



# PROBLEM BASED LEARNING IN TEACHER EDUCATION: A BIBLIOMETRIC ANALYSIS (1993-2022)

Sukhjit Singh<sup>1\*</sup>

## Abstract

**Background:** PBL as a pedagogy favors the performance of students/learners, not only in medical education but it has also travelled through other fields like business studies, dentistry, health sciences, law, engineering, science, social sciences, and teacher education. As an approach, PBL gives students a space where they can construct their professional knowledge in the field of education by promoting dialectic and bridging the gap of educational theory and practice, by promoting professional cooperative communities, and by enhancing students' ability to criticize and reflect on themselves as a group and individuals.

**Objectives:** In order to understand the research trends of Problem-Based Learning in Teacher Education, the present study's aim was to analyze international scientific publications using bibliometric analysis on Problem-based Learning in Teacher Education.

**Tools:** Tools used in this paper were the Scopus database, Microsoft Excel, and VOSviewer with search terms such as "Problem-Based\*" and "Teacher Education".

**Method:** Related articles were retrieved from the Scopus database by using the search terms "Problem-based\*" and "Teacher Education". A total of 227 documents published in different journals indexed in Scopus retrieved from the Scopus Database were analyzed. Bibliometric analysis has been done to map the Annual publications, countries, institutions, authors, journals, and keywords in the field of Problem-based Learning in Teacher Education were visually analyzed using VOSviewer and the Scopus analysis tool.

**Results/ Conclusion:** Among universities/organizations, in terms of the number of documents, University of British Columbia, Canada) contributed the most in PBL in the context of Teacher Education. The United States ranked first among the Countries. Australia was also an important contributor in terms of co-authorship between Countries. In terms of the number of publications, Derry S.J was the most prolific author. If considering, number of citations, then Cochran-Smith with 332 citations topped this list. In co-citation analysis of Authors, Barrows with 87 citations was the most significant author. This work will provide insights to Fellow Researchers and Future Researchers about the existing picture and gaps related to PBL in Teacher Education.

**Keywords:** Problem-based Learning, Teacher Education, Bibliometric analysis

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## Introduction

In recent years, Problem-based learning (PBL) as a pedagogy has received widespread attention. (Albanese and Mitchell, 1993). Research has been done to explore the feasibility of PBL as a pedagogy in different domains. In PBL, the main emphasis is on setting the learning into complex problem situations (scenarios), giving learners a space to decide their learning issues, solving authenticity problems in collaboration, and understanding the scientific knowledge implicit behind the problems (Wood, 2003; Dolmans et al., 1997). PBL also gives learners an experience in which there are high chances to promote the development of critical thinking skills, problem-solving abilities, and communication skills (Schuwirth & Vleuten, 2010). During the process of PBL, learners work in groups, find and evaluate content and material along with a lifelong learning attitude among learners.

(Compton et al., 2020).

After being originated at McMaster University in Canada in the 1960s, PBL (Jones, 2006) has been promoted and modified in more than 60 medical schools (Servant-Miklos, 2020). After being the most used in medical courses, PBL has replaced traditional teaching methods in anatomy, pharmacology, and physiology over the globe. (Devine et al., 2020).

PBL as its historical evolution has been used to bridge theory and practice for eg. at McMaster University, it emerged as a way to connect Medical professionals with real-life experiences which were not present in the conventional way of exposure to teaching. As stated by Savin-Baden and Major (2004) that PBL can be regarded as a general educational strategy, as a philosophy, or as an approach to teaching. They described the following points to consider PBL which can be seen as leverage points for Higher Education Specifically

Teacher Education.

1. Essential characteristics of PBL- organization of integrated curricula and classes around problems along with in an emphasis on cognitive skills
2. Certain conditions to facilitate PBL, - small groups, tutorial instruction, and active learning;
3. Results on which PBL emphasizes, such as the development of skills and the motivation to continue being a lifelong learner.

PBL favors the performance of students/learners, not only in medical education but also in business studies, dentistry, health sciences, law, engineering, science, social sciences, and teacher

education (Walker & Leary, 2009; Huth et al., 2021; Kühner et al., 2021; Michalsky & Cohen, 2021; Wang, 2021). PBL gives students a space where they can construct their professional knowledge in the field of education by promoting dialectic and bridging the gap of educational theory and practice, by promoting professional cooperative communities, and by enhancing students' ability to criticize and reflect on themselves as a group and individuals. (Wang, 2021)

PBL in teacher education is blooming and reaching graduate and undergraduate levels in courses i.e. Foundations of Education, Inclusion Classrooms, Elementary School Curriculum, Introductory Educational Psychology, Educational Research and Methods (Levin, 2001, Borhan, 2014) and also reach to Science Education (Goodnough, 2006; Peterson & Treagust, 2001). PBL implemented in a Teacher Education classroom allows exploring PCK (Pedagogical Content Knowledge) and makes lifelong learners. (Peterson & Treagust, 2001; Borhan (2014) concluded in a review that PBL experience in Teacher Education provide an environment where pre service teachers can develop skills and acquire knowledge related to the field of Education.

As a research method, Bibliometric analysis refers to the qualitative and quantitative evaluation of specific research areas using mathematical and statistical methods to understand the knowledge structure and explore development trends. (Bornmann and Leydesdorff, 2014; Zang et al., 2022). Merigo and Yang (2017) defined bibliometric analysis as "a quantitative study of bibliographic material and provides a general picture of a research field that research papers, authors, and fields can include categories."

Bibliometric analysis research has received extensive attention for providing a comprehensive and substantial overview of the published literature and identifying research frontiers, future research trends, and gaps. (Liu et al., 2021; Yu et al., 2021). In this way, bibliometric analysis cannot be considering as alternative to traditional theoretical literature review. Instead, it can be complimentary to help the researcher to choose the most relevant studies, author, organization and even country to explore more into the given field. (Brika et al., 2021)

Four prior bibliometric reviews of the PBL literature were located in search of the literature (Xian & Madhavan, 2013; Azer, 2017; Pinho et al., 2015; Hallinger, 2021; Zhang et al., 2022).

