

Teacher Professional Development and Professional Standards for Teachers: A Bibliometric Mapping of Literature (1975-2025)

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Abstract

The purpose of this study is to conduct literature mapping on professional development, continuous professional learning, and teacher professional standards using metadata extracted from 5,156 journal articles indexed in the Web of Science database from 1975 to 2025. The study employs bibliometric methods to describe and visually represent the literature's growth trajectory, productivity, and the social, intellectual, and conceptual structure of the field over the past 50 years. The findings reveal that research in these areas: (a) has shown steady growth, particularly since 2015; (b) is published across diverse journals in the categories of "Education Educational Research," "Psychology," and "Linguistics;" (c) is produced by scholars from various regions, with the USA, China, and Australia as leading contributors; (d) consists of a fragmented research community with limited interaction between groups; (e) is interdisciplinary, emerging from the convergence of research in education, psychology, and linguistics; and (f) has focused on eleven research themes over the past 50 years, including "Teacher Professional Development," "Educational Policy and Practice," "Educational Research Methodology," "Modern Educational Technologies and Learning," "Pedagogical Interaction in the Educational Process," "Professional Standards and Educational Development," "Social-Educational Communities and Communications," "Assessment and Learning Practice," "Educational Practice Research Methods," "Educational Reform Effectiveness," and "Innovative Technologies in Education." The bibliometric analysis provides insights for the further development and reconceptualization of the field, offering perspectives for identifying new research directions and methodological approaches in professional development, continuous professional learning, and teacher professional standards.

Keywords: *Continuous professional development, professional standard, professional standards for teachers, teacher professional development.*

Introduction

A professional standard, as a qualification characteristic, is necessary for a worker to perform a specific type of professional activity (Abdiyev et al., 2023; 2025; Hoyle, 1993; Ingvarson, 1998; Lester, 2014). The first systematic approach to standardizing professional qualifications emerged

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in the United Kingdom in the mid-1980s (Sachs, 2003). According to the International Labour Organization, the evolution of professional standards has occurred in three main stages: formation (1970-1990), institutionalization (1990-2010), and digital transformation (2010 to the present). Throughout this process, the key components of an effective professional standards model have been progressively identified and refined. The transition from basic qualification frameworks to complex competency models reflects broader changes in how teaching professionalism is conceptualized and regulated. Understanding this developmental trajectory is crucial for contextualizing the present study's focus on mapping the intellectual landscape of research in this field.

In modern education systems, professional teaching standards have become a key mechanism for ensuring teaching quality and fostering teachers' professional development (Tshelane, 2022; Zhang et al., 2024). Professional development of teachers is a continuous process of improving the professional competencies of educators, aimed at enhancing the quality of the educational process and improving student learning outcomes, including formal and informal learning, reflective practice, and collaborative interaction with colleagues (Dwomoh et al., 2023; Metin Aslan, 2024; Mokotjo, 2023). As Desimone (2009) notes, effective professional development is characterized by coherence, content focus, active learning, collective participation, and sufficient duration, allowing teachers to integrate new knowledge and practices into their daily activities.

According to the 2018 TALIS international study, more than 90% of teachers regularly participate in professional development; however, its formats and quality vary significantly between countries (OECD, 2019). Darling-Hammond and co-authors (2017) found that the most effective teacher professional development systems are integrated into school culture and oriented toward the specific needs of students and the educational context. Key trends in the professional development of educators include: personalization of educational trajectories (Kools & Stoll, 2016), development of professional learning communities (Harris & Jones, 2018), integration of digital technologies and artificial intelligence into teaching (Prestridge, 2019), focus on developing 21st century global competencies (Schleicher, 2018), as well as increased attention to psychological well-being and prevention of professional burnout among teachers (Day & Gu, 2014).

International experiences with implementing these standards highlight both positive outcomes and certain challenges in their application. Professional standards outline competency requirements for teachers at different career stages. For example, in Australia, these standards define teachers'

professional knowledge, practices, and engagement across four levels: graduate, proficient, highly accomplished, and lead teacher. Research shows that the effectiveness of these standards largely depends on organizational conditions, resource availability, and the recognition of teachers' personal attributes (Quinlivan, 2021).

