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RESEARCH TRENDS AND NETWORK APPROACH TO THE INTERSECTION BETWEEN TEACHER EDUCATION AND LEARNING OUTCOMES

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ABSTRACT
This paper provides a bibliometric study of the scientific output at the junction of teacher education and learning outcomes, thereby clarifying publishing trends, author productivity, notable sources, international cooperation, and citation effect. Examining 562 journals, books, and conference proceedings, the 943 publications looked at span 2019 and 2024. The results reveal a steady growth in academic interest based on an annual publication increase of 14.01% and an average document age of 3.09 years, therefore underscoring the field's growing and dynamic nature. Emphasizing the need of peer-reviewed research in spreading results, journal articles account for the bulk of the publications—703; conference papers—98; book chapters—89; Leading in scientific contributions (487 publications), the United States follows Indonesia (225) and China (153), therefore attesting to the global engagement in this field of research. Although it has increased, international co-authorship remains somewhat low (14.95%), suggesting room for additional collaboration. Citation analysis shows significant impact; the most commonly cited paper has 598 references. Author output, however, follows Lotka's Law and has a small core group of quite active researchers. This paper underlines the need of additional multidisciplinary research and policy-driven initiatives to improve the link between teacher preparation and student learning performance globally.

Keywords: Learning outcomes, Teacher education, Teacher training, Education performance Bibliometrics

1. Introduction

Education is therefore very important for society growth as it helps people to enhance their cognitive talents, professional competences, and social skills. Any educational system's effectiveness depends mostly on the quality of teaching given by teachers, therefore greatly affects student learning and academic performance [1]. Two connected factors often define the success of an educational system: student performance and teacher training. Teacher training is the preparation, teaching, and certification of teachers thereby arming them with the pedagogical and subject-specific knowledge required for delivering high-quality education. Conversely, learning outcomes are the measurable knowledge, skills, and abilities that students acquire from their educational experiences [2]. The two concepts are intrinsically linked, since the characteristics and training of teachers directly influence student performance and academic success. Formulating effective policies and educational initiatives that enhance teaching methodologies and student outcomes relies on an understanding of the relationship between teacher training and learning results.

Pre-service education, in-service professional development, and the attainment of relevant credentials collectively encompass the multiple facets of teacher preparation. Pre-service teacher education programs equip aspiring educators with essential knowledge in pedagogy, curriculum development, assessment methodologies, and classroom management [3]. Field

activities, including internships and student teaching, enable prospective educators to apply theoretical knowledge in real-world settings and are integral to these programs. Studies of nations with stringent teacher preparation programs, including Finland and Singapore, reveal consistently high performance on international student assessments, underscoring the critical importance of thorough training in promoting effective teaching practices [4].

Informing educators about contemporary pedagogical methods and technological advancements in education necessitates in-service teacher training, encompassing seminars, mentoring programs, and ongoing professional development. Teachers are required to engage in ongoing professional development to adapt to evolving instructional methodologies, digital technologies, and student-centered pedagogies that address emerging learning opportunities. Research indicates that professional development courses focusing on active learning methodologies, diverse teaching strategies, and formative assessment techniques enhance classroom engagement and student performance [5]. Additionally, significant factors affecting instructional effectiveness and student success include instructor attributes such as certification standards, specialized training, and subject-matter expertise [6].

Learning outcomes, as the primary metric of educational success, encompass a wide range of measures such as academic performance, student achievement, and instructional quality. Usually employed as a gauge of long-term academic performance and workforce preparedness, educational attainment is the greatest degree of education attained by an individual. Prioritizing teacher training and instructional quality helps nations show better degrees of educational attainment, so proving the great impact of teacher effectiveness on student paths [7]. Likewise, student performance—typically obtained from coursework assessments, standardized exams, and competency-based evaluations—is a key indicator of how well instructional techniques impact learning outcomes. The information currently available shows that competent and well-trained teachers usually show better test results, show better conceptual knowledge, and show better critical thinking abilities [8].

Close examination of the confluence of teacher preparation and learning outcomes has been done in educational research; several studies show how much teacher effectiveness influences student achievement. Although personal in-depth research on these subjects is still very important, a deeper awareness of the interaction between these two components inside the bigger educational environment is still very essential. Simultaneously analyzing the research output on teacher preparation and learning outcomes is essential due to the increasing global emphasis on improving educational quality and reducing learning disparities.

A bibliometric analysis of the literature on teacher preparation and learning outcomes provides a comprehensive examination of existing knowledge, research trends, and potential topics for further investigation [9]. Analyzing the academic discourse around these two elements enables scholars and policymakers to identify the most critical works, prominent thematic areas, and advancements in this study domain. This study seeks to enhance the field by systematically analyzing the relationship between teacher training and learning outcomes, as evidenced by the scientific literature on these topics in educational research. This bibliometric study's findings will guide further research, inform evidence-based policy, and facilitate the development of strategies aimed at enhancing teacher preparation and student performance globally.

2. Review of literature

2.1 Teacher Training

A major factor determining educational quality is the training of teachers as it significantly affects student learning and academic performance. All meant to improve teachers' pedagogical skills and competencies, the concept spans various strategies: teacher preparation, teacher education, and teacher certification [10]. Comprehensive teacher preparation programs, according to studies, give instructors necessary theoretical knowledge, practical teaching strategies, and classroom management approaches [11], therefore raising the quality of education. Advanced training helps teachers to be more adept in handling the needs of educational institutions and fitting to different learning environments.

Officially academic courses designed to prepare people for a profession in teaching define teacher education. Apart from supervised teaching experience, these projects frequently mix courses in pedagogy, educational psychology, and subject-specific training. Studies of organized teacher training initiatives show they improve student involvement and educational quality [12]. Both Finland and Singapore routinely show high student success rates, therefore proving the link between teacher preparation and educational outcomes. Both also show outstanding levels of teacher education.

Teacher preparation—that is, the practical elements required to prepare teachers with necessary skills and competencies before they enter the classroom—is closely associated with teacher education. Good programs designed for teacher preparation need understanding of multiple pedagogogical techniques, mentorship, and practical experience. Research show that practical teaching experiences during teacher preparation help teachers to become more confident and flexible in the classroom [13]. Furthermore studies show that teachers with thorough training are more likely to apply student-centered pedagogies, thereby enhancing student involvement and academic success [14].

A key component of teacher preparation is teacher qualifications, which include certificates, academic credentials, and required professional competencies for teachers over their starting age. Many studies have looked at how teacher qualities affect student learning and shown that well-trained teachers greatly improve academic achievement [15]. Advanced degrees and specialized training in their disciplines help to explain improved student achievement since these teachers show great effectiveness. Moreover, by guiding teachers on new pedagogical approaches and educational technology, continuous professional development and in-service training are crucial for raising teacher efficacy [16].

Studies on teacher preparation show how much effective teaching is on good qualifications, hands-on experience, and methodical instruction. Governments and educational institutions provide great importance to provide outstanding training and continuous professional development for teachers in order to improve student learning results.

2.2 Learning outcomes

Learning outcomes—which demonstrate how much knowledge, skills, and information students acquire up from instructional interventions—provide a major gauge of educational efficacy. Many times, this concept is investigated under different criteria including student performance, success, and educational attainment, which provide significant data on how teaching strategies influence pupils. Studies show that well articulated learning objectives set standards for curriculum development, instructional effectiveness, and policy formulation [17].

