J Data Sci. Info. Citation Studies., 2025; 4(2):159-173.
https://www.jcitation.org

Research Article

Scientific Mapping of Research Evolution on Innovative Pedagogy: A Bibliometric Analysis

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ABSTRACT

This Bibliometric investigation analyses the comprehensive research trends, publications, and citations over time frameworks, keyword occurrences, top productive authors, sources, and countries' research production on Innovative Pedagogy. For this study, the bibliometric analysis method was used. 4692 documents were extracted from the Scopus database published from 2000 to 2024 as of 9 September 2024 with the help of search keywords "Innovative Pedagogy" or "Innovative Pedagogies." The quantitative data analysis was conducted utilizing MS Excel (2021 version) and VOSViewer (1.6.20 version) software. The findings of this investigation indicated that the publications in the field of IP emerged before 2000; however, a significant surge was noted after 2010. Maximum publications (N=549) on IP were found in 2023. Similarly, the maximum number of citations (N=3622) was recorded in 2017. Nearly 55% of publications (N=2567) were Journal articles. The nations with the highest research output were the United States (N=1474), the United Kingdom (N=546), Australia (N=488), and India (N=214 Publications). The most productive author was Owolabi, O. A. (N=9 Publications), and the Institution was "Arizona State University, USA (13 Publications and 81 Citations). The most common keyword used in the IP domain was 'teaching' (699 occurrences, 14 links, and 1909 total link strength). This paper will be helpful for the scientific community as well as novel researchers. This paper provides a global lens on Innovative Pedagogy related publications.

Keywords: Innovative Pedagogy, Bibliometrics, Keyword Trends, Research Evolution, Scientific Visualization, VOSViewer.

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Received: 02-04-2025;
Revised: 28-05-2025;
Accepted: 16-07-2025.

INTRODUCTION

Innovative Pedagogy (IP) refers to new, practical approaches to teaching that meet the diverse needs of today's learners in a rapidly changing world. It is characterized by practices that promote engagement, adaptability, critical thinking, and problem-solving. These approaches are student-centred, focusing on collaboration, creativity, and real-world application of knowledge. IP often incorporates digital tools and embraces methods such as project-based learning, flipped classrooms, and blended learning, which transform traditional classroom dynamics into more active learning environments (Laurillard, 2012; Heick, 2020). The concept of innovative pedagogy is not static; it evolves alongside changes in technology, societal needs, and educational research. Digitalization, for example, has opened new doors for learning and teaching. The widespread adoption of online learning platforms, especially during times of crisis like the COVID-19 pandemic, has showcased the potential of emergency remote teaching to maintain educational continuity (Hodges *et al*., 2020).

Similarly, Massive Open Online Courses (MOOCs) have broadened access to education, allowing learners worldwide to engage in courses that may otherwise be inaccessible due to geographic or economic barriers (Siemens, 2013). These examples highlight how innovative pedagogies can make learning more inclusive and flexible, adapting to the needs of diverse learners. One key principle of IP is its learner-centred approach, rooted in theories like constructivism, emphasizing the importance of active, student-driven learning (Vygotsky, 1978). In this approach, teachers act as facilitators rather than mere transmitters of knowledge. Students are encouraged to take charge of their learning, often through Problem-Based Learning (PBL) and inquiry-based activities (Hmelo-Silver, 2004). In PBL, learners engage in solving real-world problems, fostering critical thinking, collaboration, and independent inquiry (Barrows, 1996). Experiential learning, another key feature, emphasizes learning through reflection. This approach allows students to apply theoretical knowledge to practical situations, promoting

DOI: 10.5530/jcitation.20250180

deeper understanding (Kolb, 1984). Assessment practices within IP are also evolving. Traditional assessments like standardized testing are being supplemented, and sometimes replaced, by formative assessments that offer on-going feedback and emphasize learning processes over outcomes (Black & William, 1998). This shift reflects a deeper understanding of how students learn and the need for assessments to be aligned with 21st-century skills. Innovative assessments may include peer review, self-assessment, and project-based evaluations, providing students a more holistic understanding of their learning progress.

The rise of technology has also enabled the use of flipped classrooms, where students first encounter new material outside of class, typically through videos or reading assignments, and then apply this knowledge during in-class activities (Bergmann & Sams, 2012). This approach inverts the traditional model of instruction, allowing more class time for active learning, discussion, and collaboration. It also aligns with the principles of differentiated instruction, which advocates for teaching methods that cater to the diverse needs of learners (Tomlinson, 2001). Digital games and simulations have also emerged as powerful tools in IP, promoting engagement and learning through interactive experiences (Gee, 2003). Such tools can be particularly effective in science and technology education, allowing students to explore complex systems and scenarios that would be difficult to replicate in a traditional classroom setting.

Moreover, combining online and face-to-face instruction, blended learning has proven highly effective in promoting engagement and academic achievement (Garrison & Kanuka, 2004). It allows for flexibility in learning pace and style, making it particularly suitable for adult learners and those with varying levels of prior knowledge. Micro-learning, another emerging trend, delivers content in small, easily digestible units. This approach aligns with contemporary learners' needs for flexibility and just-in-time learning, particularly in the workplace or continuing education settings (Hug, 2005). Micro-learning allows learners to engage with content in short bursts, making it easier to fit learning into busy schedules while ensuring that information is absorbed effectively.

Furthermore, IP supports the development of 21st-century skills, such as critical thinking, creativity, collaboration, and communication (Trilling & Fadel, 2009). These skills are essential in preparing students for a rapidly changing workforce and a globalized world. The focus on such skills reflects a broader shift in education towards preparing learners for real-world challenges rather than merely imparting theoretical knowledge. Problem-solving, teamwork, and adaptability are increasingly seen as vital competencies that education systems must foster. Cultural relevance is also a growing consideration in IP, with educators seeking to create learning experiences that reflect students' diverse backgrounds and experiences. Culturally responsive teaching, for example, aims to make learning more inclusive by incorporating students' cultural contexts into the curriculum, thereby enhancing engagement and achievement (Pellegrino, 2014). This approach aligns with the broader trend of making education more equitable and accessible to all learners, regardless of their socio-economic or cultural backgrounds. Another vital aspect of IP is its ability to adapt to changing circumstances. For instance, during the COVID-19 pandemic, many educators had to shift to online or hybrid models of instruction quickly. This sudden transition underscored the importance of flexibility and resilience in teaching practices and the potential of technology to support learning in various contexts (Fullan, 2007; Bell, 2010). The experiences of remote teaching during the pandemic have highlighted the need for educators to be agile and to evolve their pedagogical strategies to meet new challenges continuously. As educational technologies and pedagogies evolve, it is important to recognize the challenges of implementing innovative approaches. Teachers need proper training and support to effectively integrate new methods and tools into their teaching.

Additionally, institutional barriers, such as rigid curricula and standardized testing requirements, can hinder the adoption of more flexible and student-centred approaches (Ertmer & Ottenbreit-Leftwich, 2010). Nevertheless, with on-going professional development and a supportive policy environment, the potential for IP to transform education is immense. Ultimately, IP aims to make learning more engaging, personalized, and effective. By embracing various approaches—from digital tools and games to problem-based learning and culturally responsive teaching—educators can better meet the needs of their students and prepare them for the challenges of the 21st century. As research and technology continue to advance, so will the opportunities for innovation in teaching and learning. Through these dynamic and responsive approaches, educators can foster deeper learning, creativity, and lifelong learning skills in their students.

Bibliometric analysis is an emerging research area. Their development and mutual relationships are presented effectively by quantitative analysis with the help of available texts (Wang *et al.*, 2021). Analysing relevant available literature is a great way to analyse a topic or a magazine's productivity and global links. Bibliometric analysis is one of the mature and effective statistical methods based on quantitative analysis, which offers researchers great ability to reveal a comprehensive overview from a global perspective (Pal *et al.*, 2025; Pal & Kumar, 2025; Jia *et al.*, 2024). Bibliometric research has developed over many years and has achieved many outstanding scientific achievements. Broadus (1987) defines bibliometrics as "the quantitative examination of tangible published entities, bibliographic units, or their corresponding surrogates." Bibliometrics is an analytical instrument to investigate the evolution of academic disciplines through the lenses of intellectual, social, and conceptual structures (Zupic & Čater, 2015). It scrutinizes research outputs—including the themes pursued, methodologies adopted,

and sample selections employed (Ye *et al.*, 2012). Implementing fundamental or advanced statistical techniques on data extracted from prior scholarly works, such as books, conference proceedings, and academic journals (Cobo *et al.*, 2011; McBurney & Novak, 2002). Bibliometrics is described as "one of the rare truly interdisciplinary research domains that permeate nearly all scientific domains" (Glänzel, 2003). According to Koseoglu *et al.*, (2016), two principal bibliometric methodologies exist. The initial method encompasses basic bibliometric techniques, wherein the investigator reviews literature through content analysis and metrics to gauge the performance of scholarly papers and their contributors. The secondary method advances various techniques, including co-occurrence methodologies such as co-citation, co-authorship, and co-word analysis.