A critical analysis of standards implementation highlights the tension between the aspiration for standardization and the inherent complexity of teaching. Salton et al. (2022) note that formalized requirements may conflict with teachers' lived experiences, potentially restricting their professional autonomy. Mockler (2022) further claims that modern standards regimes create cultural-discursive and socio-political conditions that prioritize instrumental forms of professional learning over more authentic professional growth.

The perception and application of standards at different career stages are particularly significant. Call et al. (2021) found that while future teachers generally hold positive attitudes toward professional standards, they often struggle to see their direct relevance to personal and professional development. This suggests a need for deeper integration of standards into teacher education programs to enhance their practical value.

International experience highlights different approaches to addressing the challenges of implementation of professional standards. Estonia, for example, has adopted a decentralized system that allows for flexible teacher professional development throughout their careers (Leijen et al., 2023). In contrast, Bourke et al. (2018) found that teacher educators often engage with standards in a formalized manner, primarily to meet accreditation requirements, while also exhibiting a degree of resistance.

Singapore provides an illustrative case where political discourse on teacher professionalism integrates managerial and professional approaches. However, as Ro (2020) notes, this integration tends to narrow the understanding of professionalism, reducing it to the effective implementation of the national curriculum rather than fostering broader pedagogical autonomy.

China has sought to formalize the use of professional standards through the development of self-assessment tools. Zhang et al. (2024) describe the creation of a competency self-assessment scale for kindergarten teachers, which measures professional knowledge (8 indicators), professional practice (18 indicators), and professional attitudes (8 indicators).

The literature analysis suggests that effectively implementing professional teaching standards requires balancing standardization with maintaining professional autonomy. It is essential to strike

a balance between formal requirements and authentic opportunities for professional development. Special attention should be given to integrating standards into teacher education programs and creating conditions that support their meaningful application in professional practice.

The analysis of the evolution of the professional standard "Teacher" in the Republic of Kazakhstan highlights a comprehensive transformation in the regulation of pedagogical activity from 2017 to 2021 (National Chamber of Entrepreneurs of the Republic of Kazakhstan "Atameken," 2017; Ministry of Enlightenment of the Republic of Kazakhstan, 2022). Research by the National Academy of Education named after I. Altynsarin (2019) shows that the first iteration of the professional standard, approved by NCE "Atameken" Order No. 133 on June 8, 2017, had several systemic limitations. The document revealed a significant gap between the declared competencies and the actual needs of educational practice.

A paradigm shift in the conceptualization of the professional standard occurred within the framework of the "Modernization of Pedagogical Education" project, implemented by the Ministry of Education and Science of the Republic of Kazakhstan in 2021. The new version of the document, presented by Minister of Education A. Aimagambetov, reflects a more systematic approach to standardizing pedagogical activity and introduces several key innovations. Methodologically, the transition from a qualification-based to a competency-based approach was implemented, integrating international best practices in teachers' professional development and strengthening the practice-oriented component. Structurally, the modernization provided a clear articulation of professional development levels, differentiated requirements for various categories of pedagogical workers, and the introduction of a system of professional tracks. Institutionally, the standard was synchronized with the national qualifications framework, integrated with teacher certification mechanisms, and aligned with pedagogical education programs to ensure continuity. However, the professional standard also has several shortcomings. The Professional Standard "Teacher" (Republic of Kazakhstan, 2022) reveals significant methodological and structural issues that require scientific analysis. A major concern is the methodological inconsistency in the development of professional competencies. Although the "Professional Values" section aims to establish competencies across various qualification categories, it remains unchanged regardless of professional development levels. This lack of differentiation disrupts the integrity of the competency model and contradicts modern scientific understanding of the dynamic nature of a teacher's professional growth.

The inclusion of the "Professional Activity" section in the occupational card, while absent from the Teacher's Professional Competency Framework, creates unnecessary complications. Content analysis revealed partial duplication of competencies between this section and the "Teaching Practice" component, indicating a lack of systematic consistency in the standard's structure. Additionally, excessive detailing in the Occupational Card presents further challenges. While differentiation of requirements for various categories of teachers could be beneficial, its implementation has resulted in an overly lengthy document (64 pages), significantly reducing its practical usability.