Bibliometric analysis by Xian and Madhavan (2013) reviewed Barrows' scholarly efforts in PBL and highlighted the impact of Barrows' work on different fields where PBL traveled its journey. Scholars working in PBL rarely shared their work, which was an important argument that came forward by this bibliometric analysis. This study suggested reducing the fragmented approach in the field of PBL.

Bibliometric analysis done by Pinho et al. (2015) analyzed the evolution of Problem-based learning (PBL) by using the Web of Science database. It highlighted the role of Maastricht University in PBL research and also gave geographical spread along with the academic spread of PBL research production.

Bibliometric studies published by Azer (2017) on PBL were limited to highly cited articles only. Its main focus was on dental research.

A bibliometric analysis done by Hallinger (2021) analyzed 14,130 documents on PBL indexed in the Scopus database. The time period of this analysis was 1972 to 2019. It gave the evolution of PBL over the past five decades. As concluded by Hallinger (2021) in bibliometric analysis of PBL that in the field of business management, teacher training, architecture, social work, counseling, and social sciences focus is less.

One of the recent as well as comprehensive bibliometric analyses on PBL is done by Zhang et al. (2022) in which a total of 2790 documents were analyzed and retrieved from the web of science database. It showed that even after much research was done in PBL, there is a need for cooperation and exchange between institutions and countries in

terms of collaboration for better sharing of research in the future.

So present bibliometric analysis focuses on the context of PBL in Teacher Education to comprehend the trends and highlight the gaps in Problem-based Learning in Teacher Education.

## MATERIALS AND METHODS

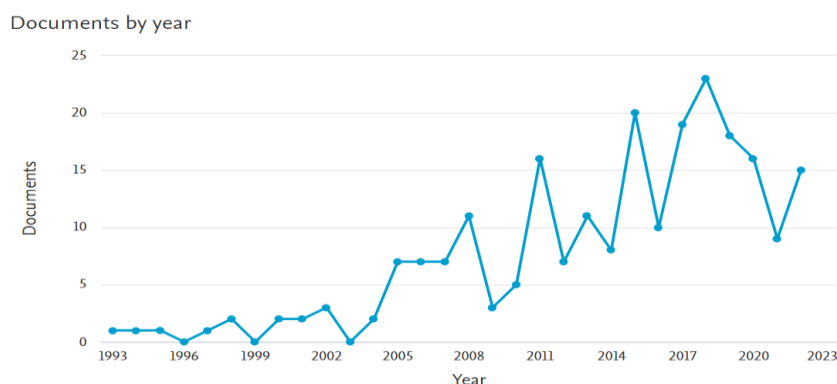
**Tools:** Tools used in this paper were the Scopus database, Microsoft Excel, and VOSviewer with search terms such as "Problem-Based\*" and "Teacher Education".

**Method:** Related articles were retrieved from the Scopus database by using the search terms "Problem-based\*" and "Teacher Education" by using TITLE-ABS-KEY query. A total of 227 documents published in different journals indexed in Scopus retrieved from the Scopus Database were analyzed. Bibliometric analysis was done to map the Annual publications, countries, institutions, authors, journals, and keywords in the field of Problem-based Learning and Teacher Education was visually analyzed using VOSviewer and the Scopus analysis tool.

## RESULTS

### TRENDS AS PER ANNUAL PUBLICATIONS

Figure 1 shows an annual increase in the number of documents. The first document was published in 1993 in this domain. Since 2002, growth in the number of documents was less but after 2002, the graph shows that the number of documents gradually increased.

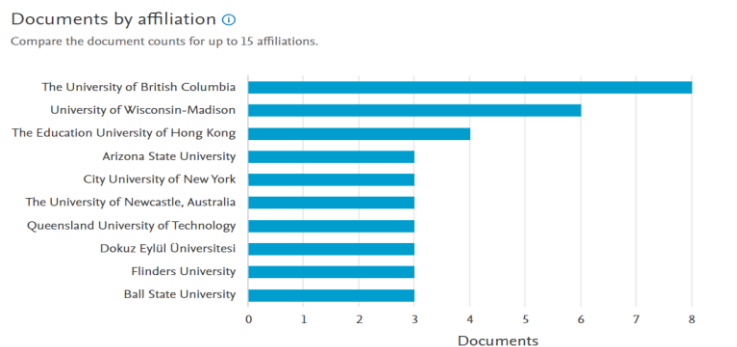


**Figure 1 :** Annual trend of publications in PBL and Teacher Education.

### Distribution of Institutions

In terms of the number of documents, the University of British Columbia (n= 8) contributed the most, followed by the University of Wisconsin-Madison (n= 6) ranked second, Education University of Hong Kong (n=4) ranked third.

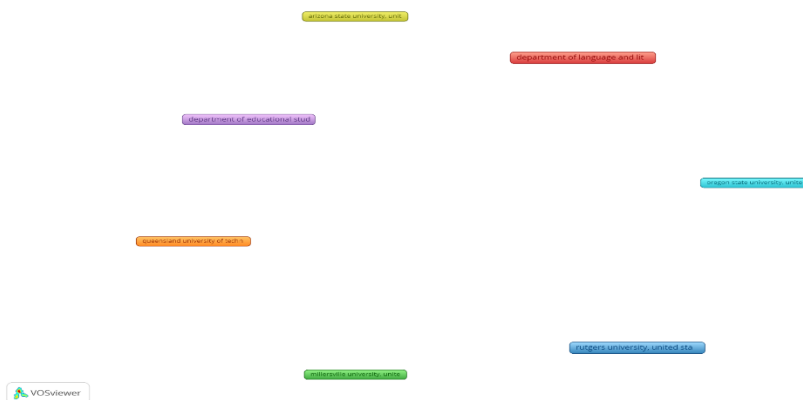
Arizona State University, City University of New York (n=3), and University of Newcastle (n=3) contributed an equal number of documents. (as shown in figure 2).