Educational attainment is a good predictor of academic success and readiness for career activities; it also shows the height of knowledge acquired by a person. Studies reveal a direct link between instructor quality and student continuing academic achievement [18]. Effective teaching techniques significantly contribute to explain growing graduation rates, increased college enrollment numbers, and greater career opportunities for pupils [19]. Furthermore, differences in educational performance among several socioeconomic levels emphasize the need of equitable access to first-rate resources and education [20].

Directly related to educational achievement, student success is a more general notion embracing academic performance, personal growth, and future job opportunities. Research evidence how much institutional support, interactive strategies, and teacher-student connections help to improve student performance [21]. Available research also indicates that students who get formative feedback, customized instruction, and instructor passion are more likely to achieve academically and remain devoted to their studies [22]. All of which determine student success are critical thinking skills, problem-solving ability, and lifelong learning capabilities, which are developed by effective teaching practices [23].

Usually assessed by coursework assessments, standardized test scores, and competency-based assessments, student performance is a basic component of learning outcomes. Research indicates that student performance is much influenced by teacher preparation; findings demonstrate that well-prepared instructors aid to boost test scores and improve knowledge across many fields [24]. Studies show that by addressing different learning needs, customized training, formative assessment tools, and active learning strategies, one enhances student performance [25]. It is commonly established that incorporating technology into the classroom improves student performance, particularly in environments of digital learning [26].

The set of studies on learning highlights the important relationship among teacher preparation and student performance. Encouragement of good educational outcomes depends on arming teachers with effective teaching tactics, evaluation instruments, and resources. Policymakers and educational institutions should give evidence-based approaches first priority so as to improve teaching quality and support student achievement in many diverse learning environments.

3. Method

The bibliometric study presented throughout this document is based on an empirical model, which was designed with the objective of analyzing both the frequency and the relevance of publications related to the topic presented. The research was carried out through a systematic analysis of literature; Scopus was used as the main database, based on its wide coverage and reliability [27]. The search was carried out during the month of February 2025.

For the study, processing and management of bibliometric data extracted from the database of citations and abstracts of articles used (Scopus), statistical and visualization software was used: RStudio and VOSviewer, which have vast recognition for the development of bibliometric studies due to their analysis capacity in: co-authorship networks, keywords and citations [28]. This research took into consideration the analysis of publication trends, influential authors, geographical distribution of research and main institutions involved. This approach made it possible to evaluate key indicators, such as publication growth rate, diversity of sources, and patterns of international collaboration [29].

On the other hand, Lotka's Law was applied, in order to examine the productivity of the authors, and Bradford's Law, to identify the most relevant journals within this field of study

[30]. Additionally, fundamental metrics were analyzed, such as the number of citations per document, co-citation networks and the most frequent keywords.

Table 1
Keywords standardization.

Variable	Descriptor
Teacher training	"Teacher Training", "Teacher Education", "Teacher Preparation", "Teacher Qualifications"
Learning outcomes	"Learning Outcomes", "Educational Attainment", "Student Success", "Student Performance"

Using the following search equation "(TITLE-ABS-KEY ("teacher training") OR TITLE-ABS-KEY ("teacher education") OR TITLE-ABS-KEY ("teacher preparation") OR TITLE-ABS-KEY ("teacher qualifications") AND TITLE-ABS-KEY ("learning outcomes") OR TITLE-ABS-KEY ("educational attainment") OR TITLE-ABS-KEY ("student success") OR TITLE-ABS-KEY ("student performance") AND PUBYEAR > 2018 AND PUBYEAR < 2025" it was possible to identify a set of documents such that, in their titles, summaries or keywords, they addressed the study topic: "Teacher training and learning outcomes". The analysis covered documents published between 2019 and 2024, thus covering a period of 5 years.

4. Results

Table 2
Main information of the data obtained from Scopus.

MAIN INFORMATION ABOUT DATA	
Timespan	2019:2024
Sources (Journals, Books, etc)	562
Documents	943
Annual Growth Rate %	14,01
Document Average Age	3,09
Average citations per doc	7,521
References	43039
DOCUMENT CONTENTS	
Keywords Plus (ID)	1261
Author's Keywords (DE)	2751
AUTHORS	
Authors	2606
Authors of single-authored docs	157

AUTHORS COLLABORATION	
Single-authored docs	159
Co-Authors per Doc	2,95
International co-authorships %	14,95
DOCUMENT TYPES	
article	703
book	18
book chapter	89
conference paper	98
conference review	7
editorial	2
erratum	2
note	2
review	22

Through Table 2, it is possible to identify global characteristics related to scientific production in the study area of the topic developed here; A total of 943 documents were found, which come from 562 sources such as scientific articles, books, magazines, among other resources. An annual growth rate in scientific production of 14.01% was found; The documents studied are arranged by type of document as follows: scientific articles (703), conference articles (98) and book chapters (89); Likewise, 2606 authors were identified.

For its part, the variable associated with the growth of scientific production can be observed in greater detail in figure 1; 2024 stands out as the year with the greatest scientific production with a total of (235) documents, in contrast, the year with the least contributions was 2020 with a total of (117) documents.

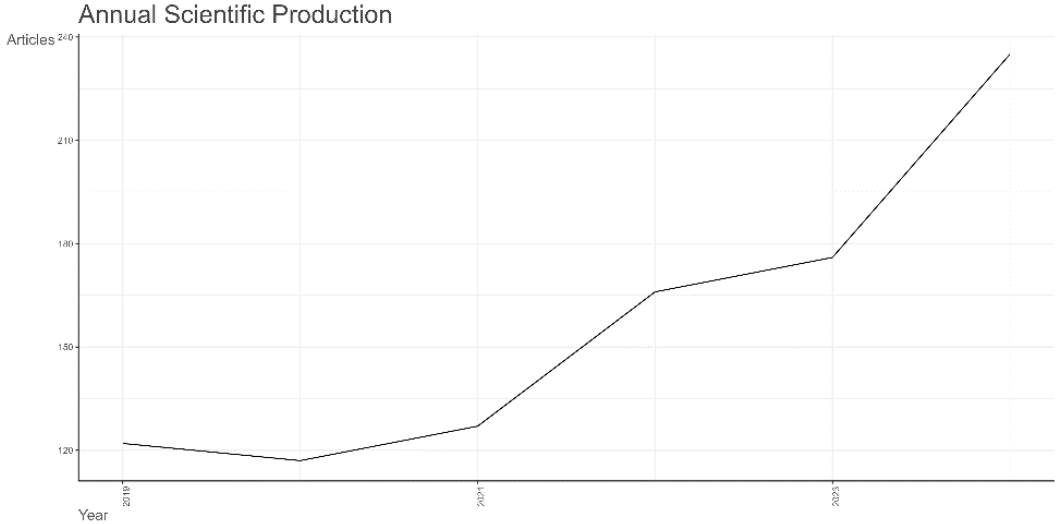

Fig. 1. Annual scientific production.

