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Evolution of topics in education research: a systematic review using bibliometric analysis

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ABSTRACT

Education research tends to exhibit interdisciplinary and multidisciplinary characteristics. Based on the subject areas in Google Scholar, within the 51 disciplines under social sciences, nine subjects are directly related to education (early childhood education, education, educational administration, educational psychology & counselling, educational technology, higher education, science & engineering education, special education, teaching & teacher education). The interdisciplinary and multidisciplinary characteristics of education research make it difficult for researchers to identify the overall development of specific topics within the field. In this paper, we first collect core papers from the field of education. Then, we construct keyword co-occurrence networks using these papers. Finally, based on the density distribution of keyword co-occurrence networks, we analyse changes in network density at each stage of educational research. Last, we identify the development trends of core topics in the education field. Our main contribution is the quantitative methodological design for examining the hot topics and evolution of education research, which is highly multidisciplinary and covers a large volume of publications.

1. Introduction

Education research is the intersection of multiple different disciplines, and includes a large group of researchers and academic journals. Among the subject areas classified by Google Scholar, for example, nine of the 51 disciplines in the social sciences are directly related to education: early childhood education, education, educational administration, educational psychology and counselling, educational technology, higher education, science & engineering education, special education, teaching & teacher education. In 2016 alone, a search in Web of Science produced 10,510 papers under "Education & Educational Research", 3,827 papers under "Education, Scientific Disciplines", and 1,311 papers under "Education, Special". Education research is therefore interdisciplinary and multidisciplinary, making it difficult for researchers and policy makers to have a comprehensive grasp on the development of scientific research in the field.

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Most of the review research in education has focused on a specific topic (Gierl, Bulut, Guo, & Zhang, 2017; Joksimović et al., 2018; Merrill, Smith, Cumming, & Daunic, 2017; Snodgrass Rangel, 2018; Surr et al., 2017) or subfield (Arbaugh et al. 2016; Brady, Williams, & Bailey, 1988; Cyphert, 1972; Dolby & Rahman, 2008; Hallinger & Chen, 2015). There is a gap in research that attempts to cover the entire field of education.

To address the interdisciplinary and multidisciplinary nature of education research, we designed a topic analysis method based on bibliometrics. The objective is to identify the evolution of research trends. We first collect relevant literature from the field of education; construct keyword co-occurrence networks of journal publications; and last, identify the development of certain topics in education research based on changes in the network density at each stage of research development. The density distribution of the keyword co-occurrence network effectively reflects how "hot" or "cold" a research topic is. Greater density reflects a closer distance and strong correlation between topics.

Bibliometrics is statistical analysis of scientific texts, and such methods include analyses based on citation relationships (Franceschini, Maisano, & Mastrogiacomo, 2015; Kostoff, 1998; Tsay & Shu, 2011), co-occurrence relationships (Cainelli, Maggioni, Uberti, & de Felice, 2014; He, 1999; Ravikumar, Agrahari, & Singh, 2015), network analysis approaches (Mika, Elfring, & Groenewegen, 2006; Yoon, Choi, & Kim, 2011; Zhai, Yan, Shibchurn, & Song, 2014), the indicator-based approaches (Glänzel, 2010; Huang et al., 2015; Payumo & Sutton, 2015), and the topic-based approaches (Hassan & Haddawy, 2015; Wang, Liu, Ding, & Liu, 2015; Yau, Porter, Newman, & Suominen, 2014). Compared to experience-based methods, bibliometric analyses have the advantage of collecting and processing mass amounts of technical information. At the same time, the analysis results are more objective and can help researchers dig deeper into scientific and technical texts to discover specific patterns of change. It is an important tool for scientific and technology text mining.

This paper is organised as follows: Our method for topic evolution analysis is presented in Section 2. The data collection process is presented in Section 3. The topic development analysis of education research is presented in Section 4. Finally, we conclude our current research, noting limitations, and put forward possible directions for future work in Section 5.

2. Methodology

The specific steps of our method (summarised in Figure 1) for analysing the development of research trends in the field of education are as follows:

(1) Collect journal publication data. In order to understand the research frontiers in education and obtain an understanding of core research topics, we use core journals in the education field as our main data source. We use the nine disciplines from Google Scholar in education research as our journal selection guide. Two journals were selected from each discipline based on journal impact factors and expert opinion. In addition, we also selected some journals on education economics, education ethics, educational review, vocational education, comprehensive journals and so on. All papers published between 2000 and May 2018 in these journals were downloaded.
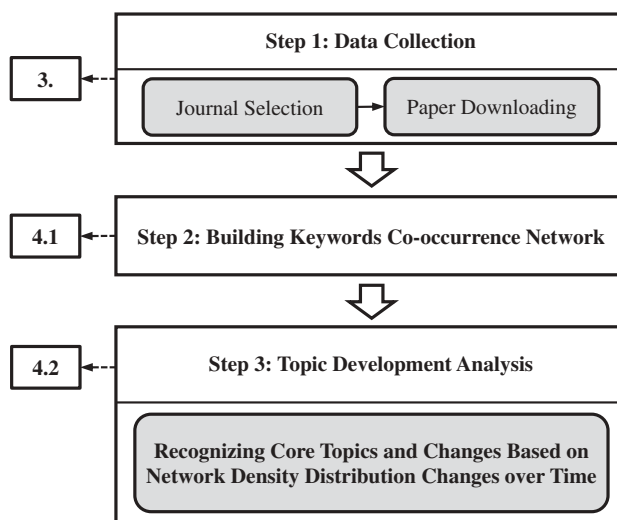
Figure 1. Methodological framework.

