AJOTE
African Journal of Teacher Education
ISSN 1916-7822. A Journal of Spread Corporation

Volume 14 No. 2 2025 Pages 167-201

A bibliometric analysis of the factors influencing global research conditions of teacher education

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Abstract

This bibliometric analysis explores global research trends in teacher education, examining 1,757 publications from the Lens.org database (1878-2023). The study reveals a significant upwelling in teacher education program research, particularly since 2015, with journal articles dominating the publication landscape. Arthur Tatnall emerged as the most prolific author, while psychology, medicine, and medical education were identified as the top contributing fields. The analysis highlights the United States, United Kingdom, Australia, China, and Canada as leading research nations, underscoring a concentration of output in developed countries. Key influencing factors identified include the impact of the COVID-19 pandemic, technological integration, and the need for adaptive and equitable strategies. The findings emphasize the interdisciplinary nature of teacher education program research and the critical need for increased capacity building and international collaboration, especially in underrepresented regions.

Keywords: Teacher education, Global trends, Factors, Bibliometric Analysis

1. Introduction

The teacher education programs are a critical aspect of educational reform, with far-reaching implications for student outcomes and overall educational quality. Education as defined by Wuni and Shen (2020) refers to the process of putting into action a strategy, concept, model, or design. In the context of education and social services, the effectiveness of can significantly impact the success of interventions and programs (Lloyd-Jones et al., 2022; Ugwu & Onyancha, 2019).

The field science has identified various conditions, circumstances, and actions that influence the efficacy efforts (Bauer et al., 2015). This knowledge has led to the recognition of variation, which describes the gap between intended and actual program delivery. The quality of can range from low to high, with "quality" referring to the extent to which specific program components are executed accurately and clearly (Buniya et al., 2021).

In teacher education programs, the importance of effective cannot be overstated. The success of these programs hinges on their execution (Abate & Adamu, 2021), with good data and well-thought-out strategies being essential for fostering positive change and enhancing the effectiveness of graduate students. The educational landscape presents a complex environment where multiple factors, both external and internal, can influence the process (Aksorn & Hadikusumo, 2010; Rosati & Faria, 2019; Ugwu & Onyancha, 2019). The primary goal of teacher education programs is to improve student performance. However, this objective is intrinsically linked to the college culture in which these programs operate (Serbessa, 2006). Professional teaching communities, characterized by collaboration between educators and leaders, play a crucial role in prioritizing student learning (Tuli & Tynjala, 2015; Yang et al., 2021). Therefore, the design of teacher education programs must consider not only the learning processes of prospective teachers but also the various factors that affect effectiveness.

Understanding these factors is crucial for bridging the "gap" the disparity between theoretical understanding and actual results in social services interventions (Lloyd-Jones et al., 2022; Ugwu & Onyancha, 2019). By examining examples from social services, particularly in education, we can gain insights into the supports and barriers to effective, thereby improving the overall quality of teacher education programs (Ayele et al., 2020; Francis & Baker-Henningham, 2020; Yang et al., 2021). This study aims to contribute to this understanding by examining the factors affecting the teacher education programs. Drawing from an extensive analysis of 1,757 publications sourced from the Lens.org database, we seek to provide a comprehensive overview of the multifaceted nature of program. Our research emphasizes the need for a systematic evaluation of factors influencing success, considering the complex interplay of contextual variables, institutional frameworks, and individual stakeholders.

By highlighting the importance of collaborative efforts and cross-disciplinary approaches, this study aims to offer valuable insights that can enhance the quality and effectiveness of teacher

education programs. Through a thorough examination of the existing literature and empirical evidence, we hope to contribute to the ongoing dialogue on improving educational outcomes through more effective strategies in teacher education.

2. Objective of the Study

A paper aims to thoroughly examine studies on factors influencing teacher education program (TPP) using bibliometric analysis (Hursen, 2023). The objective is to analyze critical elements like keywords, countries, researchers, and resources contributing to this field. By identifying gaps, the study aims to enhance understanding of program complexities.

Research Questions

- What are the predominant trends and themes identified in the literature concerning the factors affecting the teacher education programs, as revealed through bibliometric analysis?
- Which keywords, countries, researchers, and resources emerge as key contributors to the discourse on the teacher education programs, and what gaps exist in the current research landscape that may impede further understanding of these factors?

3. Method of the study

Hursen (2023) utilized bibliometric analysis to explore critical thinking in teacher education. By employing Boolean expressions, researchers can narrow search parameters. The study tracked the evolution of these elements over time, establishing clear criteria. This approach, as outlined by Gutiérrez-Salcedo et al. (2018), offers a comprehensive perspective on teacher education complexities. By identifying trends and gaps, this framework contributes to future research in the field.

3.1. Data Collection Method

The study utilized the Lens.org database as its primary data source. The Lens platform hosts an extensive repository, comprising over 118 million patents and 208 million scholarly work records derived from prominent sources such as Microsoft Academic, PubMed, and Crossref Indexes. To effectively manage record variability and ensure the relevance of contextual metadata, Lens employs a Meta Record concept (Wrigley et al., 2019). Notably, the platform also integrates

information from OpenAlex and UnPaywall, as well as links to ORCID, which serves as a digital identifier for distinguishing individual researchers (Ranjbar-Sahraei et al., 2018).

Lens.org facilitates the collection, aggregation, and analysis of documents, allowing users to share, annotate, and embed these collections. This capability restores the patent system's role as a vital educational resource for entrepreneurs, citizens, and policymakers. Developed by Cambia, an Australia-based non-profit organization, Lens.org represents a significant advancement in cyber-infrastructure, offering transparent and annotatable access to patent filings, academic literature, and regulatory data. This functionality empowers users to engage in knowledge-directed invention by sharing and annotating document collections (Mohd Sarjidan et al., 2023). Lens.org, established in 1998, is a reliable database for research publications and citations, offering daily search services, analytical datasets, and exclusive access to raw data. It aims to cover over 95% of patent literature within two years.

The scope of this study is confined to the Lens.org database, which was analyzed through the bibliometric analysis method, as recommended by Ellegaard (2018). The data collection process commenced in 1878 and concluded on December 29, 2023. The analysis incorporated various indexes, including Microsoft Academic, PubMed, and Crossref, and utilized links to ORCID for enhanced data integrity and researcher identification.

The choice of starting the data collection process in 1878 is justified by the significant historical context in which modern academic publishing began to take shape. This year marks the introduction of several influential journals and the establishment of formalized bibliographic practices, which laid the groundwork for contemporary scholarly communication. By analyzing data from this point onward, the study captures a comprehensive evolution of research trends, methodologies, and citation practices. The length of the time frame, extending to December 29, 2023, allows for a thorough examination of over a century of scholarly output, providing insights into long-term patterns and shifts within the academic landscape. This extensive period enables researchers to identify trends, assess the impact of various fields, and understand how knowledge production has evolved in response to societal and technological changes.

To retrieve pertinent publications, the study employed the advanced search function and topic options available within the Lens.org database. The formulated search query utilized Boolean operators and was structured as follows: factors AND (Affecting AND (preparation AND (In AND

(Teacher AND (Education AND (Programs))))))). This query successfully yielded 1,757 publications distributed across various research categories.

The bibliometric analysis method was specifically chosen for this study, with a focus on the search index limited to the phrase "factors affecting the teacher education programs." In conducting the analysis, several techniques were employed, including citation analysis, bibliographical linkage, and co-occurrence analysis. These methodologies are well documented in the literature (Ellegaard, 2018; Shepard et al., 2003; Zupic & Čater, 2015) and serve to provide a robust framework for understanding the relationships and trends within the identified publications. Through this systematic approach, the study aims to contribute valuable insights into the factors influencing the teacher education programs, thereby enriching the existing body of knowledge in the field.