4.1 Laws of bibliometric productivity

The main objective of Lotka's Law is to allow an analysis based on the distribution of the productivity of the authors, which in turn allows drawing a curve that shows the number of publications per author. This offers a clear vision of the impact that the authors have on the area of knowledge studied. In this regard, Table 3 shows how 94.5% of the authors have made a single publication (associated with the topic of this bibliometric study), followed by 4.6% who have made at least two, and finally less than 1.0% have published three documents or more. These observations can be seen in greater detail in Table 3 and Figure 2.

Table 3

Lotka's Law.

Documents written	N. of Authors	Proportion of Authors
1	2463	0,945
2	119	0,046
3	17	0,007
4	5	0,002
5	1	0
6	1	0

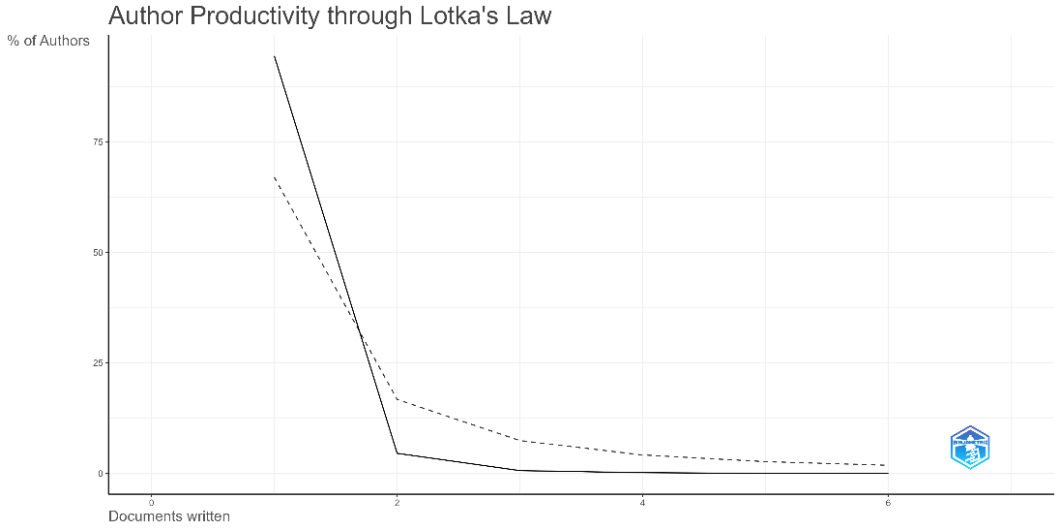

Fig. 2. Lotka's Law.

The sources that were most outstanding throughout the research were determined from the frequency of publication on the topic, as well as using the percentiles illustrated by Bradford's law; This allows journals to be classified into three performance zones, each with an increase in the number of journals and a similar proportion of articles. Table 4 shows the percentages corresponding to each Bradford Law Zone. It is highlighted that zone 2 houses a greater concentration of publications, that is, it has a higher participation percentage with 33.83%, closely followed by zone 1 and finally zone 3 with 32.98%.

Table 4
Bradford's Law.

Zone	No. Magazines	No. Titles	Percentages
Zone 1	49	313	33,19%
Zone 2	202	319	33,83%
Zone 3	311	311	32,98%

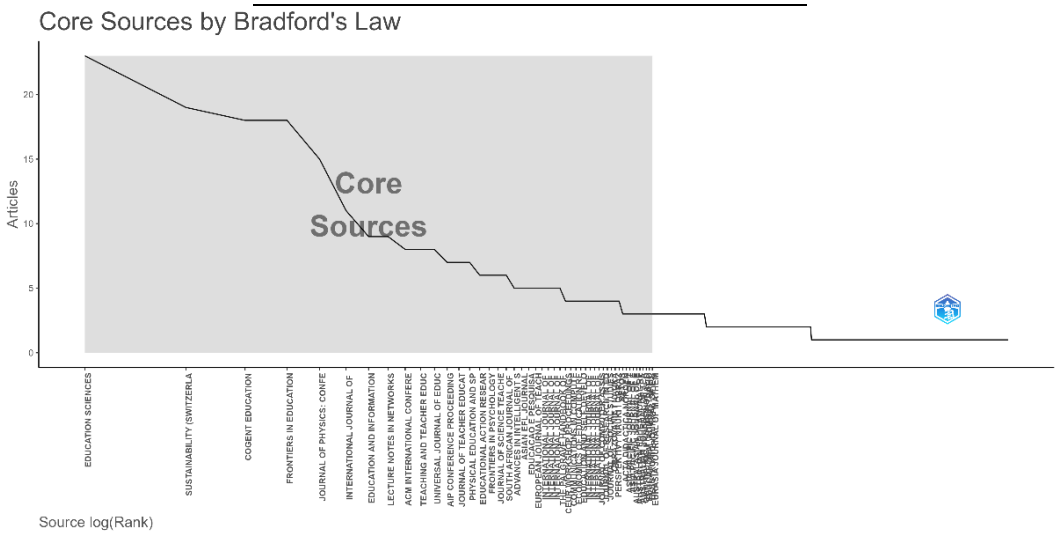

Fig. 3. Bradford 's Law.

4.2 Bibliometric indicators

Table 5 details the most important sources in the study area, this list is led by EDUCATION SCIENCES with a total of 23 publications, in second place is SUSTAINABILITY (SWITZERLAND) with 19 contributions, and in third place are COGENT EDUCATION and FRONTIERS IN EDUCATION with 18 publications each.

Table 5
Most relevant sources.

Sources	Articles
EDUCATION SCIENCES	23
SUSTAINABILITY (SWITZERLAND)	19
COGENT EDUCATION	18
FRONTIERS IN EDUCATION	18
JOURNAL OF PHYSICS: CONFERENCE SERIES	15
INTERNATIONAL JOURNAL OF LEARNING, TEACHING AND EDUCATIONAL RESEARCH	11
EDUCATION AND INFORMATION TECHNOLOGIES	9
LECTURE NOTES IN NETWORKS AND SYSTEMS	9
ACM INTERNATIONAL CONFERENCE	8

PROCEEDING SERIES	
TEACHING AND TEACHER EDUCATION	8
UNIVERSAL JOURNAL OF EDUCATIONAL RESEARCH	8
AIP CONFERENCE PROCEEDINGS	7
JOURNAL OF TEACHER EDUCATION	7
PHYSICAL EDUCATION AND SPORT PEDAGOGY	7
EDUCATIONAL ACTION RESEARCH	6

On the other hand, it is prudent to explore the geographical distribution of the results obtained during the bibliometric study, these are illustrated in Figure 4, which presents a comparison of the production of scientific documents between the countries, this is carried out with respect to the scientific production of the topic addressed. Based on the information provided by the map, it is determined that the United States is at the top of this list with a total production of 487 publications, followed by Indonesia with 225 and China with 153 contributions.