(2) Construct keyword co-occurrence networks. In bibliometrics, keywords are often used as tools to identify the research content, core topics, and method/technology used in a certain field. For identifying and analysing the distribution and evolution of core topics in education research, we constructed keyword co-occurrence networks. Co-word (or word co-occurrence) refers to the specific statistical correlations between different words or keywords that appear in the same document. A keyword co-occurrence network therefore shows the relationship between these keywords in the form of a network map. The closer the distance between certain keywords, the more relevant they are. Additionally, these more relevant keywords form a cluster that can then be used to describe a core topic of research. A whole series of topic analyses can then be conducted using these keyword co-occurrence networks. Our method uses VOSviewer to build keyword co-occurrence networks that reflect the state of research in the field of education.

(3) Analyse topic development trends based on the density distribution of keyword co-occurrence networks. Again, the density distribution of a keyword co-occurrence network effectively reflects how well-researched or neglected a specific research topic has been over time.

Using VOSviewer to generate the density map of the keyword co-occurrence network, each node in the co-occurrence network has a colour that depends on the density of items at that point (red = high-density; blue = low-density). The density of a point (node) on a map depends both on the number of neighbouring nodes and on the weights of these nodes (van Eck & Waltman, 2010). As the number of neighbouring nodes and the weights of neighbouring nodes increase, so does the node density. Higher node density may also result from shorter distances between these nodes and the target node. Therefore, the shifting colours between red and blue reflect these changes in the density map of a keyword co-occurrence network. Larger numbers of nodes in the neighbourhood of a single node, with

higher-weighted neighbouring nodes, mean that the single (i.e. target) node will be higher in density (i.e. closer to red). Conversely, smaller numbers of nodes in the neighbourhood of a single node, with lower-weighted neighbouring nodes, will result in a less dense node (i.e. close to blue).

Therefore, greater density reflects a closer distance and strong correlation between nodes (topics, in our case); the greater the density, the higher the importance of the nodes, i.e. the "hotter" or more popular a specific research topic is (van Eck & Waltman, 2010). Then based on changes in the density distribution of these topics, we can examine changes in core education research topics over time.

3. Data collection

In order for our dataset to reflect the frontiers of education research as far as possible, this study uses the top journals in education as our main data source. As mentioned, there is a large number of journals in the education field (312 journals in Web of Science alone) and a large number of published papers (10,510 in the "Education & Educational Research" field, 3,827 in the "Education, Scientific Disciplines" fields, and 1,311 papers in "Education, Special" field, in 2016 alone). Therefore, in order to ensure that our selected journals cover as many subjects as possible, we refer to the nine disciplines under education research provided by Google Scholar: two journals were selected from each subject area based on journal impact factors and expert opinions. We also selected some journals on education economics, education ethics, educational review, vocational education, and so on. All papers were downloaded from these journals to comprise the dataset for testing our proposed method. The data spans the calendar years of 2000 to May 2018. Table 1 lists the final journals that were selected as our data sources. In the Web of Science database, searches were made in this group of journals (document type: article; language: English; time: 2000–2018). A total of 19,750 papers were obtained (last retrieval time: 15 May 2018). Since 2018 is not a complete publication year, only papers from 2000 to 2017 were analysed (totalling 19,084 papers).

We first looked at the overall publications in the education field and calculated the changes in the number of publications of all journals over time in WOS, as shown in Figure 2. From 2000 to 2017, a total of 276,186 papers were published under three WOS categories, "Education & Educational Research", "Education, Scientific Disciplines", "Education, Special" (as of 2 July 2018). Figure 2 shows that there have three major stages of research development in the field of education: (1) Publication frequency in the 2000–2007 period was relatively stable, with no more than 10,000 publications per year; (2) Entering the 2008–2014 period, the frequency of publications increased, and the average total number of publications was 15,000–20,000; (3) Since 2015, the number of publications has increased dramatically. In the first year (2015), a record of 25,000 publications was reached, and each year since then, the number of publications was maintained at over 30,000.

We also analysed the statuses of publication frequency in different countries (based on the collected 19,084 papers), as shown in Figure 3. The five countries with the absolute highest number of publications are the USA, the UK, Australia, Canada, and the Netherlands. The USA has led the academic frontier in education research. It is therefore noteworthy that in 2017, the number of publications in the

Table 1. Selected journals.