**Figure 2 :** Top ten institutions with the largest number of publications.

Under Co-authorship with unit of analysis as Organization, out of 363 organizations/institutions presented in 227 documents extracted, only 10 organizations met the criteria of 2 documents per organization with minimum 3 citations. Figure 3 shows the network map of the co-authorship of 10 organizations. It shows that there is no cluster formation in terms of co-authorship among organizations. By zooming into further, in figure 3.1, 3.2 and 3.3, there are 3 clusters that were connected 7 clusters identified, i.e Department of Language and Literature, University of British Columbia, and Education Library. University of British Columbia (Cluster 1), University of Wisconsin- Madison, USA and Rutgers University, USA (Cluster 2) and Millersville

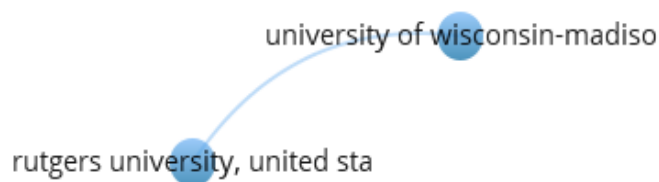
University, USA, and Penn Manor School District, USA (Cluster 3). So co-authorship analysis done at the Institutions level showed that there is lack of networking/ collaboration among institutions of different regions/ countries. A few clusters but with weak networking in terms of co-authorship. Table 1 shows the top ten organizations in terms of Documents, Citations, and Total Link Strength. Rutgers University and University of Wisconsin – Madison topped this list in terms of Total Link Strength, followed by the Department of Language and Literacy Education, University of British Columbia, Education Library, University of British Columbia, Millersville University and Penn Manor School District, USA



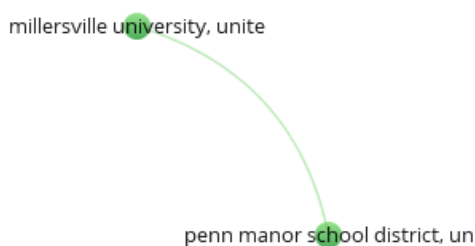
**Figure 3:** Network map of co-authorship between organizations/institutions with more than 2 documents



**Figure 3.1:** cluster 1 - within the university of British Columbia



**Figure 3.2:** Cluster 2 - within the USA (between two universities)



**Figure 3.3 :** Cluster 3 - between two institutions in USA

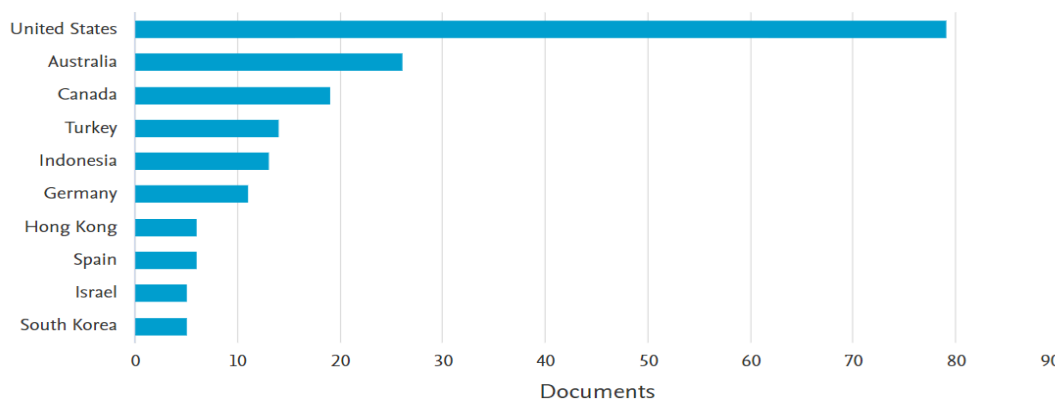
**Table 1: Document wise top ten institutions**

Sr No.	Organization/Institution	Documents	Citations	Total link Strength
1	Rutgers University, USA	4	31	4
2	University of Wisconsin-Madison, USA	4	31	4
3	Department of Language and Literacy Education, UBC, Canada	4	9	2
4	Department of Educational Studies, UBC, Canada	3	3	0
5	Education Library, UBC , Canada	2	8	2
6	Millersville University, USA	2	5	2
7	Penn Manor School District, USA	2	5	2
8	Arizona State University, USA	2	11	0
9	Oregon State University, USA	2	4	0
10	Queensland University of Technology, Australia	2	12	0

**Distribution of Countries**

Figure 4 shows the top ten countries in terms of the number of publications, United States ranked first with 78 documents, Australia ranked second with 26 documents, Canada ranked third with 19

documents, Turkey with 14 documents ranked fourth and Indonesia with 12 documents ranked fifth in this list.



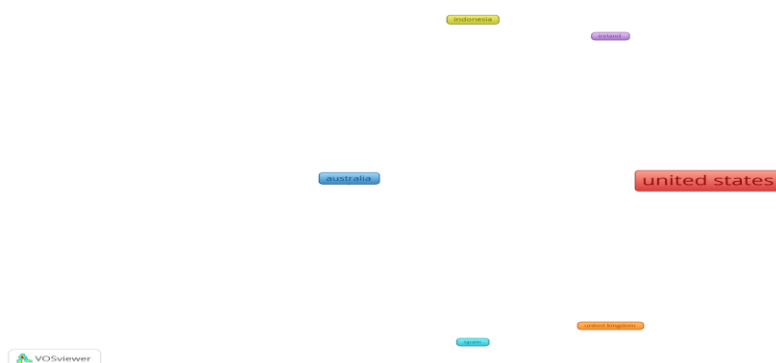
**Figure 4:** Top ten countries with the highest number of publications.

Under co-authorship with a unit of analysis as Country, analysis, out of 40 countries, with a minimum of 4 documents and 10 citations, 14 countries met the criteria, and there were 7 clusters. 1st cluster - USA, Canada, South Korea and Turkey. 2nd cluster- Chile, Finland and Israel. 3rd

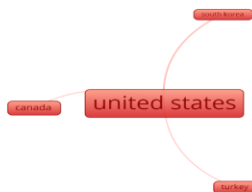
cluster - Australia, Germany, and Hongkong. Australia is common between 2nd and 3rd clusters. 4th, 5th, 6th and 7th cluster had one country each (Indonesia, Ireland, Spain and the United Kingdom).