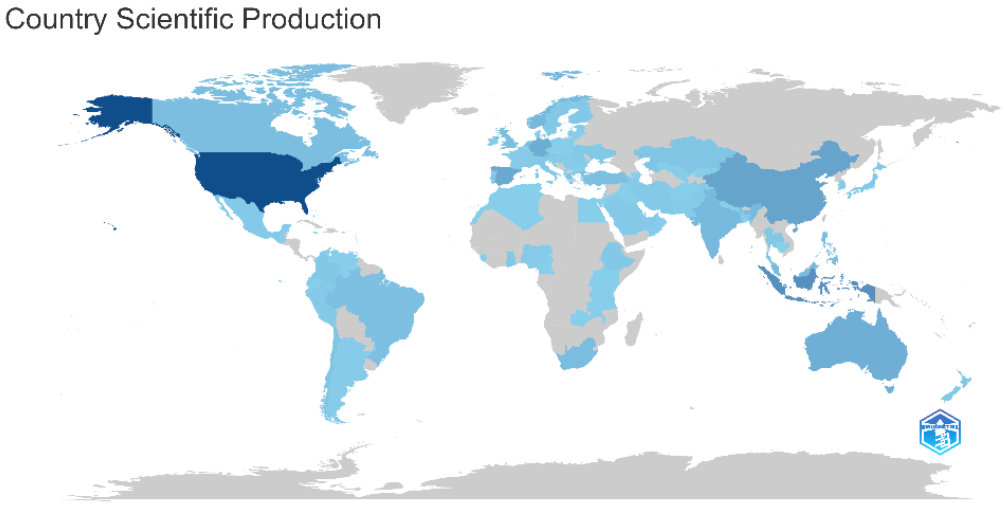

Fig. 4. Scientific production by country.

Aligned with the purpose of this study, Figure 5 shows the institutions that have made the most contributions regarding the topic of study, in first place is MICHIGAN STATE UNIVERSITY with (16) contributions, followed by UNIVERSITY OF GRONINGEN with (14) contributions and in third place BEIJING NORMAL UNIVERSITY together with STONY BROOK UNIVERSITY each with (13) contributions.

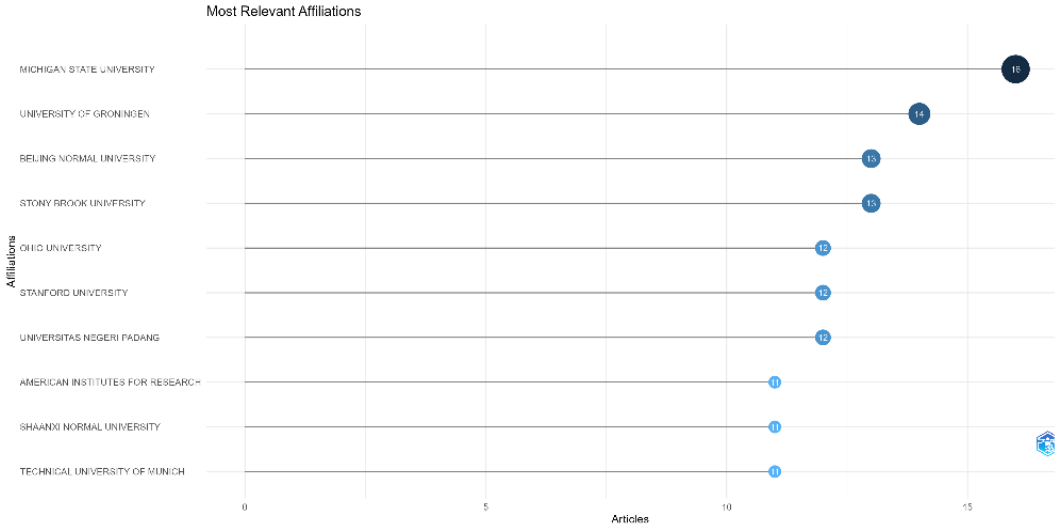

Fig. 5. Most relevant affiliations.

Similarly, and with the purpose of quantifying productivity per researcher, the frequency index was taken as a reference, which can be detailed in Figure 6. From this methodology, the leadership of JR was recognized with (6) publications, followed by WANG Y with (5) publications and ALMENDINGEN K together with BARTH M; KELLY AM; LIU X and VAN VEEN K with (4) publications each.

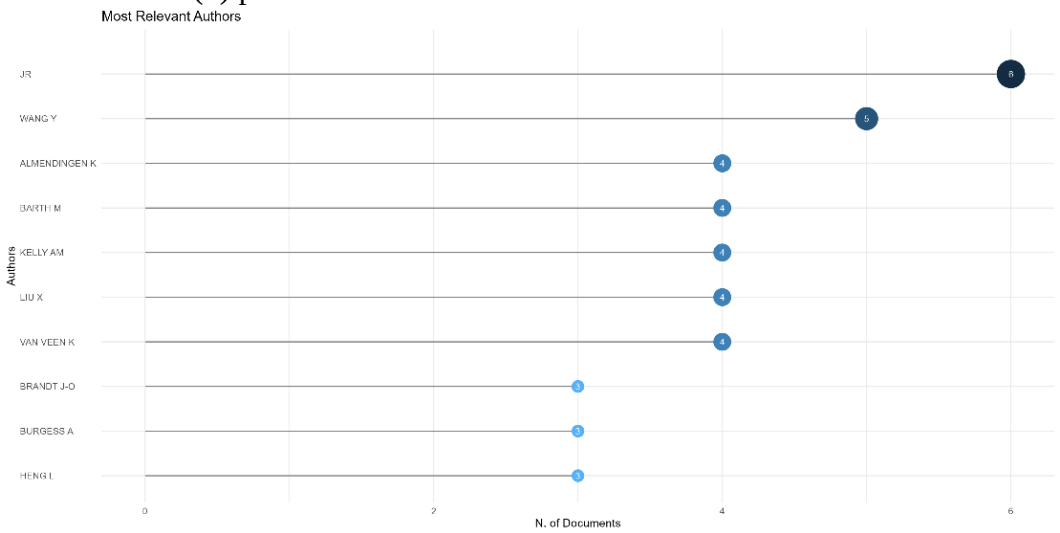

Fig. 6. Most relevant authors.

On the other hand, Table 6 illustrates a series of the twenty-five most cited publications associated with the topic presented here. It was found that the first three places in this list are constituted as follows: ZHANG W, 2020, J RISK FINANC MANAG, with a total of 598 citations; in second place, FALLOON G, 2020, EDUC TECHNOL RES DEV, with 479 citations and in third place HILLMAYR D, 2020, COMPUT EDUC with a total of 216 citations.

Table 6
Most cited articles.