| |
|---|
| **Early Childhood Education** |
| Early Childhood Research Quarterly |
| Early Education and Development |
| **Vocational Education** |
| International Journal for Educational and Vocational Guidance |
| Adult Education Quarterly |
| **Teacher Education** |
| Teaching and Teacher Education |
| Learning and Instruction |
| **Educational Administration** |
| Journal of Education Policy |
| Educational Administration Quarterly |
| **Educational Psychology** |
| Educational Psychologist |
| Journal of Educational Psychology |
| **Educational Technology** |
| Computers & Education |
| British Journal of Educational Technology |
| **Higher Education** |
| Higher Education |
| Studies in Higher Education |
| **Special Education** |
| Journal of Learning Disabilities |
| Exceptional Children |
| **Science education, Education Economy and Education Ethics** |
| Science Education |
| Economics of Education Review |
| Journal of moral education |
| **Education Reviews and Comprehensive Research** |
| Educational Researcher |
| Review of Educational Research |
| History of Education |
| Comparative education review |
| Sociology of Education |
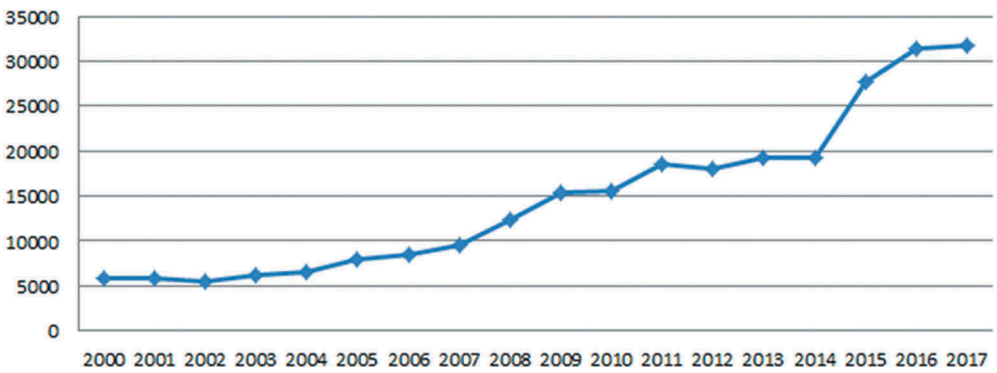
Figure 2. Changes in publication quantity between 2000 and 2017.

USA fell into a downward trend while there was an upward trend in the other countries.
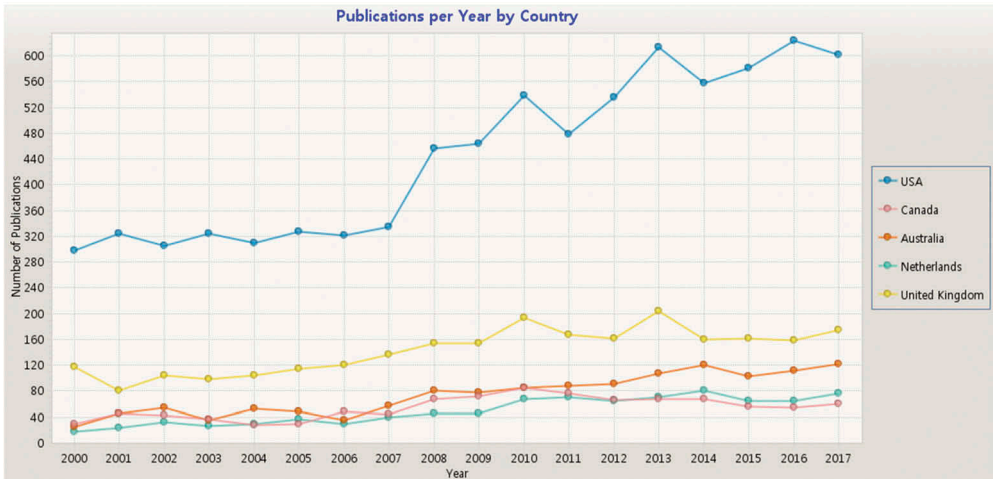
Figure 3. Top five countries with the most publications between 2000 and 2017.

4. Network construction and topic development analysis

We built keyword co-occurrence networks based on the collected data, and then analysed the core topics and the topic development trends in the field of education over the years.

4.1. Building keyword co-occurrence networks

This paper uses keyword co-occurrence networks to identify and analyse the distribution and evolution of core research topics in education. The keywords of publications are used to reflect the research topics. The top 10 keywords are shown in Table 2. Because keyword frequency alone cannot reflect the core topic distribution and the relationship between keywords, we constructed keyword co-occurrence networks based on the keywords of publicatons and then carried out topic analyses.

Keyword co-occurrence networks can reveal certain relationships between keywords in the form of a network diagram. For example, the more relevant the keywords are in the map, the closer the distance between them; that is, keywords that are close to each other form a cluster

Table 2. Top 10 keywords.

Records	Instances	Author Keywords-cleaned
631	631	Higher education
588	588	Interactive learning environment
549	549	Teaching/learning strategies
464	471	Teacher education
390	390	Pedagogical issue
375	375	Improving classroom teaching
297	297	Professional development
296	296	Human capital
282	282	Computer-mediated communication
277	277	Media in education

and can then aptly describe a core topic of research. A series of topic analyses can be conducted through the keyword co-occurrence network.

We use VOSviewer (van Eck & Waltman, 2010) to construct keyword co-occurrence networks by publication time (calendar year). Based on the density distribution maps of these keyword co-occurrence networks, we can identify the most popular research topics and research trends over time.

4.2. Identifying core topics and analysis of thematic changes

This paper identifies research topics in the field of education based on the density distribution of the keyword co-occurrence network. Using VOSviewer to generate the density map of the keyword co-occurrence network, each node in the co-occurrence network has a colour that depends on the density of items at that point. The density of a point (node) in a map depends both on the number of neighbouring nodes and on the weights of these nodes. As the number of neighbouring nodes and the weights of neighbouring nodes increased, so did the node density. Additionally, the smaller the distances between these nodes and the target node, the higher the node density (van Eck & Waltman, 2010). Therefore, based on the keyword co-occurrence network, the colour is in between red and blue. From blue to red, a redder node represents greater importance of a keyword (topic). At the same time, in the keyword co-occurrence network, related keywords may grow close to each other and form a cluster to describe one topic.

