Teachers: A Systematic Review of the Literature," *Revista Iberoamericana de Tecnologias del Aprendizaje*, vol. 15, no. 4, pp. 399–406, 2020, doi: 10.1109/RITA.2020.3033225.
[21] R. Mohamed, M. Ghazali, and M. A. Samsudin, "A Systematic Review on Mathematical Language Learning Using PRISMA in Scopus Database," *Eurasia Journal of Mathematics, Science and Technology Education*, vol. 16, no. 8, p. em1868, 2020, doi: 10.29333/ejmste/8300.
[22] R. Eito-Brun, "Visibility of the CryoSat mission in the scientific and technical literature: A bibliometric perspective," *Advances in Space Research*, vol. 62, no. 6, pp. 1626–1638, 2018, doi: 10.1016/j.asr.2017.10.026.
[23] H.-H. Pham *et al.*, "A bibliometric review of research on international student mobilities in Asia with Scopus dataset between 1984 and 2019," *Scientometrics*, vol. 126, no. 6, pp. 5201–5224, 2021, 10.1007/s11192-021-03965-4
[24] D. Moher, A. Liberati, J. Tetzlaff, and D. G. Altman, "Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement," *PLoS Medicine*, vol. 6, no. 7, p. e1000097, Jul. 2009, doi: 10.1371/journal.pmed.1000097.
[25] S. Rezaei, *Quantitative Tourism Research in Asia*. Springer Nature Singapore, 2019, doi: 10.1007/978-981-13-2463-5.
[26] J. M. Merigó and J. B. Yang, "A bibliometric analysis of operations research and management science," *Omega (United Kingdom)*, vol. 73, pp. 37–48, 2017, doi: 10.1016/j.omega.2016.12.004.
[27] K. van Nunen, J. Li, G. Reniers, and K. Ponnet, "Bibliometric analysis of safety culture research," *Safety Science*, vol. 108, pp. 248–258, 2018, doi: 10.1016/j.ssci.2017.08.011.
[28] M. Merigo, C. Torres-abad, and C. A. B. Jose, "Economics in Latin America: a bibliometric analysis," *Scientometrics*, vol. 105, pp. 1239–1252, 2015.
[29] C. Cancino, J. M. Merigó, F. Coronado, Y. Dessouky, and M. Dessouky, "Forty years of Computers & Industrial Engineering: A bibliometric analysis," *Computers and Industrial Engineering*, vol. 113, pp. 614–629, 2017, doi: 10.1016/j.cie.2017.08.033.
[30] J. R. Ledford and D. L. Gast, *Single Case Research Methodology: Applications in Special Education and Behavioral Sciences*. New York: Routledge, 2018, doi: 10.4324/9781315150666.
[31] P. Hallinger, "Science mapping the knowledge base on educational leadership and management from the emerging regions of Asia, Africa and Latin America, 1965–2018," *Educational Management Administration & Leadership*, vol. 48, no. 2, pp. 209–230, Mar. 2020, doi: 10.1177/1741143218822772.
[32] C. T. Ha, T. T. P. Thao, N. T. Trung, L. T. T. Huong, N. van Dinh, and T. Trung, "A Bibliometric Review of Research on STEM Education in ASEAN: Science Mapping the Literature in Scopus Database, 2000 to 2019," *Eurasia Journal of Mathematics, Science and Technology Education*, vol. 16, no. 10, p. em1889, 2020, doi: 10.29333/ejmste/8500.
[33] T.-T. Do *et al.*, "Research on lifelong learning in Southeast Asia: A bibliometrics review between 1972 and 2019," *Cogent Education*, vol. 8, no. 1, p. 1994361, Jan. 2021, doi: 10.1080/2331186X.2021.1994361.
[34] D. T. Y. G. Sumakul, F. A. Hamied, and D. Sukyadi, "Artificial Intelligence in EFL Classrooms: Friend or Foe?" *LEARN Journal: Language Education and Acquisition Research Network*, vol. 15, no. 1, pp. 232–256, 2022.
[35] K. J. Trivette, "Archival Science? Existential Questions and Proposed Answers," *Atlanti+*, vol. 32, no. 1, pp. 50–62, 2022.
[36] J. Ursin and H. Aittola, "'It's Not Like Everything Changes Just with a Click on New Year's Eve': Perceptions on Educational Issues of University Mergers in Finland," *Higher Education Policy*, vol. 34, no. 3, pp. 543–559, 2021, doi: 10.1057/s41307-019-00151-3.
[37] M. T. Taye and A. Alduais, "Exploring the Practice of Academic Freedom and Active Learning in Ethiopia's Higher Education: A Case Study," *Athens Journal of Education*, vol. 9, no. 4, pp. 655–678, Oct. 2022, doi: 10.30958/aje.9-4-7.
[38] E. Susantini *et al.*, "Developing Competency Evaluation of Pre-service Science Teachers in Industrial Revolution 4.0: Revealing Pedagogic and Professional Competencies," *International Journal of Educational Methodology*, vol. 8, no. 2, pp. 347–362, May 2022, doi: 10.12973/ijem.8.2.347.
[39] B. Goodman, A. Kambatyrova, K. Aitzhanova, S. Kerimkulova, and A. Chsherbakov, "Institutional Supports for Language Development through English-Medium Instruction: A Factor Analysis," *TESOL Quarterly*, vol. 56, no. 2, pp. 713–749, 2022, doi: 10.1002/tesq.3090.