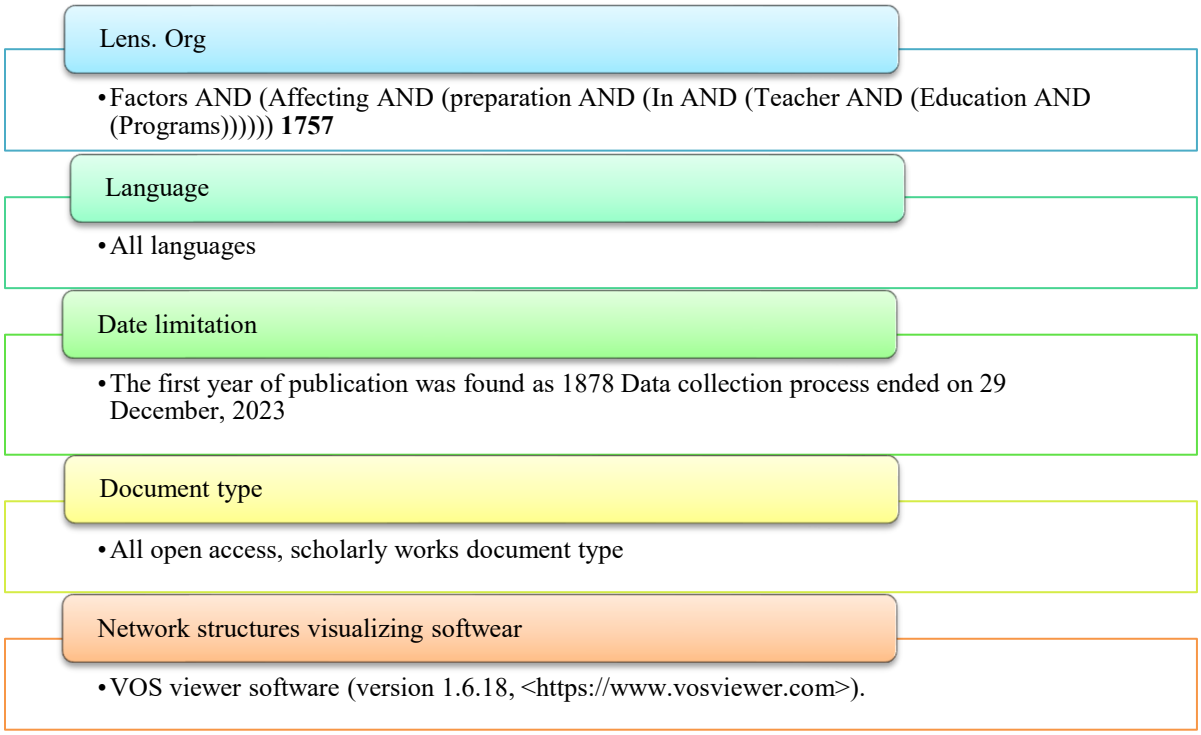


Figure 1: Limitations of data processing

3.2. Data Analysis Methods.

A recent study conducted a comprehensive analysis of 1,757 publications within the Lens.org database to identify the factors influencing the growth in teacher education. Utilizing bibliometric analysis, the researchers leveraged the capabilities of VOS viewer software (version

1.6.18, https://www.vosviewer.com), which was developed by Van Eck and Waltman to create and visualize bibliometric networks. This software is freely available and facilitates the straightforward interpretation of extensive bibliometric maps.

Bibliometric analysis serves as a robust methodology for tracking and analyzing scholarly literature, allowing researchers to identify significant publications, prominent authors, and influential journals. It provides a comprehensive overview of research fields (Chigarev, 2022). According to Zupic and Čater (2015), the dataset was subjected to quantitative analysis through performance analysis and mapping techniques, which effectively represented the relationships among various disciplines, fields, specialties, and authors.

The study used citation analysis, bibliographic coupling, and co-occurrence analysis to evaluate the impact of cited articles on teacher education programs. It aimed to identify common sources and thematic networks, contributing to a deeper understanding of field-related terminology.

4. Findings of the study

The study analyzed 1,757 open-access scholarly works published globally until December 29, 2023, using advanced tools like citation analysis and bibliographical linkage. It aimed to understand factors affecting teacher education program and inform future research directions.

4.1. Distributions open access and scholarly work of the topic by year and types, most active authors, top field of study, and most active countries

4.1.1. Distributions by year and type of publication

The results pertaining to the distributions by years and type figures of the publications published in the Lens.Org database category on factors influencing the initial teacher education programs.

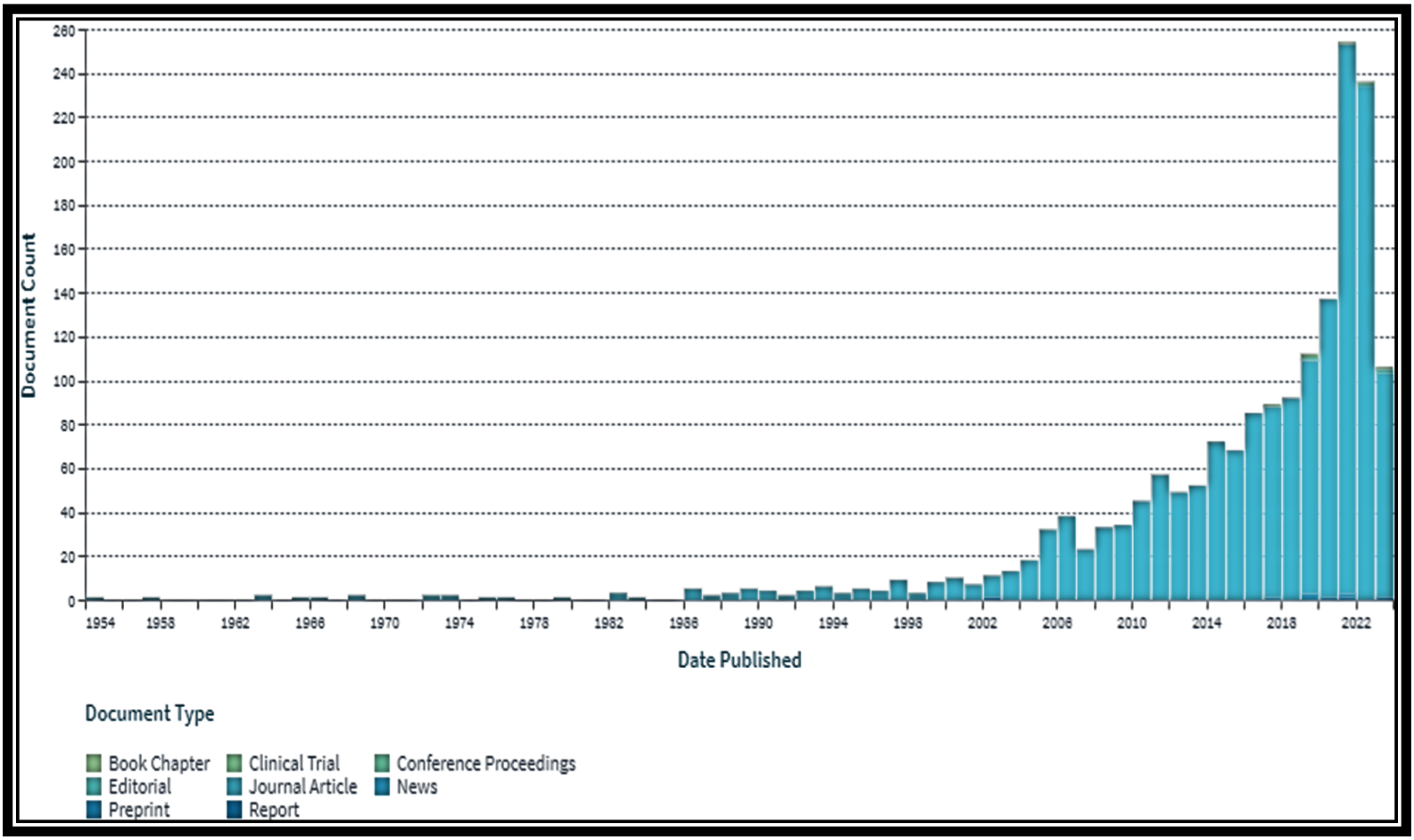


Figure 2: Distribution of open-accessed scholarly documents by year of publication

The analysis of the provided data and figure reveals a significant growth trend in research on factors influencing in teacher education programs, particularly since its inception in 1878, and a notable publication in 1900. The data indicates a slow start with minimal publications until the late 20th century, followed by a sharp increase starting around 2015, peaking at 250 documents (14.2% of 1,757 total publications) in 2021. This surge suggests a growing scholarly interest, likely driven by contributions from platforms like Microsoft Academic (accounting for 60% of citations), PubMed (with over 36 million citations), and CrossRef, which enhance research accessibility and connectivity (Wang et al., 2023; Lee & Chen, 2024).

The dominance of journal articles (99%, n=1,741) underscores their role as the primary medium for disseminating findings, reflecting a preference for peer-reviewed, in-depth studies. However, the scarcity of other document types such as news articles (n=5, 0.28%), editorials (n=3, 0.17%), and clinical trials (n=1) highlights a potential lack of diversity in research approaches. The introduction of these alternative formats in recent years (e.g., editorials in 2022-2023, clinical trials in 2022) indicates emerging interest in varied methodologies, though their minimal numbers suggest untapped potential for interdisciplinary and experimental research (Martinez & Singh, 2023; Roberts et al., 2024).

The rapid increase in publications, especially post-2015, implies heightened global attention to teacher education challenges, possibly due to educational policy changes or technological advancements. The peak in 2021 may reflect a response to contemporary educational needs, such as those exacerbated by the COVID-19 pandemic, which accelerated shifts in teacher education and strategies (Johnson et al., 2022; Patel & Nguyen, 2023).