Based on the results shown in Figure 2, we categorised all our downloaded research publications in the field of education into three time periods: (1) from 2000 to 2007; (2) from 2008 to 2014, and (3) from 2015 to 2017. Based on the density distribution of the keyword

Figure 4. Keyword co-occurrence network density distribution map (2000–2007).

co-occurrence networks, we identified and analysed the core research topics in each of the three time periods, which will be referred to as Stage 1, 2, and 3 in the sections below. Then, in order to gain a deeper understanding of the evolution of these research topics, we further identified and analysed the core topics from each individual year.

(1) Stage 1 (2000–2007)

Figure 4 shows the density distribution of the keyword co-occurrence network of the time period between 2000 and 2007. The map shows that there were four major topics during this period: (1) Teacher education, which touches on discourse analysis, diversity, and conceptual changes; (2) Teaching/learning strategies and interactive learning environments; (3) Human capital, including educational finance and demand for schooling; and (4) Higher education, including assessment, student achievement, and globalisation.

To better understand the evolution of research topics between 2000 and 2007, we identified the core topics of each year. Figure 5 shows the density distribution of the keyword co-occurrence network by each calendar year.

Corresponding to Figure 5, the high-density keywords of the calendar years 2000–2007 are shown in Table 3.

Based on the density distribution of keyword co-occurrence networks by calendar year, we discovered the following: Researchers paid more attention to computer-mediated communication, virtual reality, evaluation methodologies (middle left of
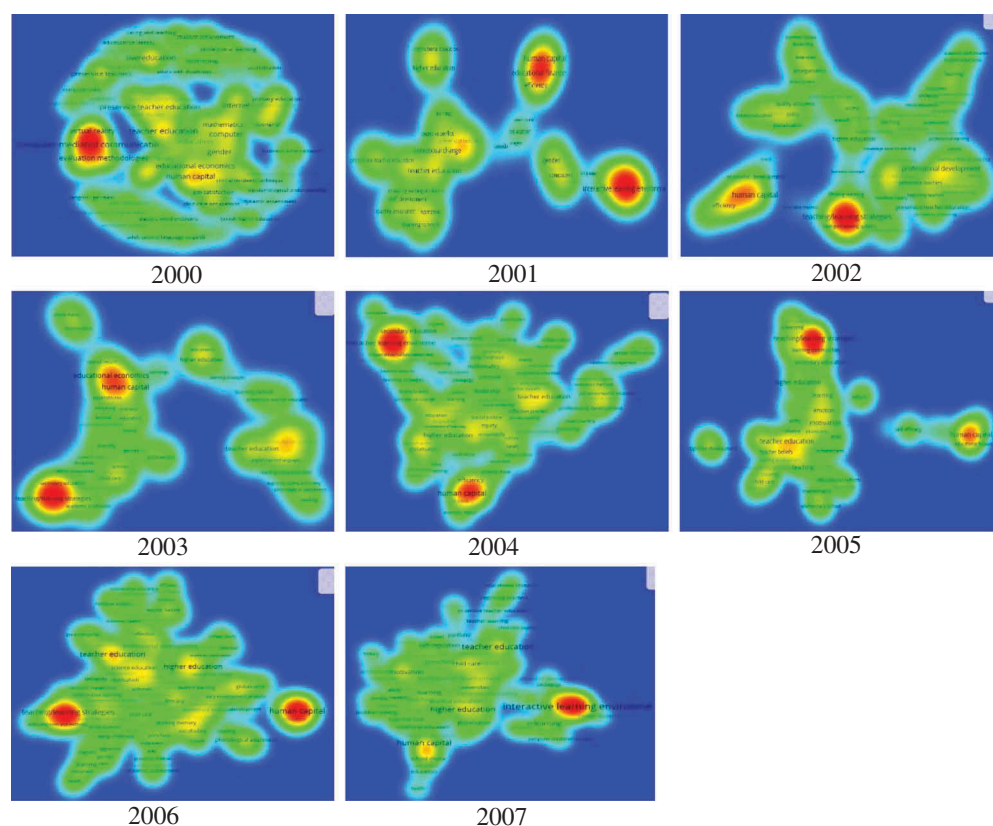
Figure 5. Keyword co-occurrence network density distribution maps (2000–2007 calendar years).

Table 3. High-density keywords in the 2000–2007 calendar years.

2000	Computer-mediated communication; virtual reality; evaluation methodologies; human capital; teacher education
2001	Human capital; educational finance; efficiency; interactive learning environment; conceptual change; pre-service teachers
2002	Human capital; educational finance; efficiency; teaching/learning strategies
2003	Educational finance; human capital; teaching/learning strategies
2004	Interactive learning environment; secondary education; cooperative/collaborative learning; human capital
2005	Human capital; teaching/learning strategies; secondary education; teacher education
2006	Human capital; teaching/learning strategies; teacher education; higher education
2007	Interactive learning environment; human capital