Articles	DOI	Total Citations	TC per Year	Normalized TC
[31] ZHANG W, 2020, J RISK FINANC MANAG	10.3390/jrfm13030055	598	99,67	26,81
[32] FALLOON G, 2020, EDUC TECHNOL RES DEV	10.1007/s11423-020-09767-4	479	79,83	21,47
[33] HILLMAYR D, 2020, COMPUT EDUC	10.1016/j.compedu.2020.103897	216	36,00	9,68
[34] GACS A, 2020, FOREIGN LANG ANN	10.1111/flan.12460	190	31,67	8,52
[35] SMALE-JACOBSE AE, 2019, FRONT PSYCHOL	10.3389/fpsyg.2019.02366	159	22,71	11,25
[36] BOWER M, 2020, BR J EDUC TECHNOL	10.1111/bjet.13009	103	17,17	4,62
[37] SAILER M, 2021, COMPUT HUM BEHAV	10.1016/j.chb.2021.106794	99	19,80	14,03
[38] VARE P, 2019, SUSTAINABILITY	10.3390/su11071890	93	13,29	6,58
[39] BRANDT J-O, 2019, INT J SUSTAIN HIGH EDUC	10.1108/IJSHE-10-2018-0183	81	11,57	5,73
[40] HENNESSY S, 2022, COMPUT EDUC OPEN	10.1016/j.caeo.2022.100080	80	20,00	12,81
[41] MONTGOMERY AP, 2019, BR J EDUC TECHNOL	10.1111/bjet.12590	77	11,00	5,45
[42] ZHANG C, 2023, INT J EDUC TECHNOL HIGH EDUC	10.1186/s41239-023-00420-7	73	24,33	21,06
[43] ZHI R, 2023, THINK SKILLS CREAT	10.1016/j.tsc.2023.101370	63	21,00	18,18
[44] HANUSHEK EA, 2020, THE ECON OF EDUC: A COMPR OVERV	10.1016/B978-0-12-815391-8.00013-6	61	10,17	2,73
[45] ALBAREDA-TIANA S, 2019, SUSTAINABILITY	10.3390/su11184927	61	8,71	4,32
[46] KALOGIANNAKIS M, 2019, MOB LEARN APPL IN EARLY CHILDH EDUC	10.4018/978-1-7998-1486-3.ch005	59	8,43	4,18
[47] DEROO MR, 2019, BILING RES J	10.1080/15235882.2019.1589604	58	8,29	4,10
[48] RESCHLY AL, 2022,	10.1007/978-3-031-	55	13,75	8,80

HANDB OF RESEARCH ON STUDENT ENGAGEMENT: SECOND EDITION	07853-8			
[49] ASPELIN J, 2019, TEACH DEV	10.1080/13664530.2019.1570323	53	7,57	3,75
[50] MESLER RM, 2021, J APPL DEV PSYCHOL	10.1016/j.appdev.2021.101299	52	10,40	7,37
[51] MACRIDES E, 2022, INT J CHILD-COMPUTER INTERACT	10.1016/j.ijcci.2021.100396	51	12,75	8,16
[52] NAIK G, 2020, WORLD DEV	10.1016/j.worlddev.2019.104736	49	8,17	2,20
[53] GÓMEZ-CARRASCO CJ, 2020, PLOS ONE	10.1371/journal.pone.0236083	45	7,50	2,02
[54] MYSTAKIDIS S, 2022, INFORMATION	10.3390/info13030136	43	10,75	6,88
[55] MANASIA L, 2020, SUSTAINABILITY	10.3390/SU12010166	43	7,17	1,93

4.3 Analysis of relationships and co-occurrences

To conclude this methodological analysis, it is considered relevant to provide a cluster analysis carried out using the VOS VIEWER software (Figure 7), this last element reveals the terms that have the greatest impact grouped by co-occurrence, where keywords such as: “Teacher education”, “Teaching”, “Teacher training”, “Students” are observed, among others.

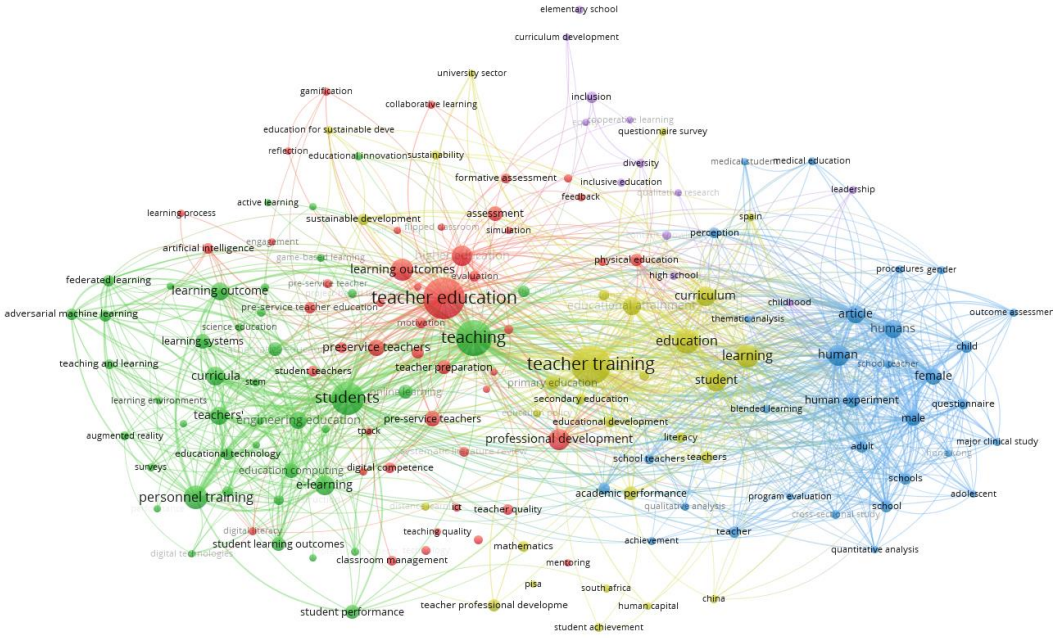

Fig. 7. Co-occurrence of keywords.

5. Discussion

The bibliometric analysis results provide important illumination on the scholarly networks and research trends at the confluence of teacher education and learning outcomes. Under investigation spans 2019 to 2024 and comprises 943 papers from 562 separate journals, books, and other scholarly sources. The field's increasing relevance—shown by its 14.01% yearly growth rate—indicates a rising awareness of the need of teacher education in deciding learning results.

According to document distribution, most of the publications—703—are journal articles; conference papers (98) and book chapters (89) follow after this. This emphasizes the caliber of the research being conducted by suggesting that in this field peer-reviewed papers still constitute the primary source of knowledge. Conference papers show even more how academic gatherings support field-based fresh idea exchange and communication. Moreover, including book chapters highlights the larger theoretical and conceptual contributions made by the professionals.

Author cooperation patterns help one to understand the dynamics of this field of research. The 2,606 authors that helped create the dataset and the average of 2.95 co-authors per document plainly show that cooperation is very widespread. Single-authored books account for 159 publications, or a small but interesting fraction of the scholarly output. The meager degrees of global research cooperation displayed by the international co-authorship rate of 14.95% demonstrate the transnational interest in teacher education and its impact on learning outcomes.

94.5% of authors have only contributed one article, 4.6% have contributed two, and fewer than 1% have contributed three or more, according to Lotka's Law, which is applied to the dataset. This is consistent with the predicted power-law distribution of scientific output, which holds that the knowledge generation of a subject is driven by a small number of productive authors. The ramifications of this distribution emphasize the need to encourage younger researchers to participate in research for longer periods of time in order to guarantee the field's ongoing progress.

Based on publication frequency, Bradford's Law divides journals into three zones. Zone 2 has the largest concentration of publications (33.83%), followed by Zone 1 (33.19%) and Zone 3 (32.98%). This comparatively balanced distribution indicates that a wide variety of publications add to the conversation around learning outcomes and teacher education. The multidisciplinary character of the study is further supported by the existence of prestigious education-focused publications including Frontiers in Education, Cogent Education, Sustainability (Switzerland), and Education Sciences.