**Table 2:** Top Ten countries along with documents, citations, and total link strength.

Sr No.	Country	Documents	Citations	Total link Strength
1	United States	79	1430	5
2	Australia	26	348	6
3	Canada	14	167	1
4	Turkey	13	204	1
5	Indonesia	11	32	0
6	Germany	6	73	1
7	Spain	6	37	0
8	Hong Kong	5	31	3
9	Israel	5	63	2
10	United Kingdom	5	47	0



**Figure 5:** Network map of co-authorship between Countries with more than 4 documents



VOSviewer

Figure 5.1: Network map of cluster 1st ( USA, Canada, South Korea and Turkey)



VOSviewer

Figure 5.2: Network map of cluster 2nd and 3rd network

### Analysis of Authors

#### Documents by author

Compare the document counts for up to 15 authors.

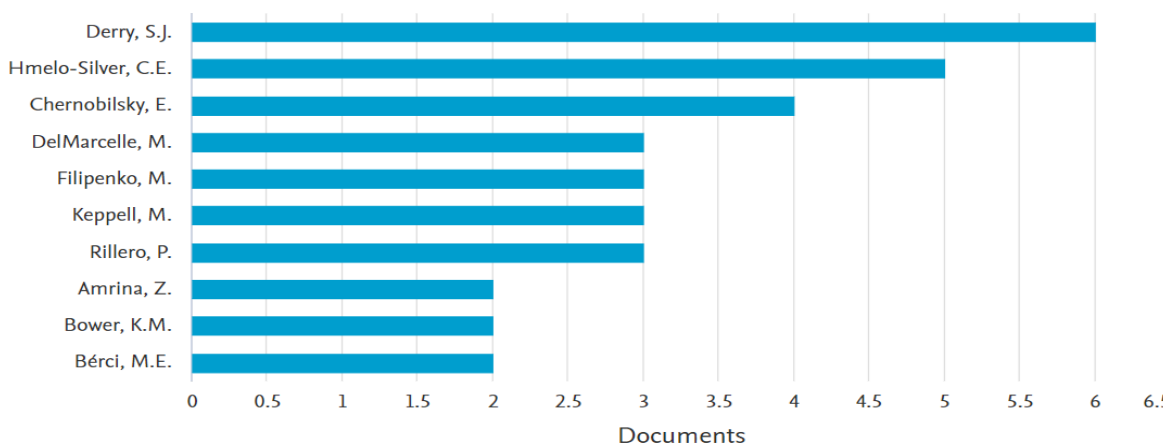


FIGURE 6: Analysis of authors- The number of author publications.

Under co-authorship analysis with a unit of analysis as Author, in terms of the number of publications, Derry S.J was the most prolific author (n = 6), followed by Hmelo-Silver C.E. (n = 5), Chernobilsky E. (n = 4), DelMarcelle M. (n =

3), Fillipenko M.(n = 3). If considering, number of citations, then Cochran-Smith with 332 citations topped this list, followed by Derry S., Hmelo-Silver and Delmarcelle.

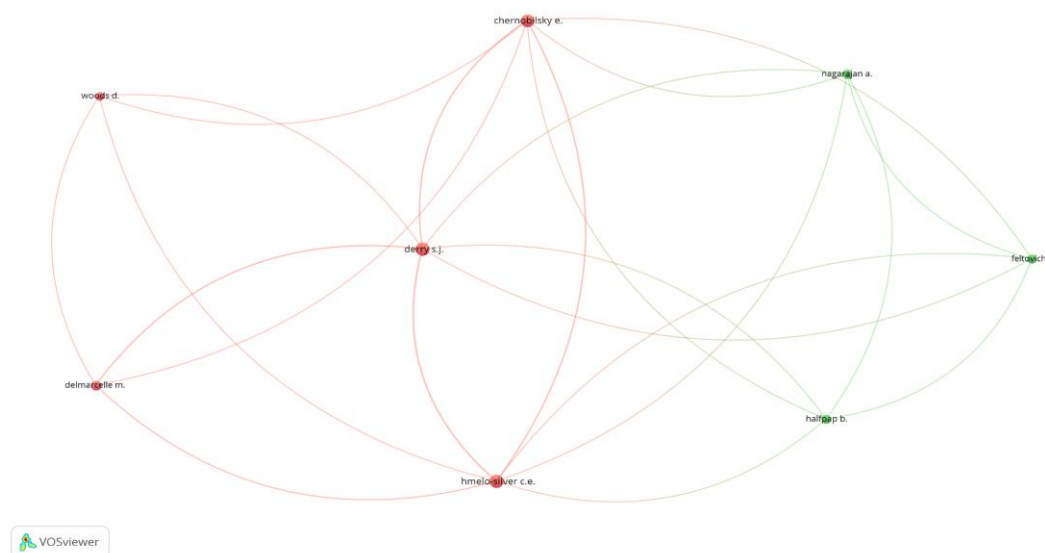
**Table 3 : author documents-wise**

Sr. No.	Author	Documents
1	Derry S.J.	6
2	Hemelo-Silver C.E	5
3	Chernobilsky E.	4
4	Delmarcelle M.	4
5	Feltovich J.	2
6	Halfpap B.	2
7	Nagarajan A.	2
8	Woods D.	2
9	Koc I.	2
10	Kuvac M.	2

**Table 4 : author citation-wise**

Sr no.	Author	Citations
1	Cochran-Smith M.	332
2	Derry S.J	61
3	Hmelo-Silver C.E	61
4	Delmarcelle M.	43
5	Goodnough K.	42
6	Selcuk G.S	40
7	Chenobilsky E.	31
8	Golghtly A.	31
9	Mulcahy D.	30
10	Eberhardt J.	25





**Figure 7:** Network map of co-authorship between authors with more than 2 documents.

Under co-citation, with cited authors as a unit of analysis, out of 10219 authors, 23 authors met the criteria of a minimum of 20 citations. In co-citation, Barrows with 87 citations was the most significant author, followed by Hmelo-Silver with 79 citations, Schmidt was third with 66 citations, Darling-Hammond was fourth with 45 citations,

and Dewey was fifth with 33 citations. In total link strength, Schmidt with 531 link strength topped this list, followed by Barrows with 511 link strength, Followed by Hmelo-silver (508), Dolmans (208), and Savery (204).