map) and other computer-aided education research, while human capital and teacher education (centre of map) emerged as potential core topics. In 2001, human capital, educational finance, and other related topics (upper centre of map) finally became core research topics. Interestingly, the topic of interactive learning environment replaced computer-mediated communication as the new core topic, but both are part of computer-aided education. In 2002, human capital, educational finance, and efficiency (lower left of map) remained core topics, but teaching/learning strategies (lower centre of map) replaced interactive learning environment as the core topic, and its density was higher than the human capital subject area. The trends from 2002 remained the same in 2003. Educational finance, human capital (upper left of map) and teaching/learning strategies (lower left of map) remained core topics, but the importance of educational finance increased. In 2004, interactive learning environment (upper left of map) became a core topic, and the major topics included secondary education and cooperative/collaborative learning. In 2005, human capital (middle right of map) continued to be a core topic, but popularity in this area weakened. Teaching/learning strategies (upper centre of map) once again replaced the interactive learning environment as the core topic, with a particular leaning towards secondary education. It is noteworthy that teacher education research was in a secondary core position from 2000 to 2005, but its development gradually increased. In 2006, human capital (middle right of map) and teaching/learning strategies (middle left of map) were still the core topics. Teacher education and higher education were part of the secondary core. By 2007, interactive learning environment (middle right of map) had become the core topic, and the human capital had significantly weakened compared to its status in 2006.

(2) Stage 2 (2008–2014)

The keyword co-occurrence network density distribution of Stage 2 (2008–2014) is shown in Figure 6. The figure shows that there were three major topics in this time period: (1) Teacher education, including professional development and teacher identity; (2) Teaching/learning strategies, including distance education and telelearning, elementary education, and intelligent tutoring systems; and (3) Higher education, including emotions and identity.

In order to understand the thematic changes of the 2008–2014 period in greater depth, we identified the core topics of each year. The keyword co-occurrence network distribution is shown in Figure 7.

In relation to Figure 7, the high-density keywords for the 2008–2014 period are shown in Table 4.
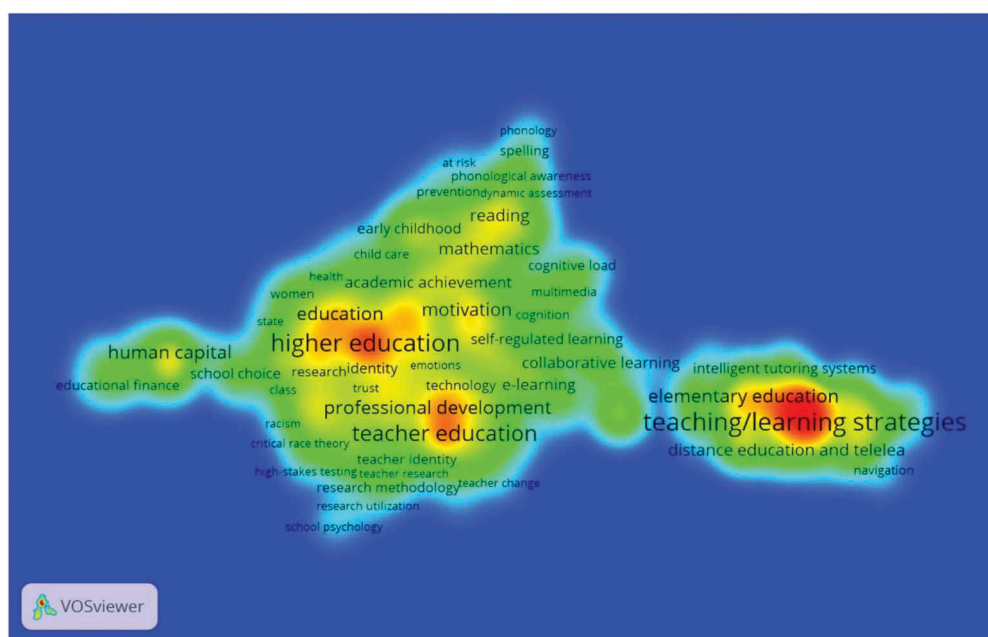
Figure 6. Keyword co-occurrence network density distribution map (2008–2014).