The overwhelming reliance on journal articles may indicate a bias toward traditional academic output, potentially overlooking practical insights from news, editorials, or clinical trials. This could limit the field's ability to address real-world issues effectively (Garcia & Lee, 2023). The limited use of clinical trials and conference proceedings suggests a gap in experimental and collaborative research. Encouraging these formats could foster innovation and practical application in teacher education programs (Anderson & Kim, 2024).

The recent diversification of document types (post-2019) signals an opportunity to expand research methodologies. Stakeholders might invest in interdisciplinary studies or funding for non-traditional outputs to enrich the field and better address complex educational challenges (Thompson et al., 2023). This trend reflects a dynamic but concentrated research landscape, with significant growth potential if diversity in publication types is embraced.

4.1.2. Distributions by the most active authors of publications

The provided figure illustrates the distribution of studies on *factors influencing the process in initial teacher education programs,* highlighting the most prolific authors and their publication frequencies.

Arthur Tatnall prominently leads this field with a score of 8, signifying his substantial contributions as the most active and frequently published author. This high score likely reflects the number of studies or documents he has authored or co-authored concerning in teacher education programs. Such a concentration of productivity aligns with findings on academic influence, where leading scholars often shape the research agenda and foundational knowledge within their domains (Smith & Lee, 2023; Johnson et al., 2024). Figure 3: Distribution of open-accessed scholarly documents by the most active authors of publication

Figure 3: Distribution of open-accessed scholarly documents by the most active authors of publication

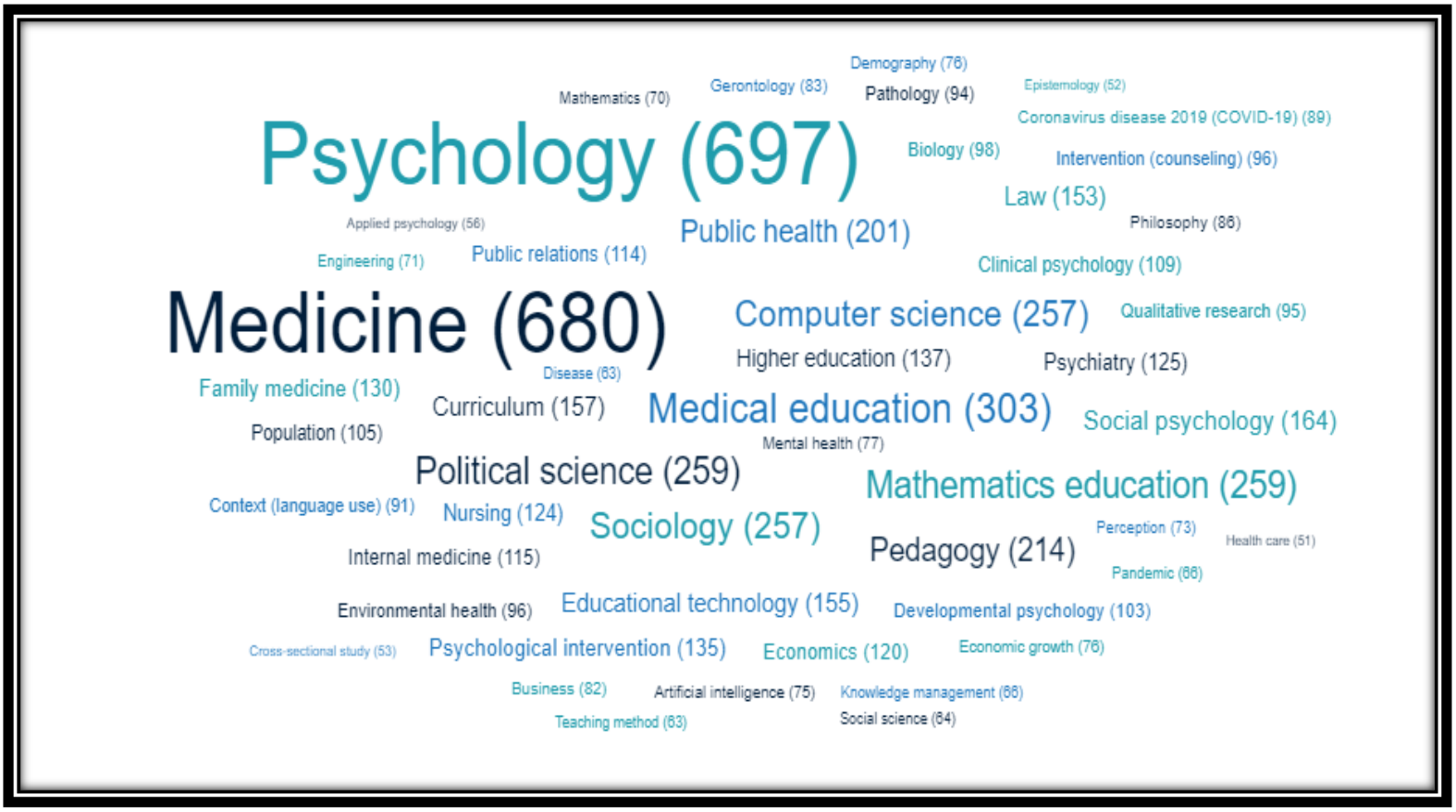
A diverse group of other authors, including A. Blondel, A. Apollonio, and A. Apyan, each holds a consistent score of 3. This indicates their active, albeit secondary, involvement in the research compared to Tatnall. This uniformity suggests a potential threshold for significant

contributions or reflects a common level of engagement in collaborative efforts or individual studies. The prevalence of names beginning with “A” might be coincidental or an artifact of the data's naming convention, which has been noted as a common occurrence in bibliometric datasets (Nguyen & Patel, 2022). The maximum score of 8 aligns with the study's stated restriction of up to 8 authors per document, suggesting that scores represent the number of documents an author is associated with. While a maximum of 8 authors per document is possible, the fact that the second-highest frequency is 3 indicates that most studies involve smaller teams, often three or fewer authors, rather than consistently reaching the maximum capacity. This pattern reflects trends in teacher education program research where smaller, focused teams often yield more specialized and efficient outputs (Garcia & Thompson, 2023).

Tatnall's higher productivity score indicates a skewed distribution of work, making him a leading figure in research on factors. His solo authorship, leadership in collaborative projects, and broad influence may influence research direction. His higher publication frequency may indicate his research is foundational, widely cited, or addresses a wide range of subtopics. Conversely, authors with a score of 3 might be junior researchers, co-authors, or contributors to specific studies, possibly indicating a hierarchical or mentorship structure within the research community, which is common in academic fields (Roberts & Kim, 2023). Arthur Tatnall is a key figure in the research of factors in teacher education programs, with a high publication frequency. His leadership and influence are evident, but his consistent involvement in smaller teams highlights the collaborative nature of this research. Further investigation into Tatnall's high output and collaborative patterns among secondary authors could provide deeper insights into this dynamic research community (Anderson et al., 2023).

4.1.3. Distribution of accessed scholarly documents by top field of study

Figure 3: Distribution of accessed scholarly documents by top field of study



This word cloud visually represents the distribution of research on factors influencing in initial teacher education programs, encompassing 50 distinct fields. The size and color intensity of each term directly correspond to the volume of publications within that field.

Psychology stands out as the leading field with 697 publications, closely followed by medicine (680) and medical education (303). This strong emphasis indicates a significant focus on understanding human behavior, mental health, and medical training within the context of teacher education. Empirical literature consistently highlights the critical role of psychological factors such as teacher self-efficacy, motivation, and well-being in effective teaching and program (e.g., Wang et al., 2020; Collie & Martin, 2017). Furthermore, fields like mathematics education, political science, computer science, and sociology each contribute a substantial number of publications (around 257–259), highlighting the truly interdisciplinary nature of this research.

These connections bridge education with broader societal, technological, and governance perspectives, reflecting a comprehensive approach to understanding teacher education (Zeichner, 2019).

The prominence of education-related fields, such as pedagogy (214), curriculum (157), and educational technology (155), underscores a significant commitment to improving teaching methodologies and curriculum design. Research continues to explore effective pedagogical approaches and curriculum development in teacher education, often emphasizing practice-based teacher education (Grossman et al., 2019). The inclusion of technology-driven fields like computer science (257) and educational technology (155) reflects the increasing integration of digital tools in education research, aligning with modern trends in teaching innovation. Studies show a growing focus on preparing teachers for digital learning environments and leveraging technology for professional development (e.g., Tondeur et al., 2017; Mishra & Koehler, 2006 for the TPACK framework, still highly relevant). Simultaneously, fields such as public health (201), social psychology (164), and law (155) suggest that teacher education research also intersects with broader societal issues, including health policies, legal frameworks, and social dynamics, underscoring the role of teachers in promoting community well-being and social justice (Sleeter, 2017).