[40] R. P. K. Andoh, D. Y. Mensah, and E. A. Owusu, "Trainers' pedagogical competencies and trainees' assimilation of training content," *Journal of Workplace Learning*, vol. 34, no. 2, pp. 133–149, 2022, doi: 10.1108/JWL-02-2021-0024.
[41] G. Rotidi, K. Kedraka, E. M. Frementiti, and C. Kaltsidis, "University Pedagogy in Greece: Pedagogical Needs of Greek Academics from Ionian University," in *Strategic Innovative Marketing and Tourism: 8th ICSIMAT*, 2020, pp. 737–744, doi: 10.1007/978-3-030-36126-6_81.

[42] N. J. van Eck and L. Waltman, "Citation-based clustering of publications using CitNetExplorer and VOSviewer," *Scientometrics*, vol. 111, no. 2, pp. 1053–1070, 2017, doi: 10.1007/s11192-017-2300-7.
[43] I. Zupic and T. Čater, "Bibliometric Methods in Management and Organization," *Organizational Research Methods*, vol. 18, no. 3, pp. 429–472, 2015, doi: 10.1177/1094428114562629.
[44] N. J. van Eck and L. Waltman, "Visualizing Bibliometric Networks," in *Measuring Scholarly Impact*, Y. Ding, R. Rousseau, and D. Wolfram, Eds., Cham: Springer International Publishing, 2014, pp. 285–320, doi: 10.1007/978-3-319-10377-8_13.
[45] B. Pham-Duc, T. Tran, H. T. T. Le, N. T. Nguyen, H. T. Cao, and T. T. Nguyen, "Research on Industry 4.0 and on key related technologies in Vietnam: A bibliometric analysis using Scopus," *Learned Publishing*, vol. 34, no. 3, pp. 414–428, 2021, doi: 10.1002/leap.1381.
[46] L. S. Shulman, "Those Who Understand: Knowledge Growth in Teaching," *Educational Researcher*, vol. 15, no. 2, pp. 4–14, Feb. 1986, doi: 10.3102/0013189X015002004.
[47] C. Buckler and H. Creech, *Shaping the future we want: UN decade of education for sustainable development: Final report*. Paris: UNESCO, 2014.
[48] M. P. Disonglo and M. Y. Limpot, "Digital Literacy, Pedagogical Knowledge, and Research Skill: A Structural Equation Model in Professional Competence of Teachers," *Asian Journal of Education and Social Studies*, vol. 42, no. 4, pp. 106–123, 2023, doi: 10.9734/ajess/2023/v42i4928.
[49] A. Brunold and B. Ohlmeier, "Civic education for sustainable development of UNESCO–decade 2005–2014," *Discourse and Communication for Sustainable Education*, vol. 13, no. 2, pp. 79–90, 2022, doi: 10.2478/dcse-2022-0020.
[50] M. Alka, H. Bancong, Sukmawati, M. Muzaini, and Ernawati, "Bibliometric Analysis of Pedagogical Content Knowledge (PCK) Publication Trends in Scopus Database from 2018 to 2022," *Studies in Learning and Teaching*, vol. 4, no. 2, pp. 306–318, 2023, doi: 10.46627/silet.v4i2.222.
[51] C. L. Svihus, "Online teaching in higher education during the COVID-19 pandemic," *Education and Information Technologies*, vol. 29, pp. 3175–3193, Feb. 2024, doi: 10.1007/s10639-023-11971-7.
[52] A. Bayar and İ. Kösterelioğlu, "Satisfaction Levels of Teachers in Professional Development Activities in Turkey," *Journal of Turkish Studies*, vol. 9, no. 2, pp. 321–333, 2014.
[53] H. Borko, "Professional Development and Teacher Learning: Mapping the Terrain," *Educational Researcher*, vol. 33, no. 8, pp. 3–15, Nov. 2004, doi: 10.3102/0013189X033008003.
[54] G. Gibbs and M. Coffey, "The Impact of Training of University Teachers on their Teaching Skills, their Approach to Teaching and the Approach to Learning of their Students," *Active Learning in Higher Education*, vol. 5, no. 1, pp. 87–100, 2004, doi: 10.1177/1469787404040463.
[55] R. W. Marx, P. C. Blumenfeld, J. S. Krajcik, and E. Soloway, "New technologies for teacher professional development," *Teaching and Teacher Education*, vol. 14, no. 1, pp. 33–52, 1998, doi: 10.1016/S0742-051X(98)00059-6.
[56] L. Postareff, S. Lindblom-Ylänne, and A. Nevgi, "The effect of pedagogical training on teaching in higher education," *Teaching and Teacher Education*, vol. 23, no. 5, pp. 557–571, 2007, doi: 10.1016/j.tate.2006.11.013.
[57] S. Lee, "Knowledge and teaching: Foundations of the New Reform," *Harvard Educational Review*, vol. 57, no. 1, pp. 1–21, 1987.
[58] E. A. Ring, E. A. Dare, E. A. Crotty, and G. H. Roehrig, "The evolution of teacher conceptions of STEM education throughout an intensive professional development experience," *Journal of Science Teacher Education*, vol. 28, no. 5, pp. 444–467, 2017, doi: 10.1080/1046560X.2017.1356671.

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