Our observations of the density distribution of the keyword co-occurrence network in the 2008–2014 period reveal the following: In 2008, the topic of human capital (upper centre of map) weakened, while teaching/learning strategies (lower right of map) once again became the core. Teacher education (centre of map) became a secondary core topic. In 2009, the focus on teacher education (lower left of map) further increased, with a focus on professional development, teacher knowledge, and qualitative research. Interactive learning environment and media in education (middle right of map) became core topics, with a focus on secondary education. By 2010, human capital (upper right of map) attracted less research, while teacher education (lower centre of map) became the most popular topic. It is worth noting that early childhood, literacy, and social justice (centre of map) suddenly appeared during this period and became secondary core topics. In 2011, teaching/learning strategies (lower right of map) became a core topic, focusing on the research of computer-mediated communication and human-computer interface. The popularity of higher education (lower left of map) continued and evolved into a secondary topic. Another core topic was education, assessment, teachers (middle left of map), which was a further development of teacher education. The research related to reading, learning disabilities, and intervention (centre of map) emerged in this year, which can be seen as developments from popular research topics in 2010, including early childhood, literacy, and social justice. In 2012, the research topics further diversified and the number of core topics increased. Interactive learning environment and improving classroom teaching (upper right of map) became the core topics. Other slightly less prominent topics included higher education (middle left of map), teacher education (lower centre of map), secondary education (upper centre of map), and achievement (middle right of map). The relationship between these research topics
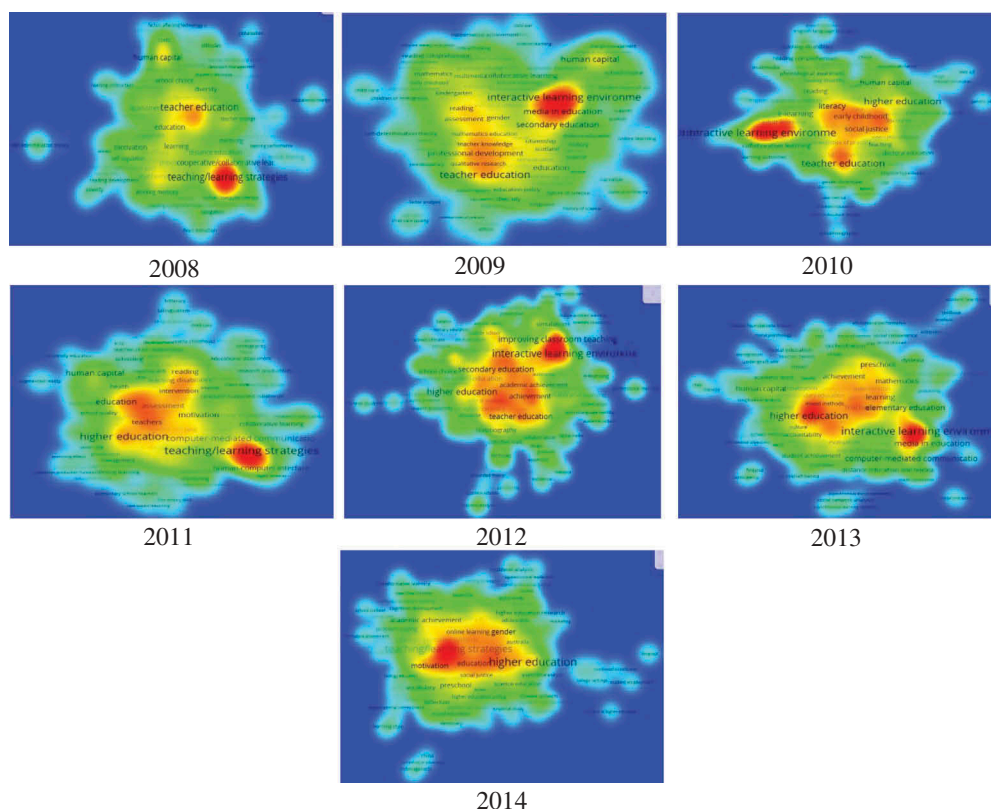
Figure 7. Keyword co-occurrence network density distribution maps (2008–2014 calendar years).

Table 4. High-density keywords in the 2008–2014 calendar years.

2008	Teaching/learning strategies; cooperative/collaborative learning; teacher education; human capital
2009	Teacher education; professional development; teacher knowledge; qualitative research; interactive learning environment; media in education; secondary education; human capital
2010	Interactive learning environment; teacher education; human capital; early childhood; literacy; social justice
2011	Teaching/learning strategies; computer-mediated communication; human-computer interface; education; assessment; teachers; higher education; reading; learning disabilities; intervention
2012	Interactive learning environment; improving classroom teaching; higher education; teacher education; secondary education; achievement
2013	Interactive learning environment; media in education; higher education; Elementary education
2014	Higher education; teaching/learning strategies; motivation; gender

grew closer, indicating that interdisciplinary research had become mainstream. By 2013, research on higher education (middle left of map) increased. Elementary education research became an important trend. The thematic hotspots in 2014 were continuations from the previous year. It is worth noting that research related to gender (upper right of map) became more prevalent as of 2014.

(3) Stage 3 (2015–2017)

The density distribution of the keyword co-occurrence network of Stage 3 (2015–2017) is shown in Figure 8. The figure shows that there were five major topics: (1) higher education, including the sub-topics of governmentality, quality, education
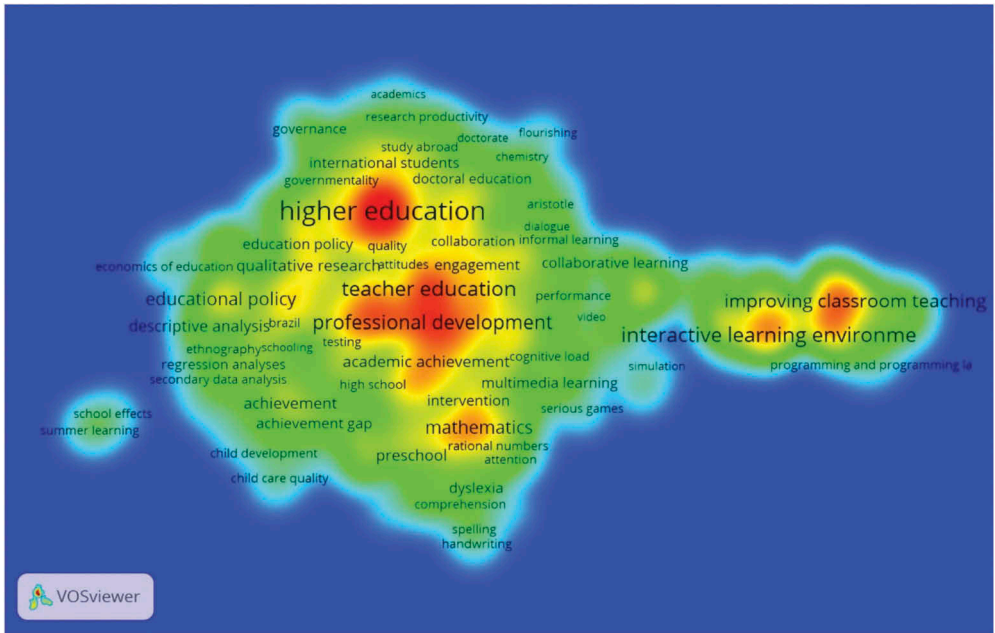
Figure 8. Keyword co-occurrence network density distribution map (2015–2017).