Similarly, identify two bibliometric methodologies: (a) evaluative techniques and (b) relational techniques. Evaluative techniques concentrate on the influence of academic research by evaluating performance through productivity metrics, impact indicators, and hybrid measures (Hall, 2011). Relational techniques investigate the interconnections among published research by examining their citations, authors, affiliations, and keywords to facilitate co-occurrence analyses. Such methodologies assist researchers and readers in elucidating the intellectual frameworks of the disciplines, the social architectures of the fields, and the inception of novel research themes (Nerur *et al.*, 2016; Ronda-Pupo & Guerras-Martín, 2012; Tan & Ding, 2015). Co-author analysis evaluates the networks that researchers construct socially through collaborative efforts on scientific publications (Acedo *et al.*, 2006). This analysis of co-authorship is particularly adept at addressing research inquiries concerning scientific collaboration. This examination of co-authorship is particularly proficient at addressing research queries about scientific collaboration (Pal & Pal, 2025).

Study Objectives

The most important objective of this study was to present the academic development, research evolution, and keyword trends in IP, a trending domain of academic research globally. This study is carried out by quantitative analysis and scientific visualization of the studies conducted in the context of various dimensions related to IP. The specific objective of this study was to provide a bibliometric analysis and scientific visualization of IP-related publications from 2000 to 2024 and also to find out the top-producing authors, sources, and knowledge disciplines in the IP field.

METHODOLOGY

Considering its quantitative nature, a quantitative research approach was used to complete this research study. In this study, bibliometric analysis was used. Bibliometric analysis is a review technique used to understand the relationships among different scientific publications' elements like authors, countries, citations, and keywords on a selected topic. (Palamar *et al.*, 2022; Wadaugsorn *et al.*, 2022). This analysis will encompass many dimensions, including delineating the most prolific authors, nations, academic institutions, and scholarly journals, quantifying articles and citations pertinent to studies associated with IP, analyzing citation patterns, and the co-citation networks among cited references. The Scopus database (Scopus.com) is utilized as the primary data source for the bibliometric analysis due to its recognition as one of the largest databases worldwide, providing extensive data to scholars, institutions, governmental bodies, decision-makers, and other pertinent stakeholders. (Guechairi, 2024; Gupta *et al.*, 2013; Rashid *et al.*, 2021). Consequently, we conducted a search in Scopus for title, abstract, and keywords employing the following keywords: ("Innovative Pedagogy" or "Innovative Pedagogies"); this represents the formula applied in Scopus: TITLE-ABS-KEY ("IP" or "Innovative Pedagogies" or "Innovative Pedagogical") without imposing any restrictions. In this way, we successfully extracted 4,754 documents across all disciplines. The data collection was executed on September 9, 2024, between 3:45 PM and 5:00 PM at Maulana Azad National Institute of Technology, Bhopal, India. After data cleaning through Excel (2021 version), 62 publications regarding insufficient information were removed. Thus, 4692 documents were analyzed with the help of VOSViewer (version 1.6.20) software (Vosviewer.com). VOSViewer is freely available for any purpose.

RESULTS AND DISCUSSION

Scientometrics or Bibliometrics analysis constitutes a scholarly domain dedicated to analyzing contemporary trends within the literature about a specific scholarly field, thereby offering insights and encouragement for prospective research endeavors (Murnaka *et al.*, 2021; Rupp *et al.*, 2021). The various scholarly disciplines encompass exploring science, technology, and innovation through a quantitative lens. The viewpoint of bibliometrics incorporates a quantitative analysis of textual and communicative elements within the interdisciplinary realms of scientific discipline. This segment presents bibliometric findings on various performance metrics, including publications by year, author, nation, sources, etc. We also present the most prolific and frequently occurring keywords, the most prevalent institutions, and leading academic journals.

Over time publication analysis

IP has made its presence felt as a powerful signature and an important part of the world of global knowledge. A total of 4692 IP-related documents were analyzed quantitatively to carry out bibliometric analysis. Figure 1 presents the total over time publications from 2000 to 2024 (09/09/2024) year-wise. It is clear from the observation of Figure 1 that the least number of publications (N=11) were published in the year 2000. The highest (N=549) publications were done in 2023. Similarly, the number of

publications in other years can be seen in Figure 1. The increasing number of publications over time (see Figure 1) on IP presents evidence of the attraction of researchers (Haboubi *et al.*, 2024). To do new research in this hot field.

Citation trends analysis

The year-wise citation Trends analysis of the total published documents in the IP field is presented in Figure 2. According to Figure 2, the minimum (N=135) citations were gained in 2000, and the maximum (N=3622) citations were gained in 2017. The citations of other years can be seen in Figure 2. The citations of IP-related publications do not show linear trends but fluctuate over the years (see Figure 2).

Analysis of document-type publications in IP

On analyzing a total of 4692 documents published in the field of IP, it was found that these documents were published in various categories of documents. Based on document types, the analysis of published documents in the field of IP is presented in Figure 3. From the perusal of Figure 3, it is clear that 2567 documents have been published in the form of articles, which is approximately 55% of the total documents. There have been 921 publications in the form of conference papers, which is approximately 20% of the total publications. Similarly, 542 publications have been in the form of book chapters, which is about 12%, and 385 publications have been in the form of books, which is about 8%. in the field of publication related to IP. Thus, about 95% percent of the publications in the field of IP are in the form of articles, conference papers, book chapters, and books. The Maximum (55%) publications in the field of IP belong to the articles. The lowest publication has been in the form of a short survey (see Figure 3).

Productive Countries in IP

On analyzing a total of 4692 documents published in the field of IP, it was found that these documents were published in 190 countries. 143 out of 190 countries make connections with each other with at least 1 published document. These 143 countries make 27 clusters and have created 592 links, with total link strength of 1195. Only 79 countries were found after selecting the criteria of at least 5 publications. These 79 countries create strong collaborative networks with 11 clusters and 466 links. The total link strength of the above 79 countries is 1063. The network visualization of these 79 countries is presented in Figure 4.

From the perusal of Figure 4, it is clear that the size of some spheres is bigger and smaller than others. In the output of VOSViewer Software's Networks visualization map, the enormous sphere shows the bigger number of publications, and the smaller sphere shows the smaller number of publications. In this way, we can identify which country produces more research than others. The USA, UK, India, and Canada are shown as the most productive countries in Figure 4.

The top 15 productive countries

For the analysis of the top 15 research-producing countries in the field of IP, the researcher set the criteria of at least 79 publications per country; after that, the top 15 productive countries were found. The top 15 IP-related research-producing countries out of 190 are presented in Table 1.

From the Perusal of Table 1, it is clear that the United States of America (USA) is the top research-producing country in IP. The USA has published 1474 documents from 2000 to 2024 in the respective field. The documents published by the USA in the field of IP have received 14,423 citations over time. USA creates 13 links between the research-producing countries related to IP.

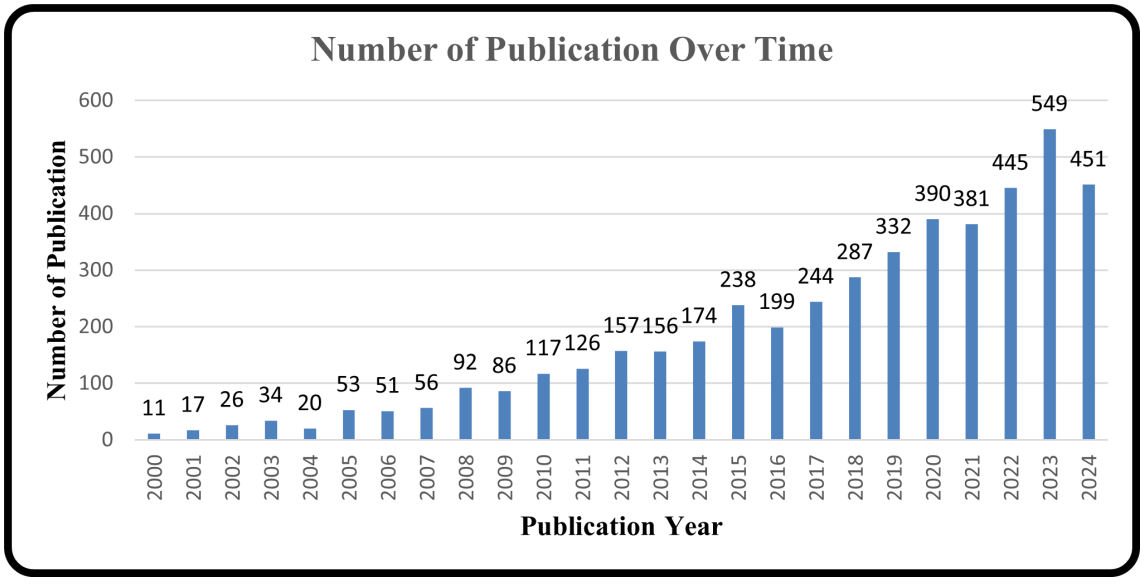

Figure 1: Total publications over time. [Source: All Figures are created by the Authors].