**Table 5:** Co-cited authors - citations wise

Sr no.	Author	Citations
1	Barrows H.S	87
2	Hmelo-Silver C.E	79
3	Schmidt H.G	66
4	Darling-Hammond I.	45
5	Dewey J.	33
6	Shulman I.S	32
7	Savery J.R	30
8	Savin-Baden M.	30
9	Cochran-Smith M.	29
10	Boud D.	25

**Table 6:** co-cited authors - total link-wise

Author	Citations	Total Link Strength
Schmidt H. G.	66	531
Barrows H. S.	87	511
Hmelo- Silver C. E.	79	508

Dolmans D.H.J.M.	20	208
Savery J.R.	30	204
Gijbels D.	23	197
Segers M.	21	191
Dochy F.	21	180
Shulman I. S.	32	171

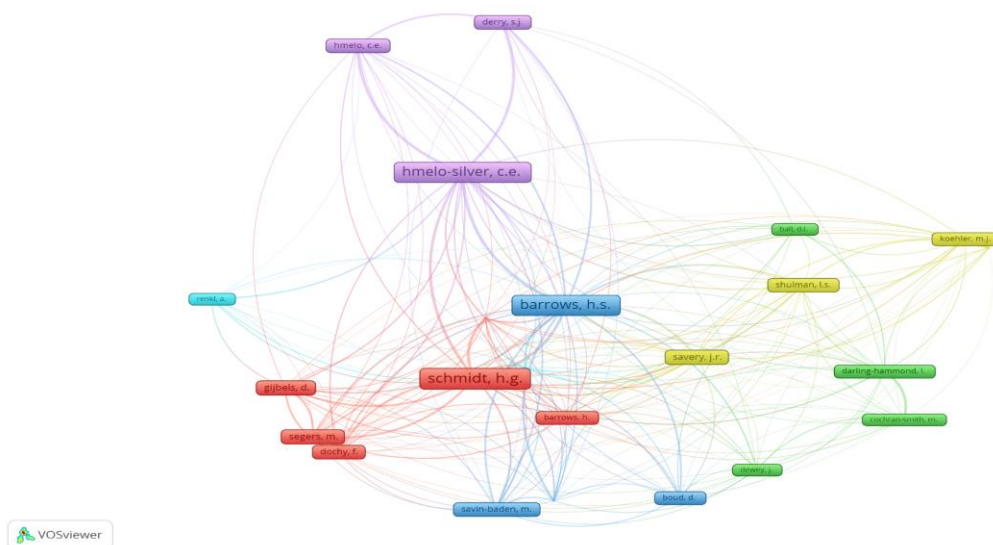


Figure 8: Network map of authors who were co-cited in the present analysis.

### Co-occurrence Analysis of Keywords

Under co-occurrence, out of 749 (all keyword) keywords, with a minimum of 5 keywords occurrence, 27 met the criteria. Figure 9 shows the network visualization of keywords. The color in the overlay visualization in figure 9.1 indicates the

average publication year of the identified keywords of the present analysis. Figure 9.2 shows the density visualization which mapped the keywords by their frequency of appearance.

**Table 7:** Top ten keywords as per occurrence and total link strength

Sr no.	Keyword	Occurrence	Total link strength
1	Teacher Education	70	108
2	Problem- based Learnig	62	88
3	Teaching	24	85
4	Problem based learning	24	72
5	Students	16	72
6	Professional Development	11	22
7	Education	10	37
8	Education Computing	8	39
9	Pre service Teacher Education	8	19
10	Curricula	7	34