The third critical issue concerns the integration of the standard with the teacher certification system. While the standard defines requirements for teacher qualifications, competencies, and professional functions, it operates independently of the certification process. Teacher certification follows separate regulatory documents and criteria that exist parallel to the professional standard without a direct connection (Ministry of Education and Science of the Republic of Kazakhstan, 2016). Although the professional standard is intended to establish fundamental professional requirements, it does not function as a tool for assessing professional performance. As a result, teachers must navigate two separate systems of requirements, diminishing the effectiveness of both frameworks.

The lack of integration between the professional standard and the certification system not only diminishes the effectiveness of both instruments but also imposes an additional administrative burden on teaching staff, requiring them to navigate separate and sometimes conflicting requirement systems.

Our bibliometric study addresses this research gap by mapping the intellectual and social structure of research on professional development, continuous professional learning, and teacher professional standards. By examining publication trends, collaborative networks, and conceptual developments across 5,156 journal articles from 1975 to 2025, we aim to identify emerging research directions that can enhance the integration of standards into professional development systems both globally and within specific contexts such as Kazakhstan.

Present Research

The purpose of this research is to provide a novel perspective on the development and current state of research in professional development, continuous professional learning, and professional

teaching standards worldwide by systematically comparing and visually presenting literature on these topics over the past 50 years. To achieve this, the study addresses the following research question: "How have studies in teacher professional development and professional standards evolved from 1975 to 2025 in terms of growth trajectory, productivity, social, intellectual, and conceptual development?».».

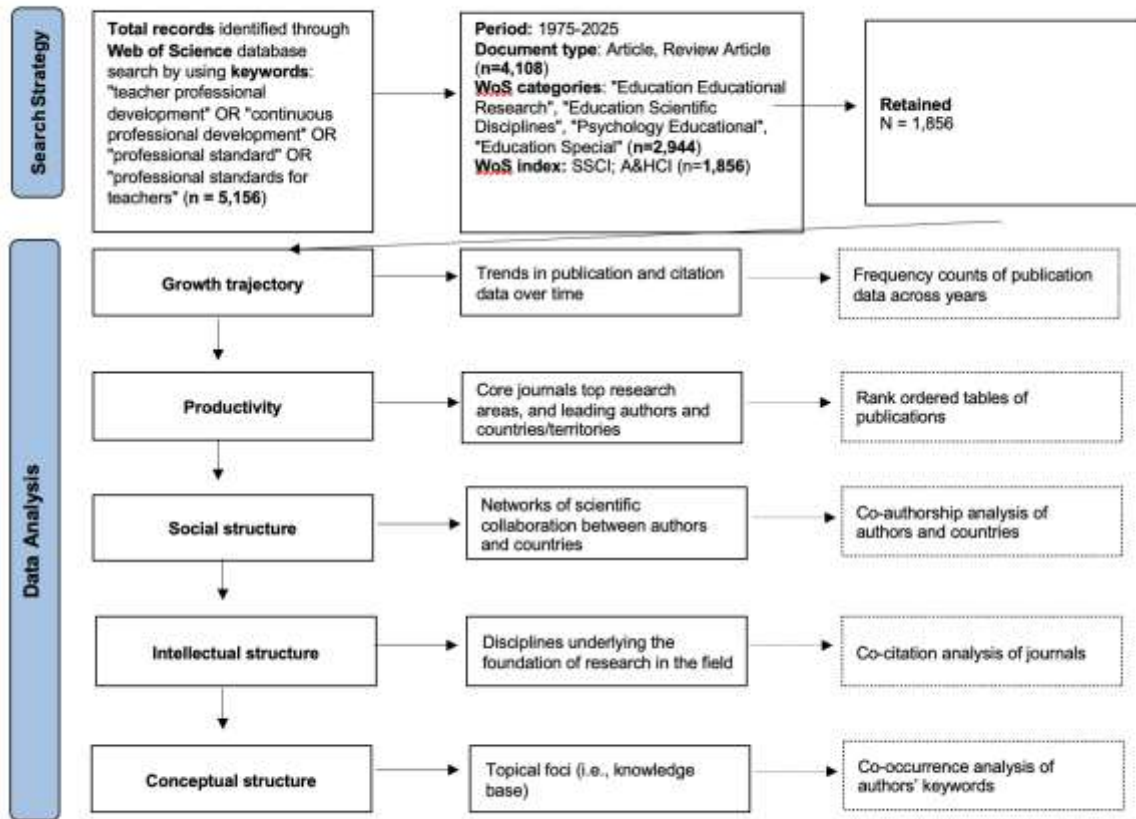
This question aims to analyze the dynamics of scientific knowledge in the field through both quantitative and qualitative indicators, including bibliometric metrics and conceptual advancements in teacher professional development. The selected timeframe (1975-2025) enables a comprehensive examination of the evolution of professional development concepts, from their early foundations to contemporary challenges, particularly in the context of digital transformation and global trends in education.