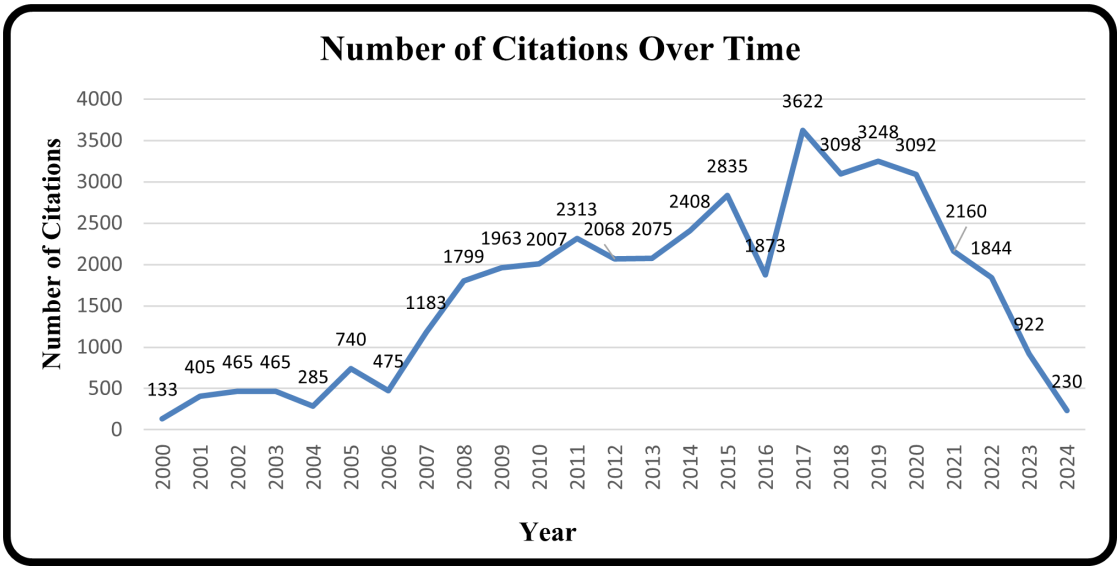

Figure 2: Total citations over time.

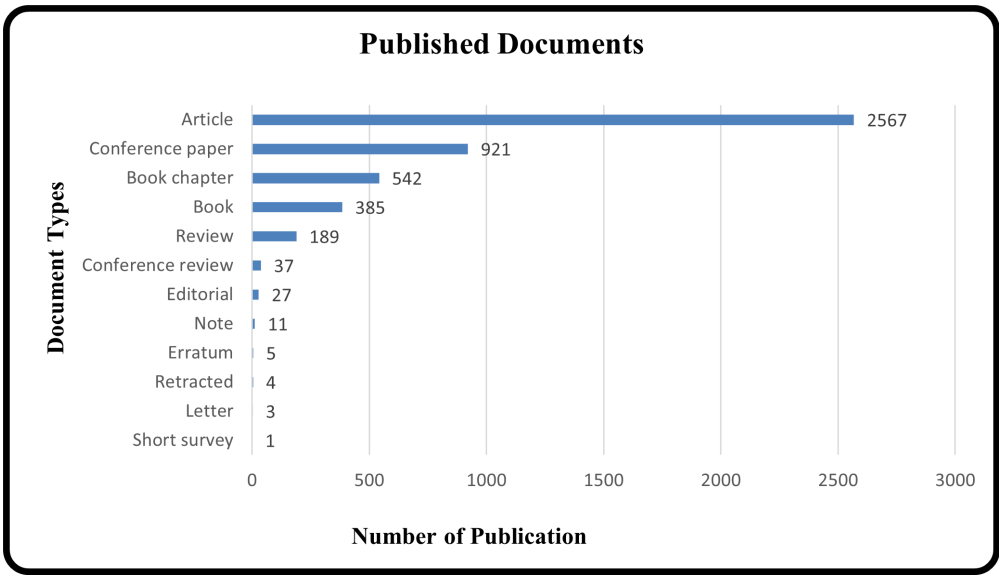

Figure 3: Total publications based on document types.

The total link strength of the USA is 166. The United Kingdom (UK) is the second most productive IP research country. The UK has received 6938 citations and created 14 links; its total link strength is 1118. With 488 documents and 5940 citations, Australia ranked third among the top 15 countries' innovative pedagogy research. Australia created 12 links, and its total link strength is 103.

Similarly, India has published 214 articles in IP from 2000 to 2024. India has received 776 citations and created 10 links, and India's total link strength is 30. In this way, India has secured fourth place among the top 15 research-productive countries in the IP field. That means Indian authors collaborated very limitedly globally, while USA, UK, and Australian authors collaborated very much in innovative pedagogical research. The other countries included in the top productive countries list can be seen in Table 1 with their publications, collaboration links, and total link strength, respectively. The top research-productive countries in the field of IP, mentioned in Table 1, created 3 collaboration network clusters. The collaboration network of the top 15 research-producing countries in the IP field can be seen in Figure 5.

From the perusal of Figure 5, it is clear that this figure has three colors. These three colors denote three clusters of the top 15 research-producing countries' collaboration networks. The first cluster, denoted in red, has 6 countries, the highest number of countries that collaborated. The USA, UK, France, Spain, Ireland, and Italy belong to the cluster first. India, South Africa, Malaysia, Australia, and New Zealand belong to the second cluster, denoted by green color.

Similarly, the Russian Federation, China Kannada, and Hong Kong belong to the last cluster. The top 5 collaborative countries

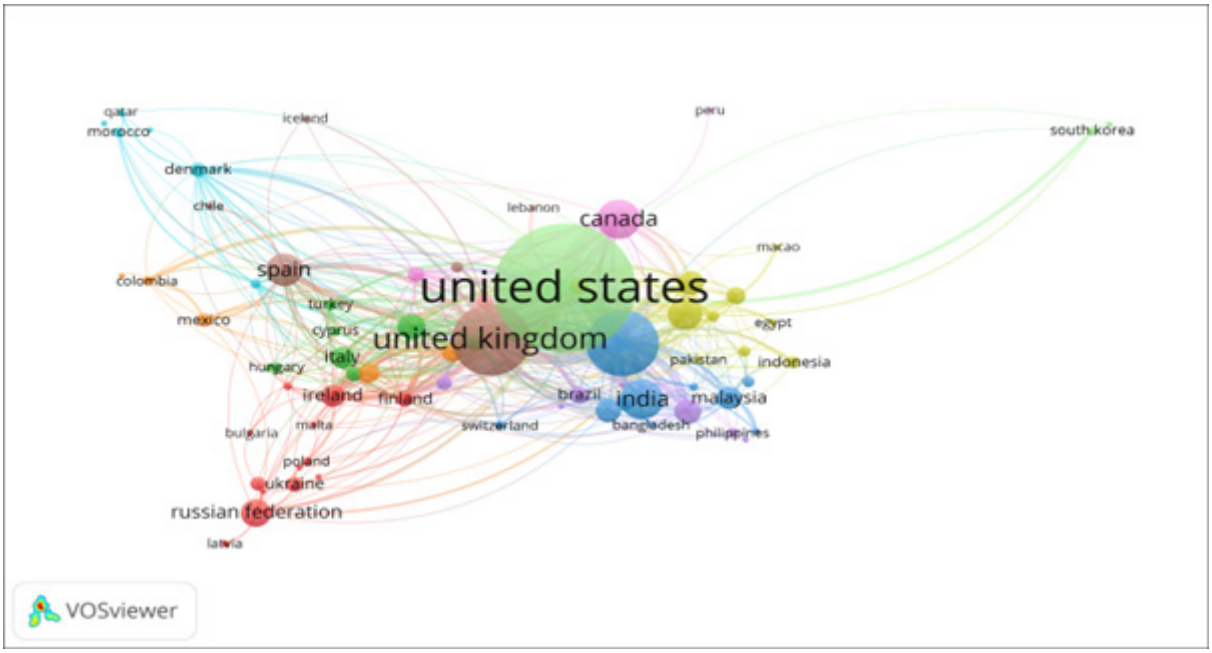

Figure 4: Collaboration Networks between Productive Countries. Source: VOSViewer Software output of network visualization map of productive Countries.