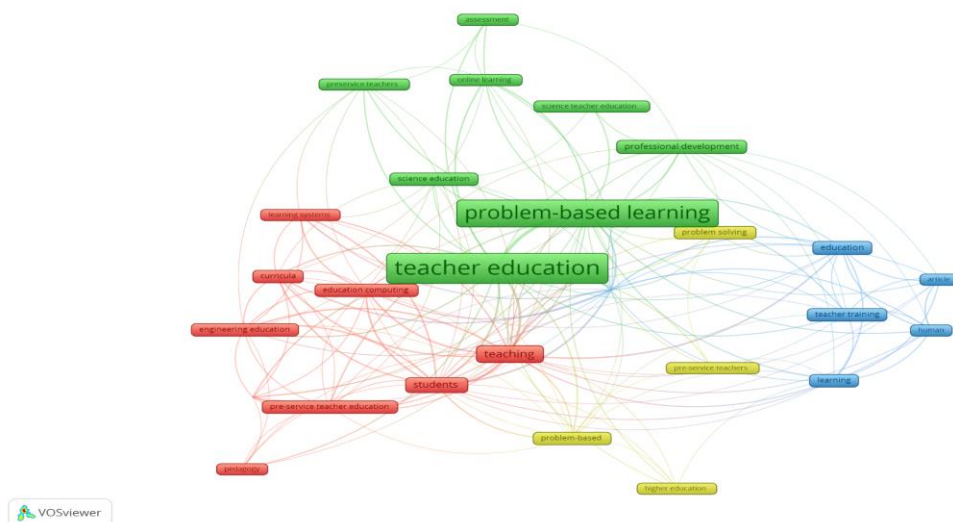


Figure 9: Network map of keywords

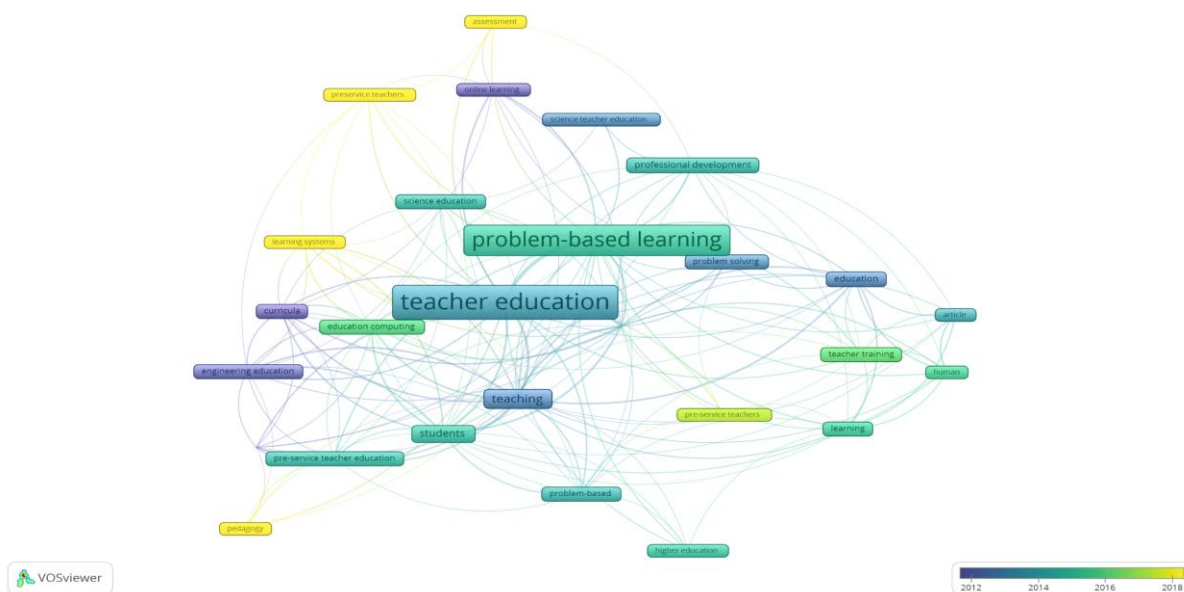


Figure 9.1 : Overlay Visualization of keywords

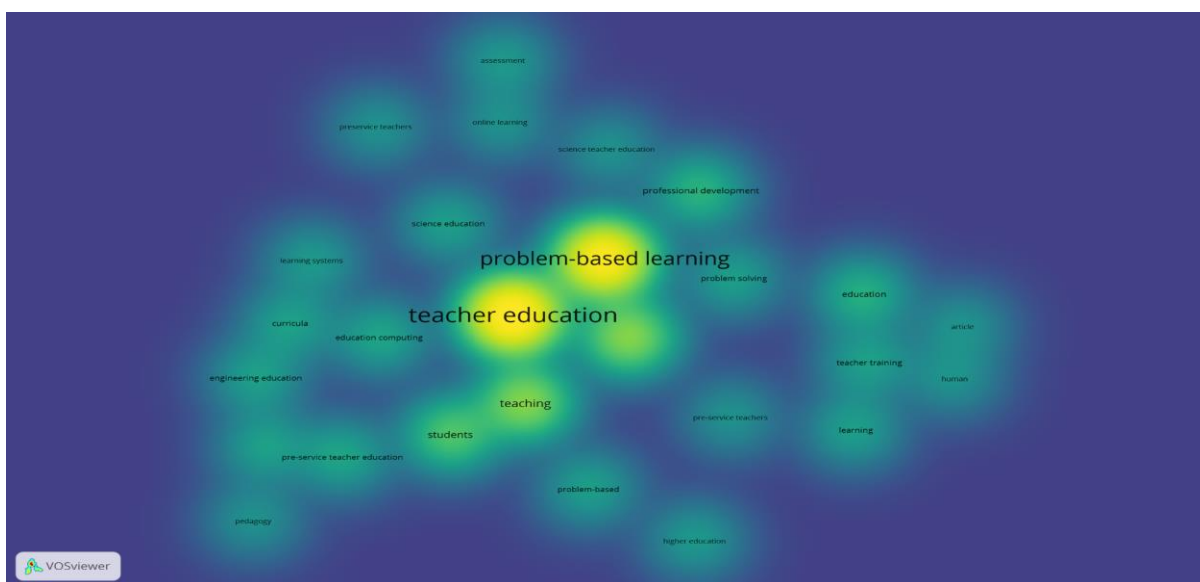


Figure 9.2: Density Visualization of keywords

## ANALYSIS OF JOURNALS

Under citation, with a unit of analysis as Journals, out of 169 Journals (sources) cited in 227 documents used for the present analysis, with a minimum of 4 documents per source and 2

citations at least, only 5 met the criteria. The network map shows there is no connection between the top 5 cited journals in this field.

**Table 8:** Top 5 journals in citation analysis.

Sr. No.	Source/Journal	Documents	Citations
1	Problem based Learning in Teacher Education	10	14
2	Interdisciplinary Journal of Problem Based Learning	8	74
3	Journal of Physics: Conference Series	4	2
4	Journal of Science Teacher Education	4	63
5	Teaching and Teacher Education	4	407



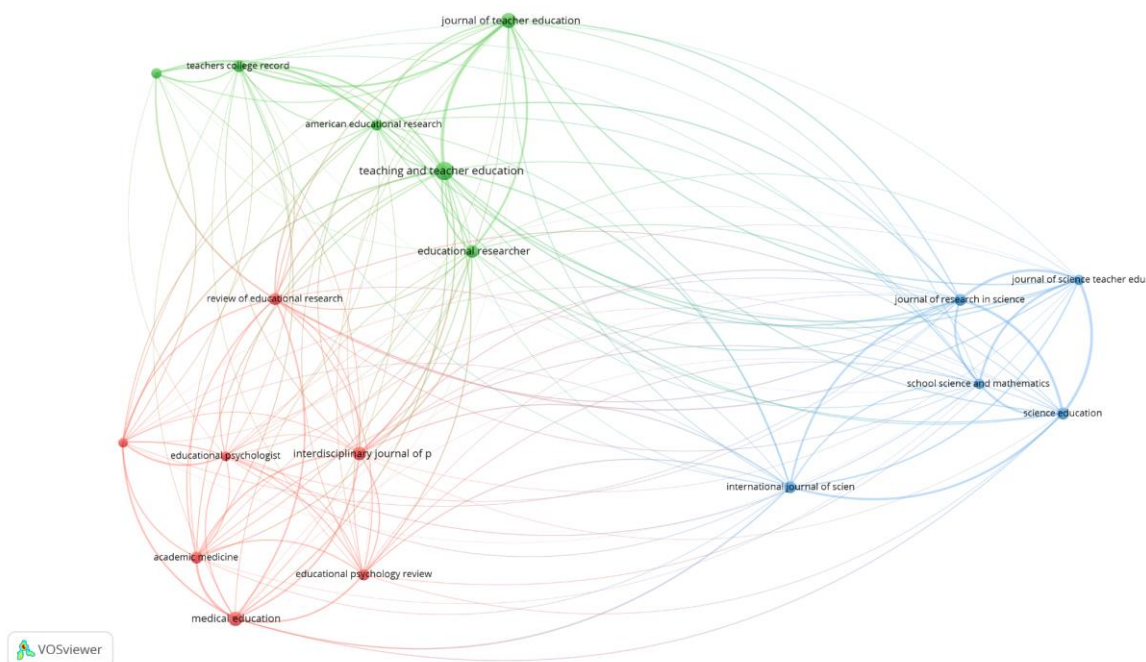
**Figure 10:** Network map of journals with a minimum of 4 documents