With 487 publications, the US leads the world in terms of geography, followed by China (153), Indonesia (225), and the US. This distribution shows how dominating these nations are in educational research, with China and Indonesia showing growing interest in teacher education scholarship and the United States retaining a strong research infrastructure. This tendency is further supported by the presence of Beijing Normal University, Michigan State University, and the University of Groningen as top institutional donors, demonstrating their dedication to furthering this field of study.

With six publications, JR is the most prolific individual researcher. Wang Y comes in second with five, followed by Almendingen K, Barth M, Kelly AM, Liu X, and Van Veen K, who each have four publications. These scholars are essential to the development of the field's

discourse and knowledge, and they may have a significant impact on scholarly and policy debates pertaining to teacher education.

Zhang W (2020) in J Risk Financ Manag received 598 citations, followed by Falloon G (2020) in Educ Technol Res Dev with 479 citations and Hillmayr D (2020) in Comput Educ with 216 citations, according to the citation analysis, which identifies the most influential articles. These widely referenced publications highlight the major ideas and theoretical developments influencing the current conversation around learning outcomes and teacher education. A considerable emphasis on incorporating digital and new pedagogical techniques in teacher training is suggested by the emphasis on risk management, educational technology, and computational education.

All things considered, the results of this bibliometric analysis provide a thorough grasp of the research patterns, networks of collaboration, and significant publications at the nexus of learning outcomes and teacher education. The consistent increase in publications, the frequency of collaborative research, and the institutional and geographic dispersion of contributions highlight how this academic subject is always changing. In order to promote a more vibrant and inclusive academic community, future research initiatives should seek to strengthen international partnerships, diversify publication platforms, and encourage consistent contributions from a wider spectrum of researchers.

6. Conclusions

This bibliometric study summarizes the whole research environment at the junction of teacher education and learning results. Based on an annual growth rate of 14.01% during the past five years (2019–2024), the findings reveal always growing corpus of research pointing to ongoing intellectual curiosity in this field. Furthermore, the somewhat young average document age of 3.09 years indicates that this is a vibrant and changing field of research sometimes influenced by many points of view and fresh ideas.

Usually, research findings are provided in peer-reviewed publications; this is shown from the prevalence of journal articles—703 out of 943 entries. Book chapters (89) and conference papers (98) underline the multidisciplinary character of this issue and the participation of scholars from the fields of education, policy studies, sustainability, and technology. The range of academic presentations of teacher education highlights its importance in more broad educational and cultural environments.

Analyzing author output reveals that only a small fraction of academics routinely contribute despite general interest in teacher education and learning outcomes. Lotka's Law shows that while less than 1% of authors have written three or more pieces on the topic, 94.5% have only published one. This tendency suggests that despite the majority only seldom cover the topic, long-term contributions and knowledge are concentrated among a small number of scholars. Top institutions such Beijing Normal University, the University of Groningen, and Michigan State University are vital for the progress of knowledge in this field according to institutional donations.

The analysis also points up important publication sources; Education Sciences, Sustainability (Switzerland), and Cogent Education are the most important publications. This distribution reflects the interdisciplinary aspect of the study, in which concepts from educational sciences combine with sustainability, policy, and technological advancements. Moreover, Bradford's Law shows that, despite a larger range of sources encourages specialized debates in the topic, a central group of journals regulates the flow of information.

With 487 publications, the United States leads the world in scientific output followed by China (153), Indonesia (225), and the United States. Popularity of Indonesia highlights regional educational developments as well as growing Asian country interest in teacher preparation. International cooperation is still somewhat limited even with its global reach based on just 14.95% of papers include co-authorship with academics from other countries. The absence of collaboration indicates the necessity for more robust academic networks and international research initiatives. Citation analysis further elucidates the significance of research contributions. Investigations into teacher education and learning outcomes impact various fields, including economics, psychology, and technology, as evidenced by highly regarded publications such as those by Zhang W (2020) and Falloon G (2020).

The prominence of extensively cited works across numerous publications provides additional proof of the interdisciplinary relevance of this research domain. Ultimately, this study underscores the critical role of teacher training in influencing learning outcomes and the evolving nature of the research subject. Notwithstanding considerable progress, there are still opportunities to enhance cooperation, widen the spectrum of research output, and address present gaps in the global scholarly community.

7. Future directions and implications

Important new insights from the bibliometric study might affect next research, policy-making, and instructional strategies. Future research has as its main goal increasing worldwide collaboration. Given the rather low percentage of international co-authorship (14.95%), it is imperative to strengthen academic networks and research partnerships across geographic borders to get a complete knowledge of teacher education and its influence on learning outcomes. Encouragement of cooperative research initiatives, international conferences, and cross-border financing opportunities might help to close this discrepancy.

Another vital direction is raising the application of interdisciplinary approaches in the industry. Publications like Sustainability (Switzerland) are becoming more and more popular, which suggests that teacher education is attracting more attention in the link between environmental, technological, and social sustainability. Future research should probe these connections utilizing expertise from fields including policy studies, psychology, and educational technology. This might lead to more all-encompassing methods of teacher preparation and instruction practices.

Furthermore important is tackling the concentration of scientific output within a small number of experts. The survey states that 94.5% of writers only publish one piece, suggesting that the academic community ought to get more involved. Universities and research institutions should give initiatives such mentorship programs, cooperative research funding, and open-access publishing options some thought to help upcoming researchers in this field. Participating more in teacher education research could help different points of view and innovative ideas to improve learning results to grow.

Moreover, the regional distribution of research output shows that, even although the United States is still a big contributor, new research centers in Asia—more especially, China and Indonesia—are becoming ever more significant. Future research might focus on the exact legal frameworks, educational reforms, and cultural aspects affecting this development. Knowing regional differences in teacher education strategies can help one to adapt best practices across several educational systems.

From a policy aspect, this study highlights the necessity of additional financing for teacher education research—especially in underdeveloped countries. Many times, the quality of

teacher training, access to professional development, and the use of technology into the classroom remain problems. Funding agencies and governments may consider making targeted donations to assist in financing research addressing such significant issues. Strong research results can direct evidence-based policies improving teacher training programs and, finally, student learning results.

Not least of all, citation analysis shows some study subjects—such as the use of technology in teacher education—are really important. More specifically, future studies should look at how digital technology, artificial intelligence, and remote learning systems influence student achievement and teacher efficacy. Research on innovative teaching techniques, adaptive learning technologies, and data-driven decision-making as educational environments evolve will significantly impact the direction of education going forward.

All things considered, this bibliometric analysis provides a comprehensive review of present research patterns and points up areas for progress and enhancement. Expanding author involvement, supporting interdisciplinary approaches, enhancing international cooperation, and matching research efforts with policy needs will be crucial in order to forward knowledge in teacher education and learning outcomes. By addressing these problems, the scholarly community could contribute to boost the general quality of education worldwide and enhance teacher training strategies.