Table 1: Top 15 Productive Countries.

Sl. No.	Country	No. of Documents	No. of Citations	No. of Links	Total Link Strength
1	United States	1474	14423	13	166
2	United Kingdom	546	6938	14	118
3	Australia	488	5940	12	103
4	India	214	776	10	30
5	Canada	204	1954	10	65
6	Spain	153	1143	9	31
7	China	141	806	10	50
8	Russian Federation	116	321	7	13
9	France	99	504	11	28
10	New Zealand	98	1037	9	31
11	Hong Kong	89	1491	8	35
12	South Africa	86	760	8	16
13	Malaysia	83	513	6	16
14	Italy	80	613	5	14
15	Ireland	79	767	8	30

are the USA, the UK, Australia, Canada, And China respectively. The geographical presentation of these top 15 productive countries can be seen in Figure 6.

Co-authorship Analysis

The VOSViewer software facilitates the construction of a network, density, and overlay visualization map of authors predicated on the similarity of their publications by utilizing the 'co-authorship' options. The magnitude of the sphere within the network visualization map indicates the number of publications attributed to the corresponding author. This implies that an increased sphere size correlates with a greater number of publications associated with that author. Such a representation enhances the comprehension of intricate details, including the interconnections among authors and the overall strength of these links. Comparably, the intensity of the color representing an author in the dense visualization map signifies a higher volume of publications than other authors. So, the analysis of co-authorship

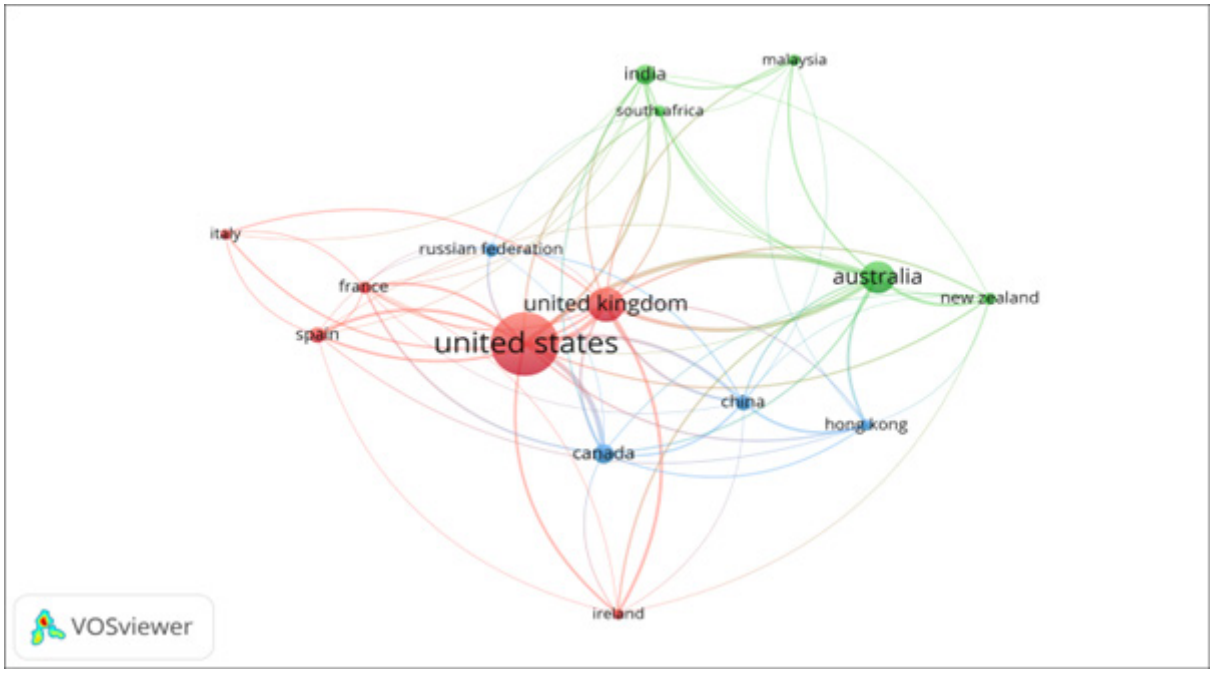

Figure 5: Collaboration Networks of top 15 Productive countries. Source: VOSViewer Software output of network visualization map of top 15 productive Countries.

Figure 6: A Map of Top 15 Productive Countries.

related to IP research provides a total of 11503 authors by running the co-authorship with the unit of analysis (author) option of the VOSViewer software. Only 38 authors out of 11503 connected for collaborative study in IP. Their collaboration Network Visualization Map in Figure 7 shows the most extensive set of connected authors. These 38 connected authors created 3 clusters and 337 links. The total link strength of mostly connected authors in IP is 338.

Top 15 Productive Authors

A total of 15 highly productive authors were identified from the dataset, which was generated by establishing a minimum criterion of 4 publications and a threshold of at least 10 citations within the co-authorship option to analyze the foremost productive authors in the domain of IP. These top 15 authors created 10 distinct clusters and established 8 interconnections (links). The aggregate strength of these connections is 26. The 4 authors (Kearney, Matthew; Schuck, Sandy; Burden, Kevin; and Hall, Tony) created

the cluster first, denoted by red color; Bakken, Jeffrey, and Uskov, Vladimir created the cluster second, which is denoted by blue color, and Deliyannis, Ioannis and Kaimara, Polyxeni created cluster third, denoted by green color (see Figure 7). The other top authors did not collaborate. The specifics regarding the top 15 authors selected from a total of 11,503 authors are delineated in Table 2.

It is clear from the perusal of Table 2, that the most productive author is Bakken, Jeffrey. Bakken has published a total of 7 documents in IP and received a total of 171 (approximately 24.43 citations per document) citations. Bakken created one academic collaboration link; his total link strength is 6. The second most productive author is Uskov Vladimir, who published 7 documents and received 148 citations (Nearly 21 citations/document). Uskov also created 1 link, and his total link strength is 6. Kearney, Matthew published 6 documents, received 207 citations (34.50 citations/document), and created 3 links. With a total link strength of 10, Matthew secured third position in the top 15 productive authors list in the IP field. Similarly, the number of publications, total citations, citations per document, collaboration links, and total link strength of other authors out of the top 15 authors can be seen in Table 2.

Top 15 Productive Institutions

A total of 4692 publications were published by 7889 institutions globally. For the analysis of the top 15 research-producing Institutions in the field of IP, the researcher set the criteria of at least 5 publications and at least 15 citations per Institution; after that, the top 15 productive Institutions in IP were found. Some of these top 15 institutions need to be connected. Only 8 institutions out of the top 15 collaborate. These connected institutions created 2 clusters and 18 links. Their total link strength is 19. The top 15 IP-related research-producing institutions out of 7889, with the levels of total published documents, total citations, citations per document, collaboration links, and total link strength, are presented in Table 3.

Top 15 Productive Sources/Journals

A total of 2570 sources were published, and 4692 documents were related to IP. Only 38 sources out of 2570 are connected. For the analysis of the top 15 sources, the researcher set the criteria of at least 15 publications and at least 22 citations; after that, the top 15 sources were found. These top 15 sources created 14 clusters and only one link. Annual Conference and Exposition Conference Proceedings is the most productive source, with 129 (2.75%) publications and 421 citations. Proceedings- Frontiers in Education Conference has published 69 (1.47%) documents and cited 348 times. Similarly, the details of the other top sources can be seen in Table 4. The top 15 sources are presented with the levels- number and percentage of documents, citations, and average citation per document in Table 4.