Method

For the bibliometric analysis of literature spanning the past 50 years, we utilized metadata from three Web of Science (WoS) indices: Science Citation Index Expanded (SCI-Expanded), Social Sciences Citation Index (SSCI), and Arts & Humanities Citation Index (A&HCI). The research specifically focused on the topics of professional development, continuous professional learning, and professional teaching standards.

The decision to use the WoS database was based on several key advantages. WoS is a recognized standard in bibliometric analysis, as highlighted by Meho and Yang (2007). According to McVeigh (2009), WoS covers multiple disciplines and indexes publications from over 20,000 journals. One of its notable strengths is the availability of publication and citation data dating back to 1900, whereas Scopus provides complete citation records only from 1996 (Li et al., 2010). Additionally, unlike alternatives such as Google Scholar, where citation accuracy is inconsistent, or PubMed, which lacks citation analysis features (Falagas et al., 2008), WoS ensures data reliability. Wang and Waltman (2016) further emphasize the superiority of WoS's journal classification system compared to Scopus. The selection of WoS as the primary data source ensured a reliable foundation for the research due to its extensive material coverage, long database history, data accuracy, and well-structured classification system. A detailed description of the methodology is presented in Figure 1 and further elaborated in the following sections.

PRISMA 2020 flow diagram for new systematic reviews which included searches of databases and registers only



Source: Syzdykbayeva et al., 2025

Figure 1 Methodological Framework

Search Strategy

The research implemented a structured search strategy to compile a representative corpus of documents relevant to the research problem. This process involved multiple stages, beginning with defining key terms and concluding with filtering results based on predetermined criteria.

The initial stage, conducted on October 13, 2024, focused on formulating the main key concepts: "teacher professional development," "continuous professional development," "professional standard," and "professional standards for teachers." To ensure comprehensive coverage, the logical operator OR was applied between the keywords, yielding a total of 5,156 potentially relevant documents.

The research covered the period from 1975 to 2025 without language restrictions. After applying the criterion "Articles, Article Reviews" and excluding books, book chapters, and conference materials, the total number of identified publications was reduced to 4,108. The next selection

criterion was based on Web of Science categories, including "Education Educational Research," "Education Scientific Disciplines," "Psychology Educational," and "Education Special," further narrowing the dataset to 2,944 publications. Applying criteria based on WoS domains, specifically the Social Sciences Citation Index (SSCI) and Arts & Humanities Citation Index (A&HCI), yielded the final dataset for bibliometric analysis, consisting of 1,856 publications.

The following metadata were extracted for each publication: article title, publication year, journal, citation count, author names, institutional affiliations and countries, abstracts, author keywords, and reference lists. The search strategy was designed to ensure a targeted selection of relevant publications. The key phrases "teacher professional development," "continuous professional development," "professional standard," and "professional standards for teachers" enabled a focused search on studies directly related to teachers' professional standards and professional development. This approach ensured that the analysis centered on the implementation of standards and mechanisms for teachers' professional growth while excluding studies on general pedagogy, didactics, and subject-specific teaching methods.

The selection of research articles and reviews as the primary data source for bibliometric analysis is justified by their high scientific validity, ensured through peer review. Articles in peer-reviewed journals, unlike conference materials and book chapters, undergo rigorous expert evaluation, guaranteeing methodological accuracy, result reliability, and conclusion validity. This selection criterion enabled the formation of a high-quality research corpus that accurately reflects the current state of scientific discourse on teachers' professional standards and professional development.