policy, doctoral education, and international students; (2) teacher education, including professional development, engagement, and academic achievement; (3) mathematics, including intervention, rational numbers, and preschool; (4) interactive learning environment; and (5) improving classroom teaching.
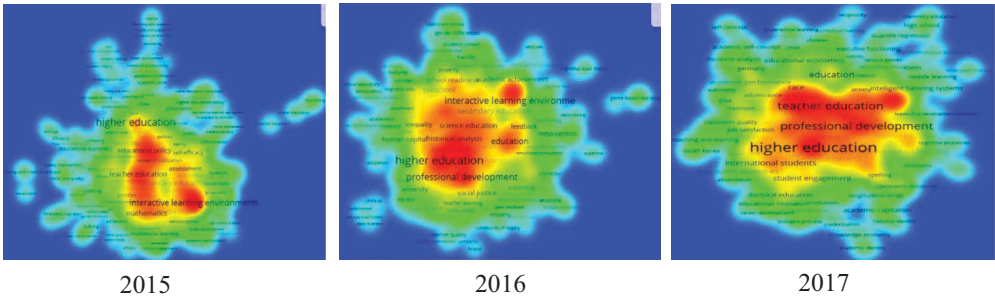

| 2015 | 2016 | 2017 |

Figure 9. Keyword co-occurrence network density distribution maps (2015–2017 calendar years).

Table 5. High-density keywords in the 2015–2017 calendar years.

2015	higher education; interactive learning environment; teacher education; educational policy; mathematics
2016	higher education; professional development; interactive learning environment; education; feedback; science education; historical analysis
2017	higher education; professional development; teacher education; intelligent tutoring systems; race; international students

In order to better understand the evolution of research topics in the 2015–-2017 period, we identified each core topic in each year. The density distributions of keyword co-occurrence networks by calendar year are shown in Figure 9.

In relation to Figure 9, high-density keywords between 2015 and 2017 are listed in Table 5.

Using the calendar-year density distribution of keyword co-occurrence networks, we found the following: In 2015, higher education (upper centre of map), interactive learning environment (lower right of map), and teacher education (centre of map) remained core topics in education research. Educational policies and mathematics received more attention from researchers and became core research topics. In 2016, feedback (middle right of map), science education, and historical analysis (centre of map) were also the focus of research and became core topics. By 2017, the core topic keywords often came together, making it more difficult to create clear categories. This reflects the increasingly interdisciplinary nature of education research. In this third stage, core keywords included higher education, professional development, and teacher education (centre of map), and the slightly less prominent terms include intelligent tutoring systems, race, and international students.

In summary, our analysis of the overall education research topic development trends from 2000 to 2017 shows that the core research topics have remained relatively stable, but certain changes occurred in the composition of these topics, and certain topics also showed increasing growth in popularity compared to others. To demonstrate these results, we created a chart of the evolution of these core research topics in education (Figure 10), where the horizontal axis represents time and the vertical axis is divided into three stages, from weak to strong topics, corresponding respectively to the following degrees of node density: less-targeted topics with potential for more research, secondary core topics, and core topics. This chart shows how the core topics, represented by high-density nodes, have changed over time. We noted the following:

(a) Five core topics were present throughout all three stages of education research: Interactive learning environment and teaching/learning strategies (blue); Human capital and educational finance (yellow); Teacher education (purple); Higher education (green); Equity and social justice (red). These topics are each described in more detail below.

(1) Topic 1: Interactive learning environment and teaching/learning strategies (blue area in Figure 10): The frequency of co-occurrence of interactive learning environment and teaching/learning strategies is very high, indicating that the correlation between these two topics is very strong. This paper therefore merges them into one topic, which we then identify as one single core topic that dominated the literature from 2000 to 2017. Its popularity has not weakened. At the same time, computer technologies from different eras have also been integrated into researchers' agendas, including "computer-mediated communication" emerging in 2000, "e-learning" in 2005, "cooperative/collaborative learning" in 2008, "media in education" in 2009–2013, and "intelligent tutoring systems" in 2017. Based on these sub-topics, we can conclude that one sustained area of education research revolves around the impact of technological developments on education.