References

[1]S.K.F. Briones, R.J.R. Dagamac, J.D. David, C.A.B. Landerio, Factors affecting the students' scholastic performance: A survey study, Indonesian Journal of Educational Research and Technology 2 (2) (2022) 97–102. https://doi.org/10.17509/ijert.v2i2.41394

[2]H. Goss, Student learning outcomes assessment in higher education and in academic libraries: A review of the literature, The Journal of Academic Librarianship 48 (2) (2022) 102485. https://doi.org/10.1016/j.acalib.2021.102485

[3]Y. Akhyar, Teachers' Pre-Service Programs Curriculum to Prepare Professional Teachers at Education Faculties, Indonesian Journal of Islamic Educational Management 6 (2) (2023) 72–84. http://dx.doi.org/10.24014/ijiem.v6i2.25044

[4]F.E. Tonga, S. Eryiğit, F.A. Yalçın, F.T. Erden, Professional development of teachers in PISA achiever countries: Finland, Estonia, Japan, Singapore and China, Professional Development in Education 48 (1) (2022) 88–104. https://doi.org/10.1080/19415257.2019.1689521

[5]M.E. Martinez, V. Gomez, Active Learning Strategies: A Mini Review of Evidence-Based Approaches, Acta Pedagogia Asiana 4 (1) (2025) 43–54. https://doi.org/10.53623/apga.v4i1.555

[6]M.I. Ani, S.O. Obih, Personality Traits, Subject Matter, Knowledge, and Teaching Skills of Secondary Teachers, Polaris Global Journal of Scholarly Research and Trends 2 (1) (2023) 79–89. https://doi.org/10.58429/pgjsrt.v2n1a123

[7]S. García, B. Olsen, A. Simbaqueba, Teaching quality in Colombia: analysing twenty years of awarding a national best-teacher prize, European Journal of Teacher Education 44 (3) (2021) 328–347. https://doi.org/10.1080/02619768.2021.1912006

[8]W. Isnaeni, Y.A. Sujatmiko, P. Pujiasih, Analysis of the role of android-based learning media in learning critical thinking skills and scientific attitude, Jurnal Pendidikan IPA Indonesia 10 (4) (2021) 607–617. https://doi.org/10.15294/jpii.v10i4.27597

[9]J. Ramirez, G. Gallego, W.N.N.N. Ez, J.G. Tirado, Blockchain technology for sustainable

supply chains: A bibliometric study, Journal of Distribution Science 21 (6) (2023) 119–129. https://doi.org/10.15722/jds.21.06.202306.119

[10] A.R. Pinto-Santos, A. Pérez Garcias, A. Darder Mesquida, Development of Teaching Digital Competence in Initial Teacher Training: A Systematic Review, World Journal on Educational Technology: Current Issues 14 (1) (2022) 1–15. https://doi.org/10.18844/wjet.v14i1.6250

[11] C.E. Wolff, H. Jarodzka, H.P. Boshuizen, Classroom management scripts: A theoretical model contrasting expert and novice teachers' knowledge and awareness of classroom events, Educational Psychology Review 33 (1) (2021) 131–148. https://doi.org/10.1007/s10648-020-09542-0

[12] K. Juuti, J. Lavonen, V. Salonen, K. Salmela-Aro, B. Schneider, J. Krajcik, A teacher–researcher partnership for professional learning: Co-designing project-based learning units to increase student engagement in science classes, Journal of Science Teacher Education 32 (6) (2021) 625–641. https://doi.org/10.1080/1046560X.2021.1872207

[13] J.B. Hill, Pre-service teacher experiences during COVID-19: Exploring the uncertainties between clinical practice and distance learning, Journal of Practical Studies in Education 2 (2) (2021) 1–13. https://doi.org/10.46809/jpse.v2i2.18

[14] A. Sørensen, P. Lagestad, H.K. Mikalsen, Student teacher experiences of learning and pedagogical involvement using a student-centered learning approach, Education Sciences 13 (9) (2023) 965. https://doi.org/10.3390/educsci13090965

[15] G. Tugume, T. Silaji, C.E. Eze, V.H.U. Eze, Examining the Relationship Between Teachers' Qualifications and Students' Academic Performance, Journal of Humanities and Social Sciences (JHASS) 6 (2) (2024) 66–77. https://doi.org/10.36079/lamintang.jhass-0602.634

[16] S. Amponsah, E. Ampadu, M. Thomas, Professional development among in-service teachers: motivational factors, pathways and coping strategies, Educational Review 75 (4) (2023) 703–718. https://doi.org/10.1080/00131911.2021.1951173

[17] S. Syarnubi, A. Syarifuddin, S. Sukirman, Curriculum Design for the Islamic Religious Education Study Program in the Era of the Industrial Revolution 4.0, Al-Ishlah: Jurnal Pendidikan 15 (4) (2023) 6333–6341. https://doi.org/10.35445/alishlah.v15i4.3421

[18] L. Candrasa, C.C. Cen, The effect of teacher teaching, learning methods and students' perceptions on the student's learning achievement in Medan city, JPPI (Jurnal Penelitian Pendidikan Indonesia) 9 (1) (2023) 449–456. http://dx.doi.org/10.29210/020221737

[19] J. Goopio, C. Cheung, The MOOC dropout phenomenon and retention strategies, Journal of Teaching in Travel & Tourism 21 (2) (2021) 177–197. https://doi.org/10.1080/15313220.2020.1809050

[20] A. Munawar, S. Malik, In relationship of Nature of Schooling with Accessibility and Quality of Education at the Secondary School Level, Journal of Educational Research and Social Sciences Review (JERSSR) 4 (3) (2024) 38–56. https://www.jerssr.org.pk/ojs/index.php/jerssr/article/view/287

[21] B. Mallik, Teacher-Student Relationship and Its Influence on College Student Engagement and Academic Achievement, Anatolian Journal of Education 8 (1) (2023) 93–112. https://doi.org/10.29333/aje.2023.817a

[22] Z. Gao, X. Li, H. Liao, Teacher support and its impact on ESL student engagement in blended learning: The mediating effects of L2 grit and intended effort, Acta Psychologica 248 (1) (2024) 104428. https://doi.org/10.1016/j.actpsy.2024.104428