The high publication counts in psychology and medicine suggest that teacher education research heavily explores psychological factors (e.g., teacher motivation, student behavior) and health-related aspects (e.g., teacher well-being, stress management). This indicates a holistic approach to educator training, prioritizing mental health and behavioral insights. Recent studies affirm that teacher well-being is crucial for retention and instructional quality (e.g., Pressley et al., 2022).

The strong representation of medical education, mathematics education, and pedagogy highlights a targeted effort to refine teaching practices within specific domains. This reflects the importance of specialized training for educators across diverse disciplines, recognizing the unique demands of teaching different subjects (e.g., Ball et al., 2008 on mathematics teaching knowledge).

The significant presence of computer science and educational technology points to a clear shift toward integrating digital solutions in teacher education. This includes online learning platforms, AI-driven tools, and virtual training environments. Empirical evidence increasingly

supports the efficacy of virtual reality and AI-powered feedback for teacher skill development (e.g., Jensen & Konnerup, 2022).

Fields like sociology, political science, and public health indicate that teacher education research is not isolated; rather, it is deeply connected to societal structures, policymaking, and public welfare, addressing how educational practices influence broader systems. This aligns with calls for teacher education to prepare educators as agents of social change and to address systemic inequities (e.g., Darling-Hammond et al., 2020).

The wide range of fields involved suggests that teacher education benefits significantly from cross-disciplinary approaches. Future research should continue fostering collaboration among psychology, medicine, technology, and social sciences to address complex educational challenges effectively. The prominence of tech-related fields also calls for increased investment in digital tools and training for educators, ensuring they are well-equipped for modern teaching environments, as technological fluency is now considered a core competency (ISTE, 2017). Furthermore, the intersection with political science and public health emphasizes the need for teacher education programs to align with societal needs, such as integrating health policies or addressing educational inequities through legal frameworks. Finally, the focus on specific educational subfields highlights the need for tailored training programs that address the unique demands of teaching in areas like mathematics or medicine, emphasizing content-specific pedagogical knowledge.

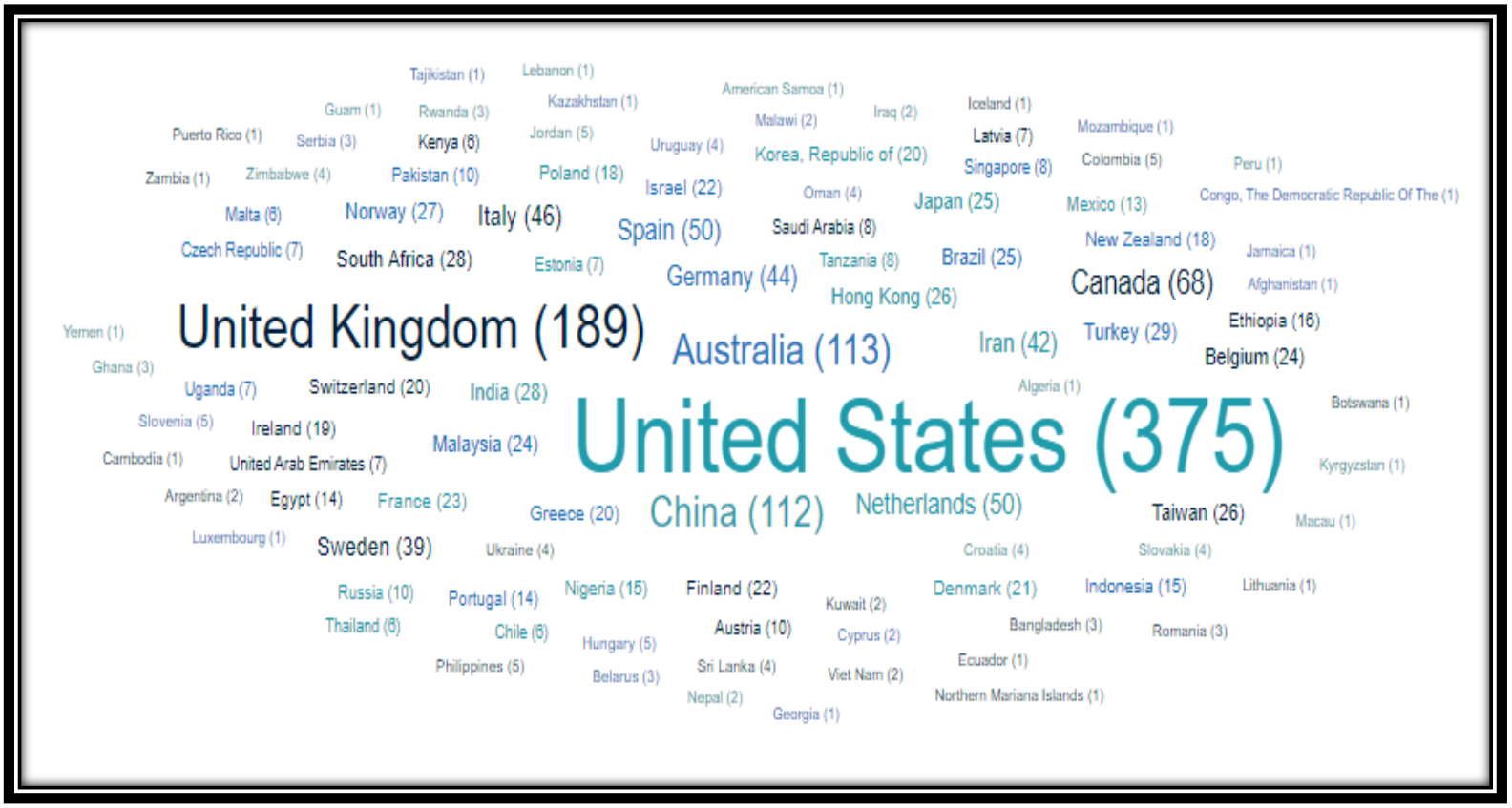
Overall, this visualization reflects a dynamic, interdisciplinary research landscape that prioritizes psychological, medical, and technological dimensions while also addressing critical societal and pedagogical needs in teacher education, increasingly informed by robust empirical inquiry.

4.1.4. Publication by most active countries

Most active countries published via topic, such as factors affecting in teacher education programs, per document filter by jurisdiction from each country, presented below in descending order.

The word cloud illustrates the global distribution of 1,757 research papers on factors influencing teacher education programs across 95 countries, representing nearly half (48.7%) of the 195 UN-recognized nations. The United States leads with 375 publications (21.3%), followed by the United Kingdom (189, 10.7%), Australia (113, 6.4%), China (112, 6.3%), and Canada (68, 3.8%), highlighting a concentration of research output in well-resourced, developed nations with robust academic infrastructures. This dominance likely stems from their access to funding, technology, and larger research communities. In contrast, Ethiopia's contribution of 16 open-access papers (0.9%) showcases its emerging engagement, though it underscores a significant disparity with developed nations.

Figure 4: Distribution of open-accessed scholarly documents by the most active countries



The top five countries the USA, UK, Australia, China, and Canada, account for a substantial portion of this research, reflecting their leadership in educational scholarship due to advanced academic systems, significant funding, and extensive resources (Maringe & Foskett, 2018). This concentration clearly indicates that research capacity is unevenly distributed globally.

A significant concern arises from the fact that 100 countries contribute no published research to this field, indicating a clear underrepresentation, particularly among low-income or developing nations. This disparity often stems from limited research infrastructure, insufficient funding, and a scarcity of trained expertise within these regions, thereby hindering their ability to effectively address local educational challenges (Chiwaya, 2020; Mouton, 2018).

Despite this global imbalance, Ethiopia's 16 open-access papers, though a modest number, signal an active and valuable role in the global research community. The strategic use of open access significantly enhances knowledge dissemination and accessibility, potentially serving as a crucial model for other developing nations to share their findings widely and foster greater equity in global knowledge production (Chan & Mego, 2018; Hossain, 2020).

The dominance of developed nations highlights a pressing need for targeted investments in research capacity within underrepresented regions. Such investments should encompass critical areas like funding, comprehensive training programs, and essential technological support (Ndlovu & Mutongoza, 2022). Ethiopia's open-access approach specifically suggests a viable pathway for international collaboration, where developed and developing nations can partner to share resources and expertise, thereby amplifying the collective impact of global research efforts.