Top 15 Cited documents

The most frequently cited documents were analyzed using the VOSViewer software, explicitly employing the citation analysis functions with the document as the unit of analysis. In this methodology, the researchers established a criterion of a

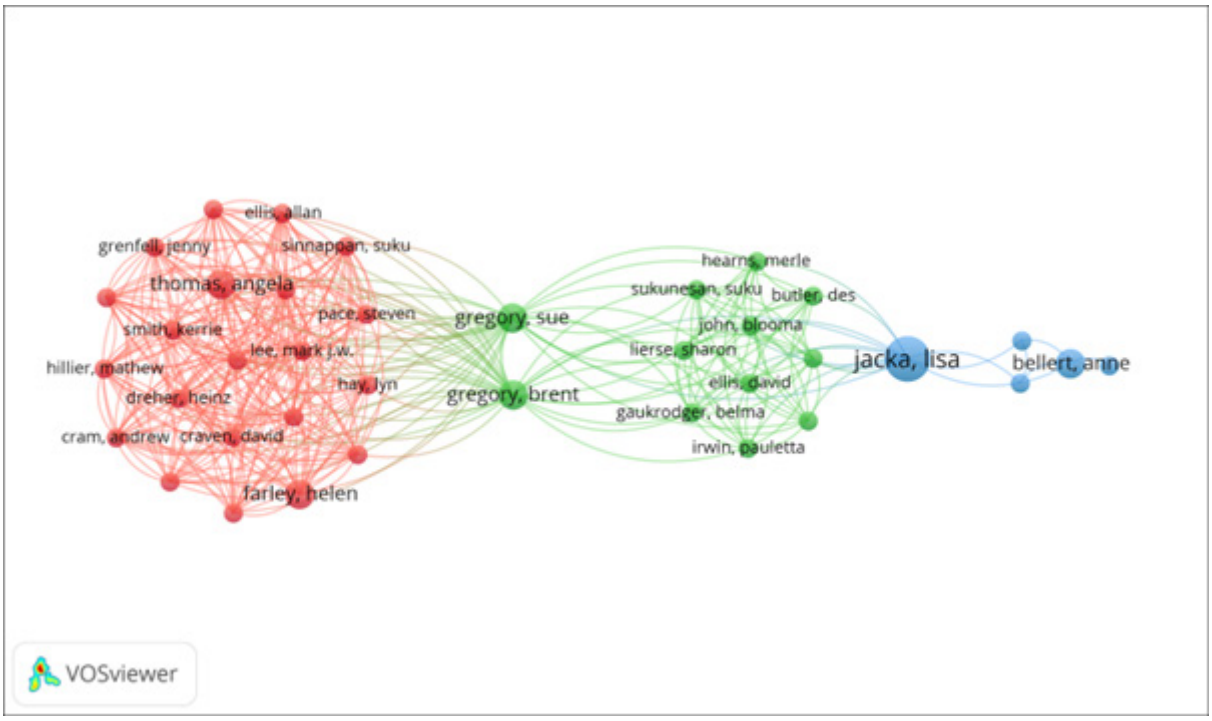

Figure 7: Collaboration Networks of authors. Source: VOSViewer Software output of Total Authors' collaboration network visualization map.

Table 2: Top 15 Productive authors.

Sl. No.	Authors	No. of Documents	No. of Citations	Citations/document	No. of Links	Total link strength
1	Bakken, Jeffrey p.	7	171	24.43	1	6
2	Uskov Vladimir L.	7	148	21.14	1	6
3	Kearney, Matthew	6	207	34.50	3	10
4	Lewin, Cathy	5	78	15.60	0	0
5	Schuck, sandy	5	131	26.20	3	8
6	Tsai, chia-wen	5	98	19.60	0	0
7	Burden, Kevin	4	165	41.25	3	9
8	Deliyannis, ioannis	4	125	31.25	1	4
9	Hall, Tony	4	156	39.00	3	5
10	Kaimara, polyxeni	4	125	31.25	1	4
11	Law, Nancy	4	87	21.75	0	0
12	Lotherington, heather	4	155	38.75	0	0
13	Mcloughlin, Catherine	4	672	168.00	0	0
14	Sinclair, jane	4	73	18.25	0	0
15	Wu, wen-chi vivian	4	208	52.00	0	0

Table 3: Top 15 Productive Institutions.

Sl. No.	Institutions	No. of Documents	No. of citations	Citations/document	No. of Links	Total link strength
1	Arizona State University, United States	13	81	6.23	0	0
2	University of Sydney, Australia	10	117	11.70	5	5
3	Queensland University of Technology, Australia	9	51	5.66	2	2
4	Monash University, Australia	8	130	16.25	5	6
5	University of Michigan, United States	7	61	8.71	0	0
6	Auckland University of Technology, New Zealand	6	31	5.16	0	0
7	University of Canberra, Australia	6	37	6.16	2	2
8	University of Tasmania, Australia	6	73	12.16	5	5
9	Australian Catholic University, Australia	5	79	15.80	5	6
10	Southern Cross University, Australia	5	79	15.80	7	7
11	University of Auckland, New Zealand	5	124	24.80	0	0
12	University of Canberra, Canberra, Australia	5	50	10.00	0	0
13	University of North Dakota, United States	5	71	14.20	0	0
14	University of Southern Queensland, Australia	5	74	14.80	5	5
15	University of Wollongong, Australia	5	183	36.60	0	0

minimum of 172 citations for each document, following which the 15 most cited documents were identified. The particulars of these top 15 cited documents are elucidated in Table 5.

Co-Occurrences Analysis of Keywords

The co-occurrence of keywords significantly indicates prevailing research themes within academic disciplines, offering supplementary assistance to scholarly investigations (Li *et al.*, 2016). A network illustrating the co-occurrence of keywords pertinent to IP was constructed utilizing VOSviewer software. This software facilitates data mining, mapping, and categorizing selected articles. The dimensions of the circles are directly proportional to the frequency of keywords appearing in the titles and abstracts of the documents. Consequently, the magnitude of the item label and the circle is contingent upon the item's weight. An increased weight corresponds to the item's larger label and circle (Xie *et al.*, 2020). The spatial relationship between two nodes signifies the intensity of their interconnection. Generally, reduced distances denote more robust relationships. The connecting line between two keywords indicates their simultaneous occurrence within the same context (Liao *et al.*, 2018). The intensity of the connection between two nodes indicates the frequency of their co-occurrence. This metric can be a quantitative parameter to illustrate the association between the two nodes (Pinto *et al.*, 2014). Figure 8 presents a graphical representation of the authors' most frequently utilized keywords in IP-related publications on Scopus. Throughout the corpus of academic literature concerning innovative pedagogical methodologies, the 'Co-occurrences with All keywords' feature was implemented using VOSViewer software to examine the keywords identified in scholarly articles about various dimensions of IP. A total of 15051 keywords were used in 4692 documents. 1085 keywords, out of a total of 15051, are found with at least 5 occurrences. A density visualization map, which shows the density of their occurrences of all keywords used in innovative pedagogical publications, can be seen in Figure 9.

The most popular keywords in IP

From observing the keyword density in Figure 8, it is clear that IP is closely related to various disciplines of scientific knowledge at the global level. Most occurrence keywords were analyzed with the help of VOSViewer software by increasing the order of their occurrence criteria; following this analytical process, the top 15 keywords exhibiting the highest frequency were identified, predicated on a minimum threshold of 173 occurrences. The top

Table 4: Top 15 Productive Sources.

Sl. No.	Sources	No. of Documents	Documents (in %)	No. of Citations	Citations/document
1	Annual Conference and Exposition, Conference Proc.	129	2.75	421	3.26
2	Proceedings- Frontiers in Education Conference	69	1.47	348	5.04
3	ACM International Conference proceeding series	30	0.64	74	2.47
4	Education Sciences	30	0.64	254	8.47
5	Lecture Notes in Computer Science	27	0.58	140	5.19
6	Sustainability (Switzerland)	26	0.55	500	19.23
7	Smart Innovation, Systems and Technologies"	25	0.53	162	6.48
8	Journal of Engineering Education Transformations	20	0.43	41	2.05
9	Communications In Computer and Information Science	19	0.40	29	1.53
10	Education and Information Technologies	19	0.40	399	21
11	British Journal of Educational Technology	18	0.38	674	37.44
12	Nursing Education Perspectives	17	0.36	250	14.71
13	Frontiers in Education	16	0.34	105	6.56
14	Nurse Education Today	16	0.34	290	18.13
15	Journal of Computer-Assisted Learning	15	0.34	518	34.53

Table 5: Top 15 Cited Documents.