[23] S. Shanta, J.G. Wells, T/E design based learning: assessing student critical thinking and problem solving abilities, International Journal of Technology and Design Education 32 (1) (2022) 267–285. https://doi.org/10.1007/s10798-020-09608-8
[24] P.A. Tontz, J. Reyes, Z. Taylor, Impact of military nurse instructor on the academic performance of eligible corpsman in an online NCLEX-PN training program, Teaching and Learning in Nursing 18 (4) (2023) e188–e194. https://doi.org/10.1016/j.teln.2023.06.010
[25] J. Stanja, W. Gritz, J. Krugel, A. Hoppe, S. Dannemann, Formative assessment strategies for students' conceptions—The potential of learning analytics, British Journal of Educational Technology 54 (1) (2023) 58–75. https://doi.org/10.1111/bjet.13288
[26] J.H.L. Koh, R.Y.P. Kan, Students' use of learning management systems and desired e-learning experiences: Are they ready for next generation digital learning environments?, Higher Education Research & Development 40 (5) (2021) 995-1010. https://doi.org/10.1080/07294360.2020.1799949
[27] M. Kumpulainen, M. Seppänen, Combining Web of Science and Scopus datasets in citation-based literature study, Scientometrics 127 (10) (2022) 5613-5631. https://doi.org/10.1007/s11192-022-04475-7
[28] M.T. Altaf, W. Liaqat, A. Jamil, M.F. Jan, F.S. Baloch, H.I. Mohamed, A bibliometric analysis of genome-wide association study (GWAS) and Sorghum (Sorghum bicolor L) based on Web of Science using VOS viewer, Journal of Soil Science and Plant Nutrition 24 (3) (2024) 5012-5028. https://doi.org/10.1007/s42729-024-01888-6
[29] Q. Wang, F. Ren, R. Li, Exploring the impact of geopolitics on the environmental Kuznets curve research, Sustainable Development 32 (3) (2024) 1700-1722. https://doi.org/10.1002/sd.2743
[30] A. Basu, B. Dutta, Redesigning of Lotka's Law with Simpson's 3/8 Rule, Journal of Scientometric Research 12 (1) (2023) 197-203. https://doi.org/10.5530/jscires.12.1.017
[31] Zhang, W., Y. Wang, L. Yang, C. Wang, Suspending classes without stopping learning: China's education emergency management policy in the COVID-19 outbreak, Journal of Risk and Financial Management 13 (3) (2020) 55, https://doi.org/10.3390/jrfm13030055
[32] G. Falloon, From digital literacy to digital competence: the teacher digital competency (TDC) framework, Educational Technology Research and Development 68 (5) (2020) 2449-2472, https://doi.org/10.1007/s11423-020-09767-4
[33] D. Hillmayr, L. Ziernwald, F. Reinhold, S.I. Hofer, K.M. Reiss, The potential of digital tools to enhance mathematics and science learning in secondary schools: A context-specific meta-analysis, Computers & Education 153 (1) (2020) 103897, https://doi.org/10.1016/j.compedu.2020.103897
[34] A. Gacs, S. Goertler, S. Spasova, Planned online language education versus crisis-prompted online language teaching: Lessons for the future, Foreign Language Annals 53 (2) (2020) 380-392, https://doi.org/10.1111/flan.12460
[35] A.E. Smale-Jacobse, A. Meijer, M. Helms-Lorenz, R. Maulana, Differentiated instruction in secondary education: A systematic review of research evidence, Frontiers in Psychology 10 (1) (2019) 2366, https://doi.org/10.3389/fpsyg.2019.02366
[36] M. Bower, D. DeWitt, J.W. Lai, Reasons associated with preservice teachers' intention to use immersive virtual reality in education, British Journal of Educational

Technology 51 (6) (2020) 2215-2233, https://doi.org/10.1111/bjet.13009
[37] M. Sailer, F. Schultz-Pernice, F. Fischer, Contextual facilitators for learning activities involving technology in higher education: The C♭-model, Computers in Human Behavior 121 (1) (2021) 106794, https://doi.org/10.1016/j.chb.2021.106794
[38] P. Vare, G. Arro, A. de Hamer, G. Del Gobbo, G. de Vries, F. Farioli, A. Zachariou, Devising a competence-based training program for educators of sustainable development: Lessons learned, Sustainability 11 (7) (2019) 1890, https://doi.org/10.3390/su11071890
[39] J.O. Brandt, L. Bürgener, M. Barth, A. Redman, Becoming a competent teacher in education for sustainable development: Learning outcomes and processes in teacher education, International Journal of Sustainability in Higher Education 20 (4) (2019) 630-653, https://doi.org/10.1108/IJSHE-10-2018-0183
[40] S. Hennessy, S. D'Angelo, N. McIntyre, S. Koomar, A. Kreimeia, L. Cao, A. Zubairi, Technology use for teacher professional development in low-and middle-income countries: A systematic review, Computers and Education Open 3 (1) (2022) 100080, https://doi.org/10.1016/j.caeo.2022.100080
[41] A.P. Montgomery, A. Mousavi, M. Carbonaro, D.V. Hayward, W. Dunn, Using learning analytics to explore self-regulated learning in flipped blended learning music teacher education, British Journal of Educational Technology 50 (1) (2019) 114-127, https://doi.org/10.1111/bjet.12590
[42] C. Zhang, J. Schießl, L. Plößl, F. Hofmann, M. Gläser-Zikuda, Acceptance of artificial intelligence among pre-service teachers: a multigroup analysis, International Journal of Educational Technology in Higher Education 20 (1) (2023) 49, https://doi.org/10.1186/s41239-023-00420-7
[43] R. Zhi, Y. Wang, English as a foreign language teachers' professional success, loving pedagogy and creativity: A structural equation modeling approach, Thinking Skills and Creativity 49 (1) (2023) 101370, https://doi.org/10.1016/j.tsc.2023.101370
[44] E.A. Hanushek, Education production functions, in: The economics of education, Academic Press, 2020. https://doi.org/10.1016/B978-0-12-815391-8.00013-6
[45] S. Albareda-Tiana, E. García-González, R. Jiménez-Fontana, & C. Solís-Espallargas, Implementing pedagogical approaches for ESD in initial teacher training at Spanish universities. Sustainability, 11 (18) (2019) 4927. https://doi.org/10.3390/su11184927
[46] M. Kalogiannakis & S. Papadakis, The use of developmentally mobile applications for preparing pre-service teachers to promote STEM activities in preschool classrooms, in: Mobile learning applications in early childhood education, IGI Global, 2020. https://doi.org/10.4018/978-1-7998-1486-3.ch005
[47] M.R. Deroo, & C. Ponzio, Confronting ideologies: A discourse analysis of in-service teachers' translanguaging stance through an ecological lens, Bilingual Research Journal, 42 (2) (2019) 214-231. https://doi.org/10.1080/15235882.2019.1589604
[48] A.L. Reschly & S.L. Christenson (Eds.), Handbook of research on student engagement, Springer Nature, 2022. https://doi.org/10.1007/978-3-031-07853-8
[49] J. Aspelin, A. Jonsson, Relational competence in teacher education, Concept analysis and report from a pilot study, Teacher Development 23 (2) (2019) 264–283, https://doi.org/10.1080/13664530.2019.1570323
[50] R. M. Mesler, C. M. Corbin, B. H. Martin, Teacher mindset is associated with development of students' growth mindset, Journal of Applied Developmental Psychology

76 (1) (2021) 101299, https://doi.org/10.1016/j.appdev.2021.101299
[51] E. Macrides, O. Miliou, C. Angeli, Programming in early childhood education: A systematic review, International Journal of Child-Computer Interaction 32 (1) (2022) 100396, https://doi.org/10.1016/j.ijcci.2021.100396
[52] G. Naik, C. Chitre, M. Bhalla, J. Rajan, Impact of use of technology on student learning outcomes: Evidence from a large-scale experiment in India, World Development 127 (1) (2020) 104736, https://doi.org/10.1016/j.worlddev.2019.104736
[53] C. J. Gómez-Carrasco, J. Monteagudo-Fernández, J. R. Moreno-Vera, M. Sainz-Gómez, Evaluation of a gamification and flipped-classroom program used in teacher training: Perception of learning and outcome, PLoS ONE 15 (7) (2020) e0236083, https://doi.org/10.1371/journal.pone.0236083
[54] S. Mystakidis, A. Christopoulos, Teacher perceptions on virtual reality escape rooms for STEM education, Information 13 (3) (2022) 136, https://doi.org/10.3390/info13030136
[55] L. Manasia, M. G. Ianos, T. D. Chicioreanu, Pre-service teacher preparedness for fostering education for sustainable development: An empirical analysis of central dimensions of teaching readiness, Sustainability 12 (1) (2019) 166, https://doi.org/10.3390/SU12010166