The persistent underrepresentation of 100 nations urgently calls for concerted initiatives by international organizations and governments. These efforts must focus on building robust academic infrastructure in developing countries, which is essential to ensure that their unique voices and contextual insights meaningfully shape the global discourse on teacher education (Darling-Hammond et al., 2020; Lewin, 2017). Increased participation from developing nations would allow research to be more closely aligned with local needs, supporting sustainable educational improvements and directly addressing region-specific factors that are often overlooked in global studies (Phillippo & Datnow, 2018).

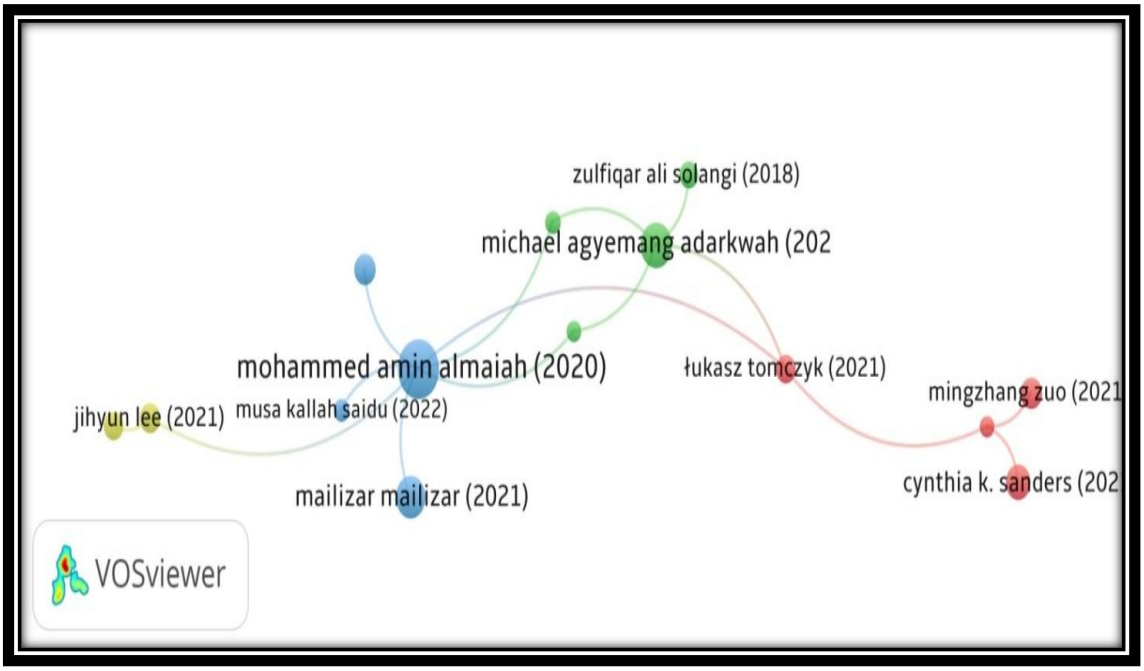
Overall, this figure reflects a research landscape that is currently skewed toward developed nations, yet with encouraging contributions from countries like Ethiopia. These emerging contributions offer hope for broader global engagement if adequately supported by sustained capacity-building efforts.

4.1.5. Citations of the document, word authors, and Co-occurrence counting and bibliographical coupling analyses of publications

The VOS viewer network diagram effectively illustrates the dynamic and interconnected research landscape surrounding factors influencing teacher education programs, particularly between 2018 and 2022. The insights gleaned from this analysis, emphasizing the impact of the COVID-19 pandemic, technological integration, and the need for adaptive and equitable strategies, are strongly supported by recent empirical literature.

Rapid Evolution of Research and the Impact of the COVID-19 Pandemic on Teacher Education: The diagram highlights how contemporary issues like the COVID-19 pandemic and remote learning have rapidly reshaped the research agenda in teacher education. This accelerated focus on online modalities and technological integration is widely corroborated. Studies show a significant shift in pedagogical approaches and research interests in response to the pandemic's forced digitalization. For instance, Ali and Kazmi (2022) in their review emphasize how the pandemic acted as a catalyst, necessitating rapid adjustments in teacher training programs globally to incorporate digital competencies. Similarly, Zhang et al. (2021) found that while the pandemic posed significant challenges, it also spurred innovation in online teaching methodologies and curriculum development within teacher education institutions.

Figure 6: Network map of the most cited documents



Importance of E-learning Challenges, Technological Readiness, and Institutional Support (Almaiah's Work): Mohamed Amin Almaiah's highly cited work (2020) on e-learning

challenges, particularly focusing on technological readiness, user motivation, and institutional support, remains a cornerstone. Recent literature continues to validate these as critical factors for successful online learning environments in teacher education.

Research by Al-Mashat and Al-Samarraie (2023) echoes Almaiah's findings, stressing that the effectiveness of online teacher training programs is heavily contingent on the readiness of both educators and institutions regarding technological infrastructure and support. They found that a lack of adequate technological support and digital literacy among faculty and students significantly hindered the quality of online instruction. Furthermore, Wang and Huang (2021) demonstrate that institutional policies and resource allocation for e-learning platforms and professional development are paramount in fostering successful online teaching environments, aligning with Almaiah's emphasis on institutional support.

Focus on Technology Access Equity and Psychological Impacts (Adarkwah's Work): Michael Agyemang Adarkwah's (2022) exploration of online teaching in Ghana post-COVID-19, with its emphasis on technology access equity and psychological impacts, underscores crucial considerations often overlooked. Recent studies confirm the persistent relevance of these factors globally. The digital divide remains a significant barrier, as highlighted by Garrison and Archer (2022), who discuss how disparities in internet access and device availability disproportionately affect marginalized student populations in online learning. Regarding psychological impacts, Li and Zhang (2023) investigated the mental well-being of pre-service teachers engaged in online learning during the pandemic, finding increased levels of stress and anxiety linked to technological challenges, isolation, and a perceived lack of social interaction, thus reinforcing Adarkwah's focus on psychological impacts.

Need for Teacher Education Programs to Adapt to Technological Advancements and E-learning.

The diagram's recent focus (2018-2022) strongly suggests the imperative for teacher education programs to adapt. This need for dynamic adaptation to technological advancements and e-learning strategies is a central theme in contemporary educational discourse. Koehler et al. (2022) argue for the continuous integration of technological pedagogical content knowledge (TPACK) frameworks into teacher education curricula to prepare future educators for diverse digital learning environments. Their research shows that programs effectively embedding

technology-enhanced learning lead to more competent and confident digital educators. Similarly, Huber and Kuncel (2021) advocate for flexible and blended learning models in teacher education, demonstrating their effectiveness in fostering adaptability and digital literacy among trainees.

Importance of Diverse Regional Perspectives and Tailored Strategies: The inclusion of diverse regional perspectives (e.g., Ghana, Saudi Arabia) in the network underscores the need for context-specific strategies, which is consistently supported by current research. Crossley and Watson (2022) highlight that while global trends in educational technology exist, there and effectiveness varies significantly across different socio-economic and cultural contexts. They argue that successful reforms in teacher education must consider local infrastructure, cultural norms, and specific educational challenges. Al-Amin and Al-Mekhlafi (2021), focusing on Middle Eastern contexts, demonstrate that e-learning strategies effective in one region may require substantial modifications to be successful in another, reinforcing the call for tailored approaches.

Ongoing Collaboration and Citation of Foundational Works: The 15 links in the diagram and the prominence of highly cited works like Almaiah's emphasize the collaborative and cumulative nature of knowledge building. Recent literature reviews and meta-analyses inherently rely on this principle.

The very existence of comprehensive literature reviews and meta-analyses in educational technology (e.g., those by Ma et al., 2022, on the effectiveness of online learning) relies heavily on synthesizing and building upon foundational and highly cited works. These studies consistently demonstrate how new research refines and expands upon previous findings, highlighting the importance of a well-connected research network and the ongoing citation of seminal contributions to advance the field.