Ranks	Authors and DOI	Document Title	Citations
	(McLoughlin & Lee, 2010) DOI: 10.14742/ajet.1100	Personalized and Self-Regulated Learning in the Web 2.0 Era: International Exemplars of IP Using Social Software	570
	(Vlachopoulos & Makri, 2017) DOI: 10.1186/s41239-017-0062-1	The Effect of Games and Simulations on Higher Education: A Systematic Literature Review	413
	(Case & Light, 2011) DOI: 10.1002/j.2168-9830.2011.tb00008.x	Emerging Methodologies in Engineering Education Research	381
	(Lévesque, 2009)	Thinking Historically: Educating Students for the Twenty-First Century	345
	(Martin, 2009) DOI: 10.1016/j.linged.2009.01.003	Genre and Language Learning: A Social Semiotic Perspective	294
	(Krajcik *et al.*, 2008) DOI: 10.1002/sce.20240	Learning-Goals-Driven Design Model: Developing Curriculum Materials That Align with National Standards and Incorporate Project-Based Pedagogy	290
	(Boling *et al.*, 2012) DOI: 10.1016/j.iheduc.2011.11.006	Cutting the Distance in Distance Education: Perspectives on What Promotes Positive, Online Learning Experiences	275
	(Taguchi, 2009) DOI: 10.4324/9780203872956	Going Beyond the Theory/Practice Divide in Early Childhood Education: Introducing an Intra-Active Pedagogy	267
	(Soll, 2009).	The Information Master: Jean-Baptiste Colbert's Secret State Intelligence System	214
	(Diekelmann, 2001) DOI: 10.1097/00012272-200103000-00006	Narrative Pedagogy: Heideggerian Hermeneutical Analyses of the Lived Experiences of Students, Teachers, And Clinicians	200
	(Winstone and Carless, 2020). DOI: 10.4324/9781351115940	Designing Effective Feedback Processes in Higher Education: A Learning-Focused Approach	188
	(Shapiro *et al.*, 2009) DOI:10.1097/ACM.0b013e3181938bca	Medical Humanities and Their Discontents: Definitions, Critiques, and Implications	181
	(Kumar & Hsiao, 2007) DOI: 10.1061/(ASCE)1532-6748(2007)7:1(18)	Engineers Learn "Soft Skills the Hard Way": Planting a Seed of Leadership in Engineering Classes	179
	(Lyle, 2008) DOI: 10.1080/09500780802152499	Dialogic Teaching: Discussing Theoretical Contexts and Reviewing Evidence from Classroom Practice	178
	(Jemal, 2017) DOI: 10.1007/s11256-017-0411-3	Critical Consciousness: A Critique and Critical Analysis of the Literature	175

15 keywords, with their Total occurrences, links, and their total link strength, are presented in Table 6.

From the perusal of Table 6 above, it is clear that 'Teaching' is the most popular keyword with maximum (699) occurrences. This keyword has been used in 14 collaborative studies, and its total link strength is 1909. The second and third most popular keywords are students (643 occurrences) and pedagogy (629 occurrences). Similarly, Total Occurrences, collaboration Links, and total link strength of other top keywords can be seen in Table 6.

These top 15 keywords are well-connected. They create two clusters and 100 collaboration links; their total link strength is 6502. The network visualization map of collaboration links of these keywords is presented in Figure 8. The first cluster is shown in red, and the second in green colors. The keywords Teaching, students, pedagogy, Higher education, curricula, engineering education, innovation, e-learning, and learning systems belong to the cluster first, and curriculum, education, learning, human, and article belong to the last (second) cluster, respectively. The collaboration network visualization map of the most famous and

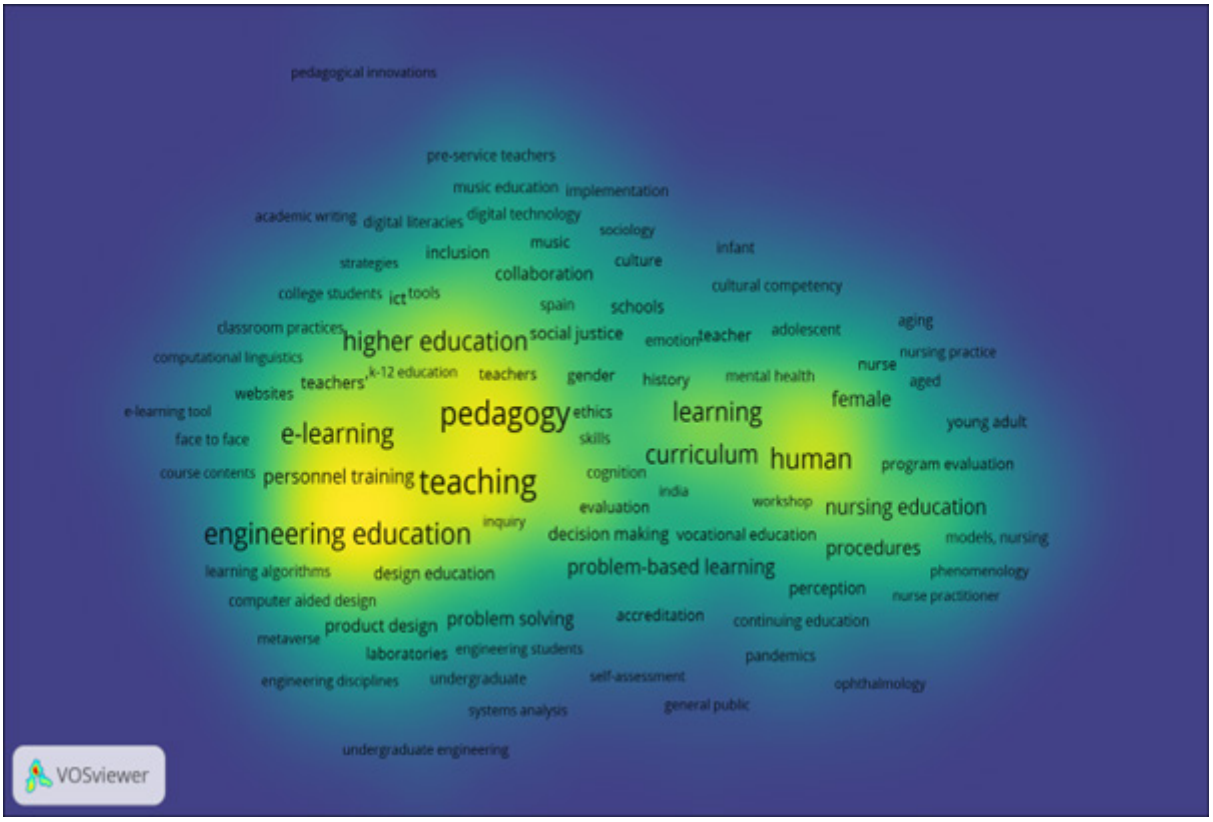

Figure 8: Keyword density visualization map of IP. Source: VOSViewer Software output of Density visualization map of most occurrence keywords.

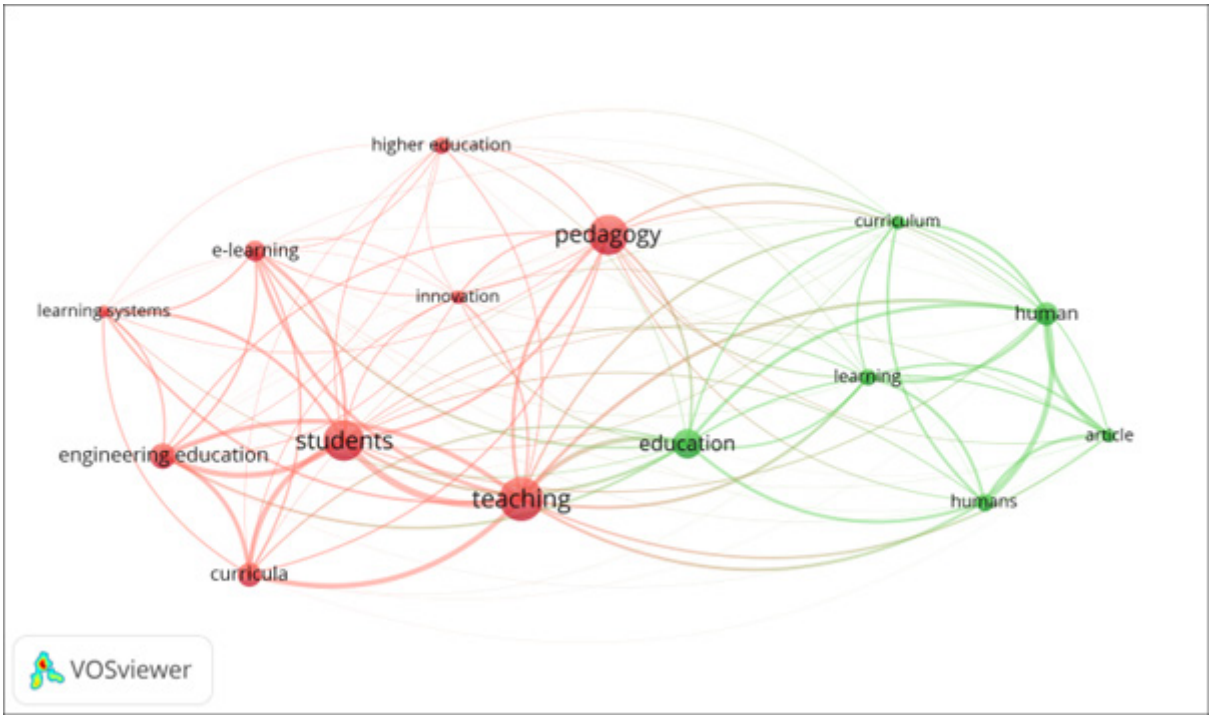

Figure 9: Network visualization map of top 15 keywords in IP. Source: VOSViewer Software output of network visualization map of top 15 keywords.