Under Co-citation with unit of analysis as Journals/Source, Figure 10 shows the network map of co-citation of journals, out of 4625, with a minimum of 30 citations, 18 met criteria. Table 5 shows the top ten Journals/ Source in terms of Citations and Total Link Strength. ‘Teaching and Teacher Education’ topped this list with 107 citations and 639 total link strength, ‘ Journal of Teacher Education’ with 78 citations and 532 total link strength at second rank, ‘Medical Education’

with 69 citations and 380 total link strength at third rank, ‘Interdisciplinary Journal of Problem-based Learning’ with 58 citations and 288 total link strength at third rank, followed by ‘Educational Journal’ with 55 citations and 329 total link strength at fourth rank and ‘Teacher College Record’ with 48 citations and 305 total link strength at fifth rank.

**Table 9:** Top ten sources (citation-wise along with total link strength )

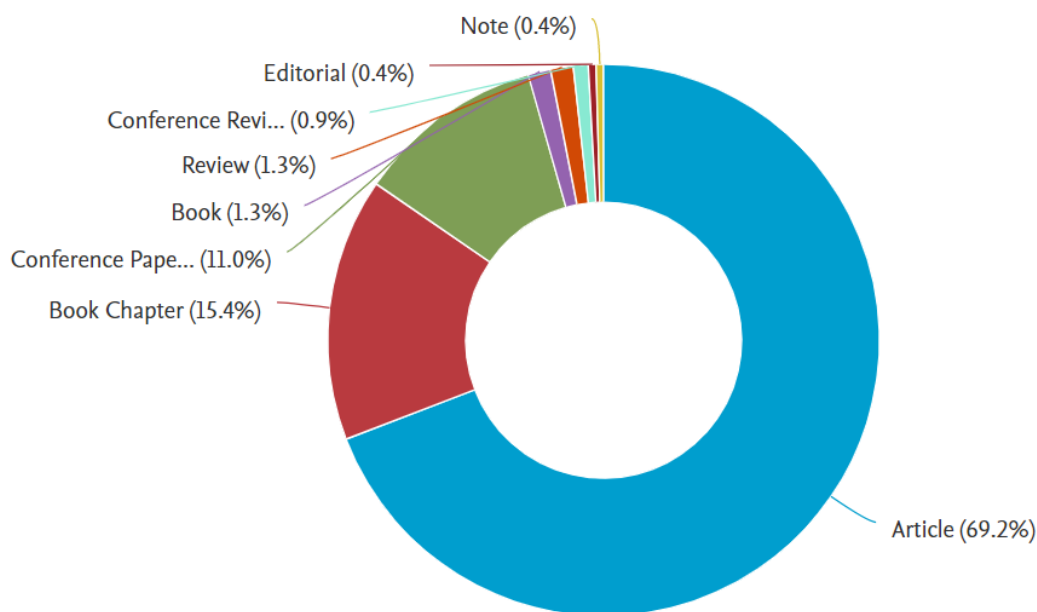
Sr. no.	Source/Journal	Citations	Total Link Strength
1	Teaching and Teacher Education	107	639
2	Journal of Teacher Education	78	532
3	Medical Education	69	380
4	Interdisciplinary Journal of Problem based Learning	58	288
5	Educational Researcher	55	329
6	Teachers College Record	48	305
7	Journal of Research in Science Teaching	47	532
8	Science Education	47	526
9	Review of Educational Research	47	370
10	International Journal of Science Education	46	381



**Figure 10:** Network map of co-citation Journals/Sources with more than 30 citations

**ANALYSIS BY DOCUMENTS and Subject wise/ research area**

Documents by type

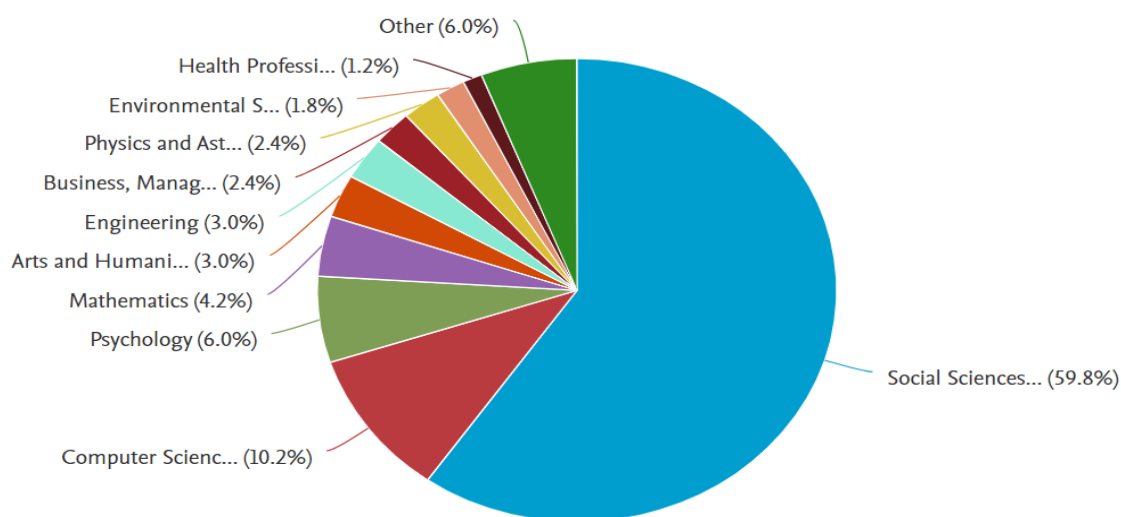


**Figure 11:** Types of Documents extracted in this analysis

In terms of the type of documents, 69.2 % are articles, 15.4 % are book chapters, 11% are conference papers, rest of the documents include books, reviews, and Editorials. Subject-wise, 59.8

% of documents belong to Social Sciences, 10.2 % belong to Computer Science, followed by Psychology (6%), Mathematics (4.7%), and other subjects as shown in figure 12.