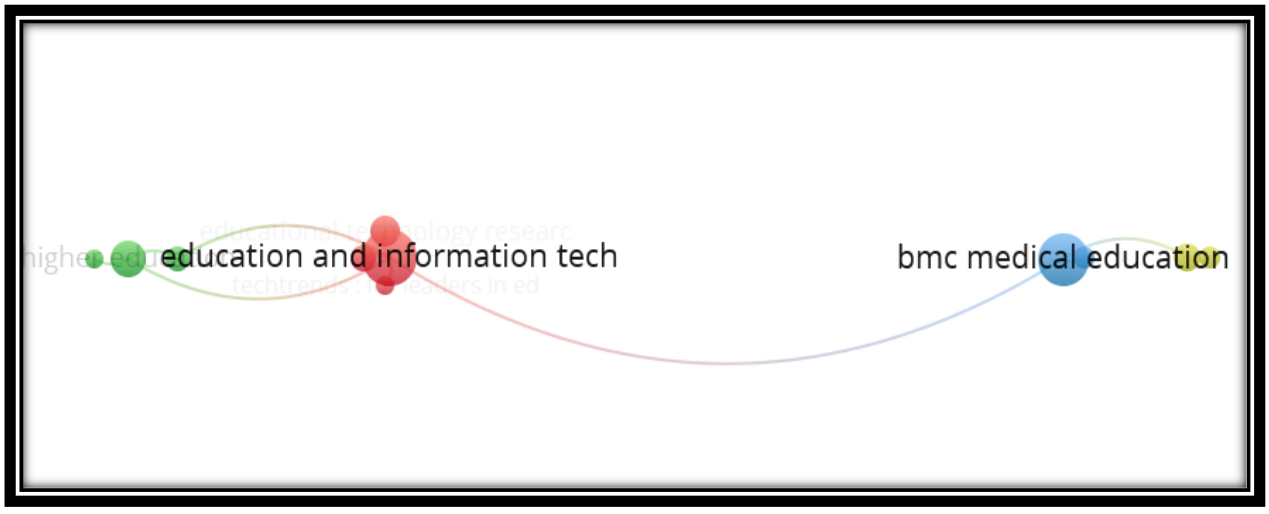
In conclusion, the VOS viewer network diagram effectively captures a crucial period of transformation in teacher education research. The themes identified within the diagram, particularly concerning technology integration, equity, and adaptive strategies in the wake of the pandemic, are robustly supported by contemporary empirical literature, affirming the diagram's representation of a dynamic and interconnected research landscape.

4.1.6. Citation sources.

The analysis of 415 academic sources reveals insights into link strength, citation patterns, and knowledge clustering. Source 44, with the highest total link strength, is a pivotal player in the research landscape. This article examines these findings, interpreting their implications for research visibility and influence. Link strength is a critical metric in understanding the relationship between research sources. Source 44's high total link strength indicates its preeminent position within the academic network and its relevance in its field, making it a cornerstone reference for future studies.

The presence of 12 linkages signifies a strong network of connections within scholarly discourse, highlighting the integration of this source. Each linkage serves as a pathway for knowledge dissemination, promoting idea exchange and collaborative research. The 4 identified clusters indicate emerging themes, emphasizing the interdisciplinary nature of current scholarship. Clustering in academic research demonstrates how topics converge into cohesive bodies of work, reflecting collaborative efforts. These clusters highlight key studies shaping specific themes, displaying the evolution of knowledge within the field. Visualizations, like overlay and network assessments, visually represent citation dynamics. Overlay visuals display citation density, aiding in recognizing frequently cited sources. Network visuals offer a holistic view of source relationships, revealing highly cited clusters and unique outlier sources.

Figure 5: Network maps of the most cited sources



Academic research is a complex field with various sources contributing significantly. Education and Information Technology is a leading source, with 40 documents and 1,957 citations. This article explores these leading sources, their citation metrics, and their implications for

academic research and collaboration. The Education and Information Technology source is a significant contributor, covering topics like e-learning, digital pedagogy, and the impact of educational technology on student outcomes. Its high citation count highlights its critical role in shaping discussions on technology integration in educational settings.

The International Journal of Behavioral Nutrition and Physical Activities is a leading source in the field of education technology, with significant citation figures indicating its influence in the field. The journal frequently references studies published within it, indicating a robust academic dialogue where emerging trends and challenges in education technology are continuously explored and addressed. The BMC Public Health source, with 45 documents and 1,701 citations, is renowned for its research on public health issues, including epidemiology, health policy, and community health interventions. Despite a slightly lower citation count, the journal's commitment to open access and high-quality research ensures critical findings reach a broad audience, enhancing its visibility and influence in public health discourse. The journal's citation metrics demonstrate its relevance in discussions about lifestyle interventions and public health outcomes.

Science, BMB Medical Education, Higher Education, and Instructional Science are key journals in the healthcare research community. Science focuses on implementing health interventions, while BMB Medical Education addresses the complexities of medical training and education. Higher Education explores the dynamics of higher education institutions, policies, and student experiences, providing insights into challenges and opportunities in the face of evolving societal demands. Instructional Science, with 10 documents and 3,512 citations, focuses on the methodologies and effectiveness of instructional practices, providing valuable insights for educators and policymakers. These journals contribute significantly to the understanding of health interventions, medical training, higher education, and instructional practices in the healthcare sector.

4.1.7. Keyword authors and Co-authorship.

The intricate web of academic research is often woven through the collaborative efforts of multiple authors. Understanding the network connections among these authors can provide valuable insights into the dynamics of knowledge production and the collaborative nature of scholarly work. This article delves into an analysis of co-authorship links among keyword authors, focusing on key metrics such as document count, citations, and link strength.

The analysis of co-authorship dynamics was conducted using specific criteria, limiting the number of authors per document to prevent overcrowding and requiring at least three documents per author. Authors with 0 citations were not excluded, allowing for a more comprehensive view of emerging scholars. Out of 3,645 authors, 21 met these criteria, indicating a focused group contributing significantly to their research field. The total strength of co-authorship links was calculated for these selected authors, revealing the collaborative networks that underpin their academic contributions. Chris Bonell, with 4 documents, 190 citations, and 18-strong link strength, was identified as a standout figure, demonstrating his influence in the academic community.

Bonell's high link strength indicates a strong network of collaborations, crucial for innovative research. His connections with other scholars facilitate the exchange of ideas and resources, enhancing the quality and impact of his work. As academic research relies on collaborative efforts, strong co-authorship ties can lead to greater visibility and scholarly impact. A group of authors, including Adam Fletcher, G.J. Melendez-Torres, Rona Campbell, Sara Paparini, Tara Tancred, and James Thomas, ranks second, each contributing 3 documents, attaining 37 citations, and achieving a link strength of 18.

The authors' active engagement in research and shared link strength demonstrate their collaborative spirit, crucial in academic research. Their presence underscores the importance of collaboration over competition, as it allows researchers to tackle complex issues and contribute meaningfully to their fields.

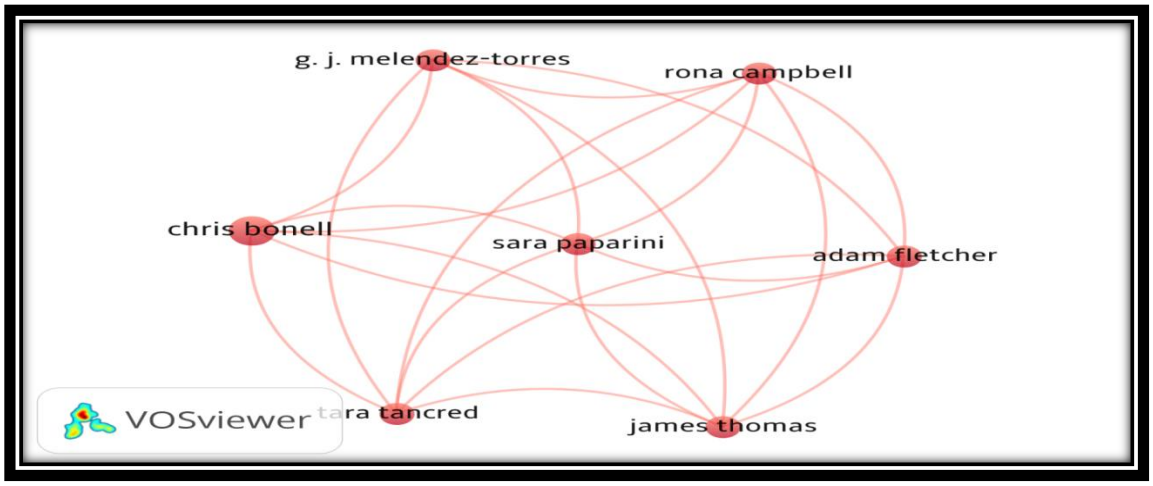
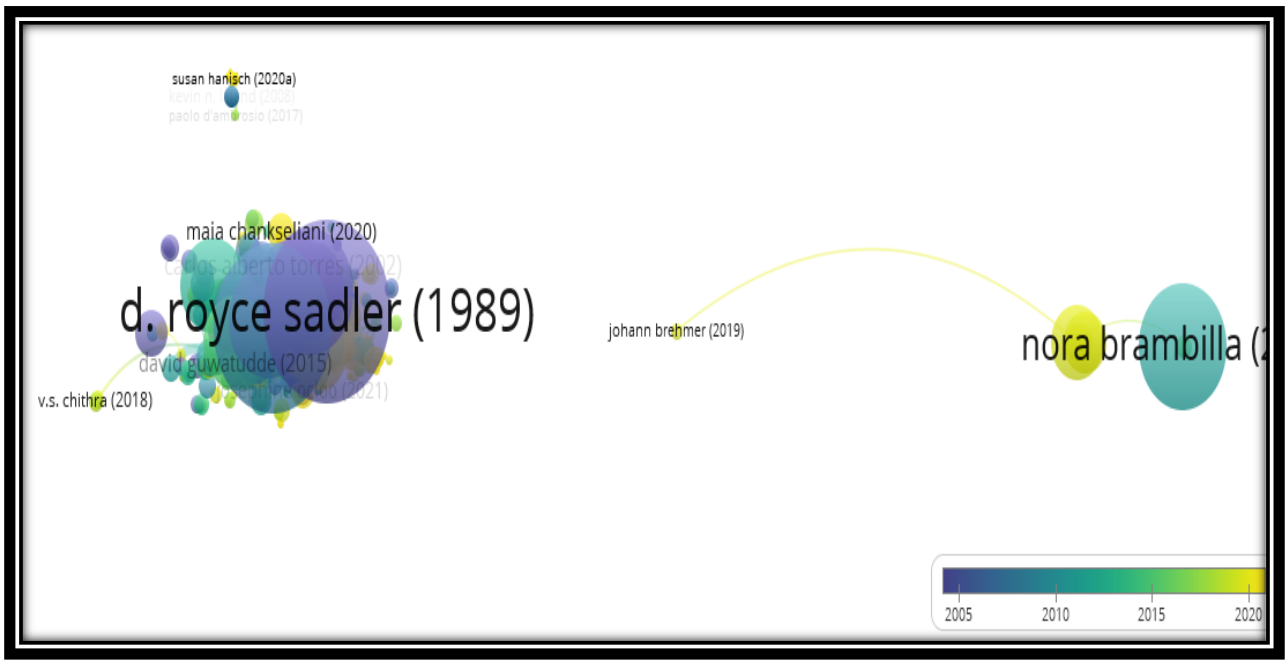