(2) Topic 2: Human capital and educational finance (yellow area of Figure 10): Human capital and educational finance could be considered secondary core topics in
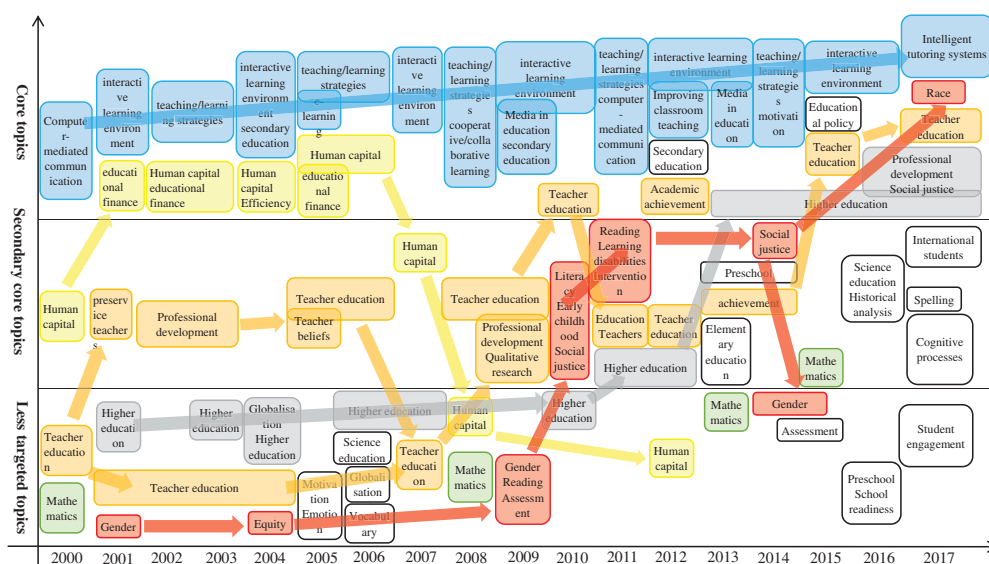
Figure 10. Thematic development and evolution of education research.

2000. They warmed up rapidly in 2001 and became core topics, which continued up to 2006. In 2007, the topics became less popular. By 2008, even less attention was given to these areas of research. These topics have since ceased to be research hotspots and should now be considered less targeted research areas.

(3) Topic 3: Teacher education (purple area in Figure 10): There has been a gradual uptick in research on teacher education. From 2000 to 2004, it was only a less targeted topic with research potential. Professional development, on the other hand, became a secondary core topic in 2002. Beginning in 2005, the topic of teacher education became a secondary core topic, where it has remained for most of the overall time period we sampled. It became a core topic only after 2015.

(4) Topic 4: Higher education (green area in Figure 10): This topic showed a gradual upward trend when it was a less targeted topic in the 2001–2010 period. However, starting in 2011, it developed into a secondary core topic, finally becoming a core topic of research beginning in 2013.

(5) Topic 5: Equity and social justice (red area of Figure 10): This topic as a whole showed a gradual upward trend as well. Between 2001 and 2009, this was a less targeted topic that focused on specific subject matters of gender and equity. By 2010, the topic developed into a secondary core topic, with research content that leaned more towards social justice, literacy, and learning disabilities. However, by 2015, research in this area became divided and publications on gender-related matters declined, while equity and race both became core topics in 2016.

(b) Based on Figure 10, we can see that, currently, popular sub-topics in education research include: secondary education, mathematics, self-efficacy, international students, preschool, creativity, doctoral supervision, and dyslexia.

(c) The scope of research in the field of education has become broader, presenting a cross between different topics in the field of education. For example, "intelligent tutoring systems" is an interdisciplinary research field that falls between artificial intelligence and education, while dyslexia involves interdisciplinary research between education and psychopathology.

5. Conclusion

In this paper, we describe a topic analysis in education research based on bibliometrics, leaving the scope as open as possible while focusing on the frontiers of the field. Using this proposed method, we first collect relevant literature from the field of education; construct keyword co-occurrence networks based on the journal publications; and then study the entire field of education research by analysing the changes in network density at each stage of development. The objective of this method is to reveal the core research topics and the changes in research trends.

The results of our bibliometric analysis suggest that education research has exhibited a certain degree of continuity over time. Our data revealed five main topics that ran through the various stages of education research: (1) Interactive learning environment and teaching/learning strategies; (2) human capital and educational finance; (3) teacher education; (4) higher education; (5) equity and social justice. Aside from interactive learning environment and teaching/learning strategies being a core topic of research throughout the development of the field, the other four topics have shown somewhat greater volatility, evolving from less targeted topics to secondary core topics, and finally into core topics.

At the same time, the field of education has also shown trends towards interdisciplinary research, such as intelligent tutoring systems, involving the combination of artificial intelligence and education, or dyslexia, involving the combination of education and psychopathology. Such research directions have significantly diversified the field of education. The number of research topics has increased over the years, and the areas covered by education research have become more extensive.

In addition to core research topics, we also revealed topics that researchers have not paid as much attention to. Among them, however, secondary education, mathematics, and self-efficacy have slowly become core topics, while related research on international students and preschools has also gradually increased and these may become core topics of research in the future. Following the general trend towards greater interdisciplinary research, the topics of creativity, doctoral supervision, and dyslexia have also begun to receive extensive attention.

Though effective, the results of our proposed method still have certain shortcomings: (1) The analysis is descriptive, and the interpretation of trends may be insufficient. (2) Criteria for selecting the core journals may be improved for clarity. (3) In addition to keywords, topic terms extracted from the actual text of publications could be taken into account in the future. (4) Some keywords (e.g. "higher education") may be too common to be used for narrowing down research topics. (5) In order to gain a deeper understanding of specific research topics, it would be necessary to combine expert knowledge and quantitative analysis in future studies.

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