Documents by subject area



**Figure 12 :** Types of documents classified by subject area



Under Citation with a unit of analysis as Documents, out of 227 documents, with minimum 30 citations criteria - 18 documents met the criteria. “Authentic assessment of Teaching in

Context (2000)” was the most cited document by Darling-Hammond.

**Table 10:** Top ten citations analysis of publications.

Rank	Title	First Author	Source	Publication	Citation
1	Authentic Assessment of Teaching in Context	Darling-Hammond	Teaching and Teacher Education	2000	356
2	The New Teacher Education: for better or for worse?	Cochran-Smith	Educational Researcher	2005	275
3	Learning to teach Primary Science through Problem-based Learning	Peterson	Science Education	1998	57
4	The New Teacher Education in United States: Direction Forward	Cochran-Smith	Teachers and Teaching : Theory and Practice	2008	57
5	A study on teaching gases to prospective science teachers through Problem-based Learning	Senocak	Research in Science Education	2007	50
6	Strength based mentoring in pre-service teacher Education- a literature review	Y. He	Mentoring and Tutoring: Partner in Learning	2009	50
7	Blended Problem based learning for Teacher Education: Lessons learnt	Donnelly	Learning,Media and Technology	2006	50
8	Disciplinary Literacy in English Language Arts: Exploring the Social and Problem-Based Nature of Literary Reading and Reasoning	Rainey	Asia-Pacific Journal of Teacher Education	2017	46
9	Learners' attitudes to wiki technology in problem based, blended learning for vocational teacher education	Robertson	Australasian Journal of Educational Technology	2008	44
10	An approach to teaching critical thinking across disciplines using performance tasks with a common rubric	Cargas	Thinking Skills and Creativity	2017	42



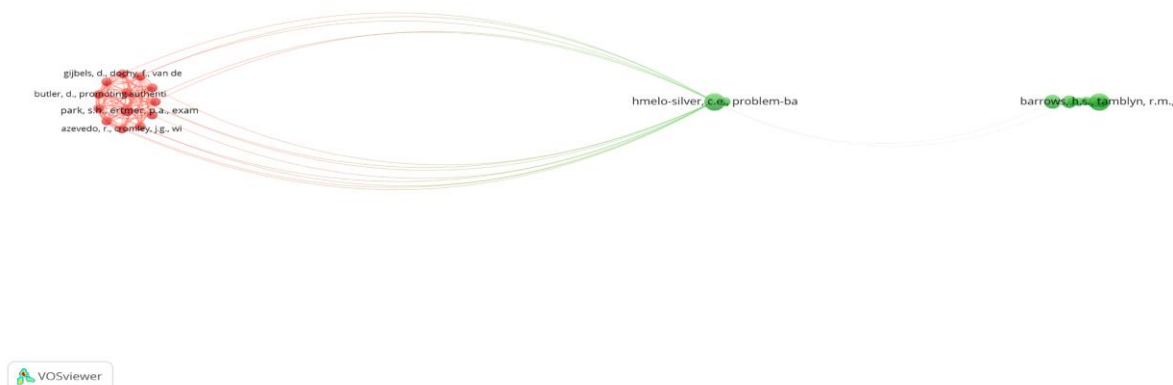
**Figure 13: Network map of documents with 30 citations**

Under co-citation with a unit of analysis as References, out of a total of 8383 references, with 4 minimum references, 26 references met the criteria of 5 minimum cited references. , out of these 26, only 24 were connected and making a network. In the field of Teacher Education, the most co-cited reference was “Problem-based

Learning: what and how do students learn? “ (2004) by Hmelo-Silver C.E. Table 6 shows the top five cited references along with total link strength.

**Table 11: Top 5 cited references**

Sr no.	Cited Reference	Citations
1	Problem-based learning: what and how do students learn? (2004)	9
2	Problem-based learning: An approach to medical education (1980)	7
3	Those Who Understand: Knowledge Growth in Teaching( 1986)	7
4	Problem-based learning in initial teacher education: taking the agenda forward(2002)	6
5	Examining barriers in technology-enhanced problem-based learning: Using a performance support systems approach (2008)	6



**Figure 14: Network map of co-cited references**



As Zhang et. al., (2022) listed the inevitable limitations of bibliometric analysis. In this study. Similar limitations existed for the present study. Firstly, this type of data changes with time, and conclusions can be more comprehensive with time as more data would be there for analysis. Secondly, only one database i.e Scopus, was considered for this analysis. Thirdly, decisions about the conditions for making network maps such as the number of minimum citations, documents, and other settings in Vosviewer were subjective in approach. Even though, contextual arguments i.e. limited research were considered for these decisions. Lastly, key terms for this analysis could be limited or it may have missed grey literature in this field.

### Conclusion:

The first document related to this analysis was published in 1993 in Scopus Database. Since 2002, growth in the number of documents was less but after 2002, it gradually started increasing. Among universities/organizations, in terms of the number of documents, the University of British Columbia, Canada) contributed the most in PBL in the context of Teacher Education. United States ranked first among Countries. Australia was also an important contributor in terms of co-authorship between Countries. In terms of the number of publications, Derry S.J was the most prolific author. If considering, the number of citations, then Cochran-Smith with 332 citations topped this list. In the co-citation analysis of Authors, Barrows with 87 citations was the most significant author. Among Journals, the network map showed there was no connection between the top 5 cited journals in this field. In co-citation analysis, 'Teaching and Teacher Education' topped the list of Journals. "Authentic assessment of Teaching in Context (2000)" was the most cited document by Darling-Hammond. The most co-cited reference was "Problem-based Learning: what and how do students learn?" (2004) by Hmelo-Silver C.E. Apart from the above information, it is very important to understand that there is a need to collaborate more in the case of Countries, Organizations, and Researchers who are contributing in Problem-based Learning in the context of Teacher Education. This work will provide insights to Fellow Researchers and Future Researchers about the existing picture and gaps related to PBL in Teacher Education.

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