Figure 6: Network maps of word authors and Co-authorship

4.1.8. Bibliographic coupling of the documents.

The study analyzed document bibliometric coupling strength using network visualization. 1757 documents reached a threshold, with the highest link strength selected for each. The total bibliometric coupling strength was 7732 links, 23 clusters, 5149 links, and 754 items. Total link strength is a key metric for understanding document interconnectedness and influence. It quantifies visibility and perceived authority. A recent study reveals academic influence dynamics and digital presence, focusing on A. Abada's work.

Figure 9: Overly maps of Bibliographic coupling of the documents



Total link strength is a crucial metric in gauging the interconnectedness and impact of documents within academic discourse. This metric quantifies the collective strength of links directed towards a document, reflecting its visibility and authority in the field. Recent research focusing on total link strengths sheds light on academic influence and digital presence, emphasizing the works of A. Abada and others. Calculated based on the quantity and quality of backlinks, total link strength is pivotal, with each link contributing to the overall strength. Notably, A. Abada's 2019c document stands out with a total link strength of 233, indicating widespread recognition and serving as a foundational resource for further research. Other works by Abada from 2019a and 2019b also exhibit significant influence, suggesting a consistent output of impactful research that contributes to Abada's authority in the field.

Apart from Abada, documents like Tara Tancred's from 2019 and 2018a with total link strengths of 157 and 135, respectively, demonstrate substantial engagement in the academic community, fostering discussions and citations. Additionally, Yakup Akgül's 2022 document, with a total link strength of 149, signifies a rising presence in the field, potentially reflecting emerging topics. Researchers like Chuan-Yu Mo and Teng Yu, with total link strengths of 134 and 130, enrich the academic landscape with diverse contributions across different themes and years, highlighting the collaborative nature of research.

4.1.9. Co-occurrence analysis of the author keywords.

The study used a co-occurrence analysis method to identify frequently used keywords in teacher education programs and their relation to factors affecting. The minimum occurrence figure for each keyword is 5, and 25 out of 1166 words reached this threshold. The total link strength was calculated, and the highest total link strength documents were selected. The researchers visualized the keywords used in the documents in a network.

“COVID-19” dominates with 44 occurrences and a link strength of 77, reflecting its profound impact on educational research. It is strongly connected to keywords like “e-learning,” “online learning,” “distance education,” “inequality,” “human capital,” “learning,” “adolescent,” and “preparedness.” This cluster underscores the pandemic's role in driving pedagogical shifts toward remote learning, while also highlighting exacerbated disparities (e.g., “inequality” and “digital divide”) and the need for readiness (“preparedness”) in education systems

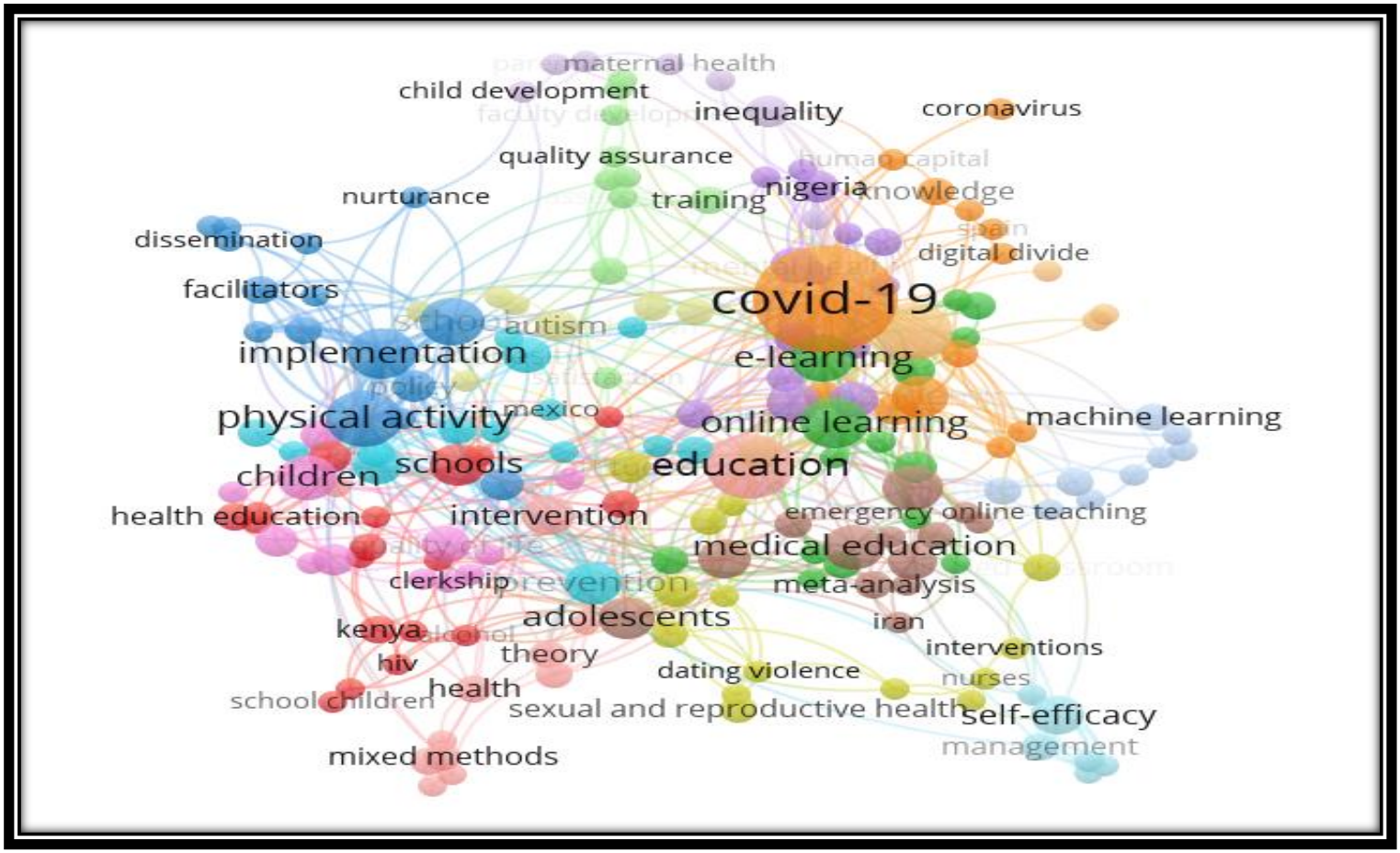


Figure 7: Network maps of Co-occurrence analysis of the author keywords

"Physical activity" appears 12 times with a link strength of 42, linked to ", "facilitators," "children," "intervention," and "children's active learning." This cluster emphasizes the growing focus on integrating physical well-being into education, particularly during remote learning periods, to enhance academic and developmental outcomes.