Table 6: Top 15 keywords used in IP publications.

Sl. No.	Keyword	Total Occurrences	No. of Links	Total link strength
1	Teaching	699	14	1909
2	Students	643	14	1499
3	Pedagogy	629	14	800
4	Education	451	14	1175
5	Engineering Education	386	13	955
6	Curricula	363	14	940
7	Human	342	13	1079
8	E-Learning	301	14	676
9	Humans	252	11	888
10	Higher Education	243	14	272
11	Learning	237	14	739
12	Curriculum	206	14	608
13	Article	195	13	646
14	Innovation	193	14	353
15	Learning Systems	173	11	465

trending top 15 keywords in IP-related publications can be seen in Figure 9.

CONCLUSION

This study analyses and highlights over time publications, citation trends, top productive authors, countries, sources, most popular keywords, and the geographical distribution of top research-producing countries on the IP from 2000 to 2024. The dominance of the keyword "Teaching" in the literature is evidenced by its occurrence in 699 publications. The highest number of publications (N=549) was found in 2023, and the maximum number of citations (*n*=3622) was recorded in 2017. The maximum number of publications (2567) was found in the article type of document. The study also reveals the significant contributions of researchers from the nations with the highest research output, the United States, the United Kingdom, Australia, and India, in the co-authorship analysis. The top 3 productive authors were Bakken, Jeffrey; Uskov Vladimir; and Kearney, Matthew; the top 3 productive institutions were Arizona State University, United States; University of Sydney, Australia; and Queensland University of Technology, Australia; and the top 3 productive sources were Annual Conference and Exposition, Conference Proceedings, Proceedings-Frontiers in Education Conference, and ACM International Conference proceeding series. Future research should consider using multiple databases and expanding search terms to capture a more comprehensive and diverse range of scholarly works on IP. Additionally, qualitative studies explore the experiences and perspectives of educators, students, and other stakeholders involved in innovative practices.

ACKNOWLEDGEMENT

I would like to express my sincere gratitude to my co-authors for their valuable support and also to the anonymous reviewers for their critical evaluation. This work is done with the help of Mr. Shashwat Mishra. Mr. Mishra is pursuing PhD in the Department of Management Studies at Maulana Azad National Institute of Technology (MANIT), Bhopal, India. He extracted the file that was used in this study.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

REFERENCES

Acedo, F., Barroso, C., Rocha, C., & Galán, J. (2006). Co-Authorship in Management and Organizational Studies: An Empirical and Network Analysis. Journal of Management Studies, 43. DOI: 10.1111/j.1467-6486.2006.00625.x

Barrows, H. S. (1996). Problem-based learning in medicine and beyond: A brief overview. New Directions for Teaching and Learning, 68, 3–12. DOI: 10.1002/tl.37219966804

Bell, S. (2010). Project-based learning for the 21st century: Skills for the future. The Clearing House: A Journal of Educational Strategies, Issues and Ideas, 83(2), 39–43. DOI: 10.1080/00098650903505415

Benckendorff, P., & Zehrer, A. (2013). A Network Analysis of Tourism Research. Annals of Tourism Research, 43, 121–149. DOI: 10.1016/j.annals.2013.04.005

Bergmann, J., & Sams, A. (2012). Flip your classroom: Reach every student in every class every day. International Society for Technology in Education.

Biggs, J. (1999). What the student does: Teaching for enhanced learning. Higher Education Research & Development, 18(1), 57–75. DOI: 10.1080/0729436990180105

Black, P., & Wiliam, D. (1998). Assessment and classroom learning. Assessment in Education: Principles, Policy & Practice, 5(1), 7–74. DOI: 10.1080/0969595980050102

Boling, E. C., Hough, M., Krinsky, H., Saleem, H., & Stevens, M. (2012). Cutting the distance in distance education: Perspectives on what promotes positive, online learning experiences. The Internet and Higher Education, 15(2), 118–126. DOI: 10.1016/j.iheduc.2011.11.006

Broadus, R. N. (1987). Toward a definition of "bibliometrics". Scientometrics, 12(5), 373–379. DOI: 10.1007/BF02016680

Case, J. M., & Light, G. (2011). Emerging Research Methodologies in Engineering Education Research. Journal of Engineering Education, 100(1), 186–210. DOI: 10.1002/j.2168-9830.2011.tb00008.x

Cobo, M., López-Herrera, A. G., Herrera-Viedma, E., & Herrera, F. (2011). Science Mapping Software Tools: Review, Analysis, and Cooperative Study Among Tools. Journal of the American Society for Information Science and Technology, 62, 1382–1402. DOI: 10.1002/asi.21525

Winstone, N., & Carless, D. (2019). Designing effective feedback processes in higher education: A learning-focused approach. Routledge.

Diekelmann, N. (2001). Narrative Pedagogy: Heideggerian hermeneutical analyses of lived experiences of students, teachers, and clinicians. Advances in Nursing Science, 23(3), 53–71. DOI: 10.1097/00012272-200103000-00006

Ertmer, P. A., & Ottenbreit-Leftwich, A. T. (2010). Teacher technology change: How knowledge, confidence, beliefs, and culture intersect. Journal of Research on Technology in Education, 42(3), 255–284. DOI: 10.1080/15391523.2010.10782551

Fullan, M. (2007). The new meaning of educational change (4th ed.). Teachers College Press.

Garrison, D. R. (1997). Self-directed learning: Toward a comprehensive model. Adult Education Quarterly, 48(1), 18–33. DOI: 10.1177/074171369704800103

Garrison, D. R., & Kanuka, H. (2004). Blended learning: Uncovering its transformative potential in higher education. The Internet and Higher Education, 7(2), 95–105. DOI: 10.1016/j.iheduc.2004.02.001

Gee, J. P. (2003). What video games have to teach us about learning and literacy. ACM Computers in Entertainment, 1(1), 20–20. DOI: 10.1145/950566.950595

Glänzel, W. (2003). Bibliometrics as a Research Field: A course on theory and application of bibliometric indicators. https://www.semanticscholar.org/paper/bibliometrics-as-a-research-field-a-course-on-and-Gl%C3%A4nzel/4c0a6c1c7642c1eec9cbbc8423b3020b155a3c16

Guechairi, S. (2024). Mapping Altmetrics: A Bibliometric Analysis Using Scopus (2012-2024). Science and Knowledge Horizons Journal, 4, 172–192.

Gupta, B. M., Kumbar, B., & Gupta, R. (2013). Social Science Research in India: A Scientometric Analysis of Publications, 2001-10. DESIDOC Journal of Library & Information Technology, 33, 442–450. DOI: 10.14429/djlit.33.5475

Haboubi, C., El Hammoudani, Y., Jaradat, N., Jodeh, S., Haboubi, K., Haboubi, E., Dimane, & Dimane, F. (2024). A Bibliometric Analysis of Cannabis-Related Research. Palestinian Medical and Pharmaceutical Journal, 9, 125–136. DOI: 10.59049/2790-0231.1132

Hall, C. (2011). Publish and perish? Bibliometric analysis, journal ranking, and the assessment of research quality in tourism. Tourism Management, 32, 16–27, DOI: 10.1016/j.tourman.2010.07.001

Heick, T. (2020). What is learner-centred? Teach Thought. https://www.teachthought.com/pedagogy/learner-centered/

Hmelo-Silver C. E. (2004). Problem-based learning: What and how do students learn? Educational Psychology Review, 16(3), 235–266. DOI: 10.1023/B:EDPR.0000034022.16470.f3

Hodges, C., Moore, S., Lockee, B., Trust, T., & Bond, A. (2020). The difference between emergency remote teaching and online learning. Educause Review, 27, 1–12. https://er.educause.edu/articles/2020/3/the-difference-between-emergency-remote-teaching-and-online-learning

Hug, T. (2005). Microlearning: A new pedagogical challenge (introductory note). Microlearning Conference, 1–6. DOI: 10.4324/9781003116426

Jemal, A. (2017). Critical Consciousness: A Critique and Critical Analysis of the Literature. The Urban Review, 49(4), 602–626. DOI: 10.1007/s11256-017-0411-3

Jia, H., Li, H., Rong, Y., Jiang, K., Liang, X., & Li, G. (2024). Knowledge Mapping of Macrophages in Osteoporosis: A Bibliometric Analysis (1999–2023). Orthopedic Surgery, n/a-n/a. DOI: 10.1111/os.14159

Kolb, D. A. (1984). Experiential learning: Experience as the source of learning and development. Prentice-Hall.

Koseoglu, M. A., Rahimi, R., Okumus, F., & Liu, J. (2016). Bibliometric studies in tourism. Annals of Tourism Research, 61, 180–198. DOI: 10.1016/j.annals.2016.10.006

Krajcik, J., McNeill, K. L., & Reiser, B. J. (2008). Learning-goals-driven design model: Developing curriculum materials that align with national standards and incorporate project-based pedagogy. Science Education, 92(1), 1–32. DOI: 10.1002/sce.20240

Kumar, S., & Hsiao, J. K. (2007). Engineers Learn "Soft Skills the Hard Way": Planting a Seed of Leadership in Engineering Classes. Leadership and Management in Engineering, 7(1), 18–23. DOI: 10.1061/(ASCE)1532-6748(2007)7: 1(18)

Laurillard, D. (2012). Teaching as a design science: Building pedagogical patterns for learning and technology. Routledge. DOI: 10.4324/9780203125083

Li, H., An, H., Wang, Y., Huang, J., & Gao, X. (2016). Evolutionary features of academic articles co-keyword network and keywords co-occurrence network: Based on two-mode affiliation network. Physica A: Statistical Mechanics and Its Applications, 450, 657–669. DOI: 10.1016/j.physa.2016.01.017

Liao, H., Tang, M., Luo, L., Li, C., Chiclana, F., & Zeng, X.-J. (2018). A Bibliometric Analysis and Visualization of Medical Big Data Research. Sustainability, 10(1), Article 1. DOI: 10.3390/su10010166

Lyle, S. (2008). Dialogic Teaching: Discussing Theoretical Contexts and Reviewing Evidence from Classroom Practice. Language and Education, 22(3), 222–240. DOI: 10.1080/09500780802152499

Martin, J. R. (2009). Genre and language learning: A social semiotic perspective. Linguistics and Education, 20(1), 10–21. DOI: 10.1016/j.linged.2009.01.003

McBurney, M. K., & Novak, P. L. (2002). What is bibliometrics, and why should you care? Proceedings. IEEE International Professional Communication Conference, 108–114. DOI: 10.1109/IPCC.2002.1049094

McLoughlin, C., & Lee, M. J. W. (2010). Personalized and self-regulated learning in the Web 2.0 era: International exemplars of IP using social software. Australasian Journal of Educational Technology, 26(1), Article 1. DOI: 10.14742/ajet.1100

Murnaka, N. P., Suwarno, Rusdarti, Rustono, Sudana, I. M., & Raharjo, T. J. (2021). Educational Technology Research Trends: A Bibliometrics Analysis and Visualization. Turkish Journal of Computer and Mathematics Education, 12(6), 2695–2701.

Nerur, S., Rasheed, A. A., & Pandey, A. (2016). Citation Footprints on the sands of time: An analysis of idea migrations in strategic management. Strategic Management Journal, 37(6), 1065–1084. DOI: 10.1002/smj.2377

Palamar, J. J., Ciccarone, D., Rutherford, C., Keyes, K. M., Carr, T. H., & Cottler, L. B. (2022). Trends in seizures of powders and pills containing illicit fentanyl in the United States, 2018 through 2021. Drug and Alcohol Dependence, 234, 109398. DOI: 10.1016/j.drugalcdep.2022.109398

Pal, R. K., & Pal, S. (2025). Scientific Mapping of Research Evolution on Artificial Intelligence in Education: A Scientometric Analysis. Indian Journal of Social Sciences Research and Analytics, 01(1), 12-23. DOI: 10.5281/ZENODO.15613568

Pal, S., & Kumar, V. (2025). Scientific Mapping of Research Evolution on Buddhist Philosophy: A Bibliometric Analysis. Journal of Data Science Informetrics and Citation Studies, 4(1), 9–19. DOI: 10.5530/jcitation.20250144.

Pal, S., Kumar, V., & Kumar, V. (2025). Scientific Mapping of Global Research Trends on Jain Philosophy: A Bibliometric Analysis. Journal of Data Science, Informetrics, and Citation Studies, 4(1), 78–86. DOI: 10.5530/jcitation.20250171

Pellegrino, J. W. (2014). Assessment as a positive influence on 21st-century teaching and learning: A systems approach to progress. Education and Technology Debate. DOI: 10.1007/978-3-030-26596-4

Pinto, M., Pulgarín, A., & Escalona, M. I. (2014). Viewing information literacy concepts: A comparison of two branches of knowledge. Scientometrics, 98(3), 2311–2329. DOI: 10.1007/s11192-013-1166-6

Prensky, M. (2001). Digital natives, digital immigrants. On the Horizon, 9(5), 1–6. DOI: 10.1108/10748120110424816

Rashid, S., Rehman, S. U., Ashiq, M., & Khattak, A. (2021). A Scientometric Analysis of Forty-three Years of Research in Social Support in Education (1977–2020). Education Sciences, 11(4), Article 4. DOI: 10.3390/educsci11040149

Ronda-Pupo, G., & Guerras-Martín, L. (2012). Dynamics of the evolution of the strategy concept 1962–2008: A co-word analysis. Strategic Management Journal, 33, 162–188. DOI: 10.1002/smj.948

Rupp, M., Schneckenburger, M., Merkel, M., Börret, R., & Harrison, D. K. (2021). Industry 4.0: A Technologically Oriented Definition Based on Bibliometric Analysis and Literature Review. Journal of Open Innovation: Technology, Market, and Complexity, 7(1), 68. DOI: 10.3390/joitmc7010068

Selwyn, N. (2011). Education and technology: Key issues and debates. Bloomsbury Publishing.

Shapiro, J., Coulehan, J., Wear, D., & Montello, M. (2009). Medical humanities and their discontents: Definitions, critiques, and implications. Academic Medicine: Journal of the Association of American Medical Colleges, 84(2), 192–198. DOI: 10.1097/ACM.0b013e3181938bca

Siemens, G. (2013). Massive open online courses: Innovation in education? Open Learning: The Journal of Open, Distance and e-Learning, 28(3), 215–226. DOI: 10.1080/02680513.2013.796481

Taguchi, H. L. (2009). Going Beyond the Theory/Practice Divide in Early Childhood Education: Introducing an Intra-Active Pedagogy. Routledge. DOI: 10.4324/9780203872956

Tan, L., & Ding, J. (2015). The frontier and evolution of the strategic management theory. Nankai Business Review International, 6(1), 20–41. DOI: 10.1108/NBRI-09-2014-0036

The information master: Jean-Baptiste Colbert's secret state intelligence system—Google Search. (n.d.).

Tomlinson, C. A. (2001). How to differentiate instruction in mixed-ability classrooms (2nd ed.). ASCD.

Trilling, B., & Fadel, C. (2009). 21st-century skills: Learning for life in our times. John Wiley & Sons.

University of Toronto Press—Thinking Historically. (n.d.). University of Toronto Press. https://utorontopress.com/9781442610996/thinking-historically

Vlachopoulos, D., & Makri, A. (2017). The effect of games and simulations on higher education: A systematic literature review. International Journal of Educational Technology in Higher Education, 14(1), 22. DOI: 10.1186/s41239-017-0062-1

Vygotsky, L. S. (1978). Mind in society: The development of higher psychological processes. Harvard University Press.

Wadaugsorn, K., Panrong, T., Wongphan, P., & Harnkarnsujarit, N. (2022). Plasticized hydroxypropyl cassava starch blended PBAT for improved clarity blown films: Morphology and properties. Industrial Crops and Products, 176, 114311. DOI: 10.1016/j.indcrop.2021.114311

Wang, X., Xu, Z., Su, S.-F., & Zhou, W. (2021). A comprehensive bibliometric analysis of uncertain group decision-making from 1980 to 2019. Information Sciences, 547, 328–353. DOI: 10.1016/j.ins.2020.08.036

Xie, L., Chen, Z., Wang, H., Zheng, C., & Jiang, J. (2020). Bibliometric and Visualized Analysis of Scientific Publications on Atlantoaxial Spine Surgery Based on Web of Science and VOSviewer. World Neurosurgery, 137, 435-442.e4. DOI: 10.1016/j.wneu.2020.01.171

Cite this article: Pal S, Kumar V, Gangwar S. Scientific Mapping of Research Evolution on Innovative Pedagogy: A Bibliometric Analysis. Journal of Data Science, Informetrics, and Citation Studies. 2025;4(2):159-73.