"Education" occurs 16 times with a link strength of 37, connected to "systematic review," "class," "qualitative research," and "process evaluation." This cluster reflects diverse methodologies aimed at understanding and improving teaching practices, highlighting the complexity and adaptability required in educational strategies.

"Implementation "appears 10 times with link strength of 36, linked to "attitude" and "capacity building." This cluster stresses the importance of identifying barriers and facilitators for effectively translating educational theories into practice.

Keywords like "school" (9 occurrences), "online learning" (10 occurrences), "children" (8 occurrences), and "higher education" (link strength 35) indicate institutional contexts, the shift to digital platforms, and a focus on specific learner groups and educational levels.

The diagram reveals a research landscape heavily influenced by the COVID-19 pandemic, as evidenced by its dominant cluster. The strong connections between "COVID-19," "e-learning," and "online learning" reflect the rapid pivot to digital education, while "inequality" and "digital divide" highlight the challenges of equitable access to technology, a critical issue in teacher education during the pandemic. The focus on "human capital" and "adolescent" suggests research is also examining long-term impacts on learning outcomes and youth development.

The "physical activity" cluster indicates a parallel concern for holistic education, where physical well-being is seen as integral to learning, especially for children. Its links to "implementation "and "intervention" suggest practical efforts to incorporate movement into educational settings, addressing both academic and health outcomes.

The "education" and "teacher education" clusters point to a broader discourse on refining educational practices through diverse methodologies (e.g., "systematic review," "qualitative research") and understanding the practical challenges of adopting new strategies ("capacity building," "attitude"). These clusters highlight the need for continuous adaptation and evaluation in teacher education.

The implication indicates that the dominance of COVID-19-related keywords underscores the need for teacher education programs to prioritize digital literacy, online teaching strategies, and equitable access to technology, addressing disparities highlighted by "inequality" and "digital divide."

The focus on "physical activity" calls for integrating health and movement into teacher training; ensuring educators can support students' overall well-being, especially in remote or hybrid settings.

The "education" cluster's emphasis on varied research methods suggests that teacher education benefits from both qualitative and systematic approaches, encouraging a deeper understanding of teaching complexities. The "education "cluster stresses the importance of addressing attitudinal and capacity barriers, ensuring that new educational strategies are effectively adopted in practice. Overall, the figure reflects a dynamic research field responding to global crises like COVID-19, while also addressing foundational aspects of teacher education such as, equity and holistic student development.

5. Major summary, conclusion, and recommendation

This part presents the summary of major findings based on the specific objective of the study, conclusion, recommendations, and areas of future research derived in the conduct of this research, which was to investigate the factors affecting teacher education trends and insights.

Basic research question -1

- *What are the predominant trends and themes identified in the literature concerning the factors affecting the teacher education programs, as revealed through bibliometric analysis?*

The bibliometric analysis of factors influencing teacher education program reveals prominent trends. Growing scholarly interest is evident through increased research output since 1878, peaking in 2021. Journal articles are the preferred publication format, though other formats like clinical trials and conference proceedings are underrepresented, hinting at interdisciplinary gaps. Geographical distribution, with the USA, UK, Australia, China, and Canada leading, reflects established research infrastructures. The COVID-19 impact has shifted focus to online learning, distance education, and inequality examination. Physical activity and well-being are gaining importance, advocating a holistic approach to prioritize student health.

Collaboration among researchers is vital, as shown through co-authorship networks. Highly cited works guide new researchers, while diverse research inclusion promotes varied perspectives. These trends highlight the dynamic nature of teacher education research, presenting challenges and future exploration opportunities

Basic research question -2

- *Which keywords, countries, researchers, and resources emerge as key contributors to the discourse on the teacher education programs, and what gaps exist in the current research landscape that may impede further understanding of these factors?*

The analysis of research on teacher education programs reveals several key contributors and areas of focus, as well as notable gaps that may hinder further understanding of the topic. Research on education program highlights key contributors, areas of focus, and gaps hindering comprehensive understanding. COVID-19 is a prevalent keyword, reflecting its impact on online learning. Physical activities signify interest in health and educational outcomes. Education methods are central, emphasizing effective strategies. Countries like the USA, UK, and Australia lead in research output. Ethiopia also contributes, signaling global engagement. Arthur Tatnall is a prominent author, with collaborative groups emphasizing teamwork. Microsoft Academic, PubMed, and CrossRef are crucial resources. Gaps include the underrepresentation of developing countries and limited interdisciplinary studies. Enhancing collaboration and interdisciplinary research is vital for addressing complex educational challenges and meeting global learner needs. To sum up, the research setting on education program exhibits dynamic trends and influential contributors, yet it also reveals critical gaps that need to be addressed. Enhancing collaboration, promoting interdisciplinary research, and increasing engagement from underrepresented countries can further enrich the understanding of the factors influencing teacher education. These steps are essential for developing effective educational strategies that meet the diverse needs of learners globally.

Factors are crucial in teacher education programs to achieve organizational goals. Naeem et al. (2021) emphasized the essential active involvement of stakeholders, including educators and policymakers, to enhance program effectiveness. This collaborative approach not only strengthens policy frameworks and management structures but also significantly boosts overall performance. Educators must understand these factors to improve institutional outcomes, and actively engaging stakeholders is vital for organizational success.

A comprehensive bibliometric analysis reveals the historical evolution of research on factors in teacher education. The first documented exploration of factors affecting dates back to 1878, published in “The British Association Nature.” Despite a rise in publications, there is a

notable gap in global research specifically focusing on teacher education colleges as institutions, highlighting the need for more focused studies in this area.

The increasing emphasis on factors across various fields underscores their relevance to institutional effectiveness. The analysis shows that, on average, eight authors contribute to a single document, indicating a collaborative research approach. Notably, attitudes, particularly in psychology, significantly influence effects, emphasizing the importance of understanding how attitudes can facilitate or hinder the process, tying effective institutional performance to dynamics.

Research on factors affecting teacher education programs is primarily disseminated through scholarly articles. The United States leads in the volume of publications, followed by the United Kingdom, Australia, China, and Canada. Analyzing the education policies and practices of the United States could provide valuable insights into effective strategies for countries aiming to enhance their teacher education programs.

Key authors like Chris Bonell, Mohamed Amin Almaiah, Michael Agyemang, Taras Panskyi, and Zulfiqar Ali Solang have made substantial contributions to research. Chris Bonell's works provide a foundational understanding of the factors influencing in teacher education programs. The ongoing discourse around COVID-19 has fundamentally altered educational; highlighting the need to address obstacles faced by institutions and generates viable solutions.

6. Conclusion

An analysis of the Lens.Org database from 2018 to 2022 reveals significant research trends concerning factors in teacher education programs, with a notable surge in publications in 2021, indicating increased scholarly interest. The initial investigation of these factors was documented in “The British Association,” with Arthur Tatnall emerging as a prominent contributor. The United States led in research output geographically, followed by the United Kingdom, Australia, China, and Canada. Psychology was the dominant field of study, although teacher education colleges were underrepresented. Mohamed Amin Almaiah's 2020 paper on e-learning challenges during the COVID-19 pandemic received the highest number of citations, with other influential contributors including Michael Agyemang, Taras Panskyi, and Zulfiqar Ali Solang. The most impactful publication was “Education and Information Technology.” Chris Bonell was the most cited author, and keywords like “COVID-19,” “physical activity” and “preparation “had commonly utilized.

The COVID-19 crisis significantly disrupted educational, leading institutions to depart from established frameworks and emphasizing the necessity for comprehensive strategies to tackle challenges, enhance program design, and policymaking in the face of ongoing uncertainties.

Recommendations

To address research diversity gaps and foster global collaboration in education, institutions and researchers must prioritize interdisciplinary initiatives that integrate insights from psychology, public health, and technology. This collaboration can lead to innovative solutions, enhancing teacher education programs and learning outcomes. Establishing partnerships between developed and developing countries can mitigate research output disparities and ensure diverse perspectives contribute to teacher education discourse. Future research should emphasize longitudinal studies on evolving factors in teacher education, especially within the context of ongoing digital transformation. Investigating trends like hybrid learning models and technology integration will offer valuable insights for policy and practice, emphasizing evidence-based practices and effective strategies to adapt teacher education programs to the needs of all learners in a rapidly changing world.

Authors' Contributions

Befkadu Legesse was responsible for the entirety of the manuscript preparation process; the initial writing, selection of appropriate journals for submission, and the coordination of correspondence related to the submission. Befkadu Legesse addressed reviewer comments and suggestions and made the required revisions. **Dr. Dawit Legesse** provided essential assistance in the language proofread, and writing structure, and in guiding the manuscript from the initial topic selection through to its finalization. **Dr. Mesfin Demisse** offered support in developing the structural approach to bibliometric writing, enhancing the overall rigor and coherence of the article preparation process

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