The selection of Web of Science categories—"Education Educational Research," "Education Scientific Disciplines," "Psychology Educational," and "Education Special"—was guided by the need to create a research sample exclusively focused on the educational sphere. The choice of SSCI and A&HCI indices for bibliometric analysis was determined by the disciplinary alignment of the research topic, as teachers' professional standards and their professional development are integral to education, which intersects both social sciences and humanities.

Data Analysis Procedures

The literature corpus was analyzed using a bibliometric approach to provide a comprehensive overview of the evolution and current state of the research subject (Guskey, 2002; Villegas-Reimers, 2003; Kedzior, 2004; Van Veen, 2012; Postholm, 2012; Wilson, 2013; King, 2016; King, 2017). Publication frequency and citation metrics were calculated annually, and a ranking table

(Table 1) was compiled to highlight the field's productivity in terms of key journals, research directions, leading scholars, contributing countries, and other indicators.

The bibliometric analysis was conducted using VOSviewer software, which facilitates the visualization and construction of bibliometric maps (Hernández-Torrano et al., 2020). In VOSviewer, analysis units are represented by nodes, where node size reflects significance, and positioning indicates similarity with other nodes. Lines connecting nodes represent relationships, with line thickness indicating the strength of these connections. Node colors denote cluster membership, helping to categorize research themes and collaborations. The process of constructing bibliometric maps in VOSviewer involves three stages: normalization of differences between nodes, construction of a two-dimensional map, and grouping nodes into clusters (Van Eck & Waltman, 2014). To examine the social structure of research, a co-authorship analysis was conducted at both the author and country/territory levels. The intellectual structure of the field was examined through journal co-citation analysis, where clusters of frequently co-cited journals were interpreted as foundational disciplines of the research subject. The conceptual structure of the field was explored through author keyword co-occurrence analysis. In this study, groups of co-occurring keywords represent thematic focuses that have been examined in the literature over the past 50 years.

Findings

Growth Trajectory: Evolution of Publications and Citations

The WoS database demonstrates significant evolution in research on professional development, continuous learning, and teacher professional standards from 1975 to 2025 (Figure 2). A total of 1,856 articles have been published, with the first appearing in 1987, accumulating 45,366 citations. The average number of citations per publication is 24.44, and the h-index has reached 85, reflecting the high quality and impact of research in this field. The total number of cited articles stands at 32,882, with citations excluding self-citations amounting to 31,930. The high proportion of citations excluding self-citations (97% of the total) indicates that these studies have gained substantial recognition in the scientific community, underscoring their significant contribution to the development of this research area.

In the field of pedagogical education and teachers' professional development, three highly cited works published between 2002 and 2006 deserve special attention (Mishra, 2006; Clarke, 2002; Ertmer, 2005). The seminal study by Mishra and Koehler (2006), which has received 4,124

citations, introduced the TPACK (Technological Pedagogical Content Knowledge) framework, providing a theoretical model for understanding the complex knowledge required for effective technology integration in education. Expanding on this theme, Clarke and Hollingsworth (2002) proposed the interconnected model of teacher professional growth, cited 1,069 times, which outlines the dynamic interactions between teachers' personal development, instructional practices, learning outcomes, and external influences. Complementing these studies, Ertmer's work (2005), with 1,042 citations, emphasized the critical role of teachers' pedagogical beliefs as a determining factor in the successful integration of technology into teaching. These three influential works, widely recognized in the scientific community, contribute to a comprehensive understanding of the interrelationship between technological knowledge, professional growth, and personal beliefs in modern education.

The analysis of publication activity dynamics and citation rates in the field of teachers' professional development from 1987 to 2025 reveals a clear trend of exponential growth in both indicators. The graph highlights three key developmental periods: the initial stage (1987-2000), characterized by low publication activity (fewer than five publications per year) and minimal citation levels; the gradual growth period (2001-2010), during which publications increased steadily from five to 40 per year, accompanied by a rise in citation index; and the intensive development stage (2011-2024), marked by a sharp acceleration in both publication volume (reaching 180 publications per year) and citations (exceeding 6,000 annually). Notably, the period from 2015 to 2023 exhibits the most dynamic growth, reflecting a significant surge in research interest and the increasing importance of teachers' professional development in contemporary educational discourse. The projected decline in indicators for 2025 is likely due to incomplete data for the current period.

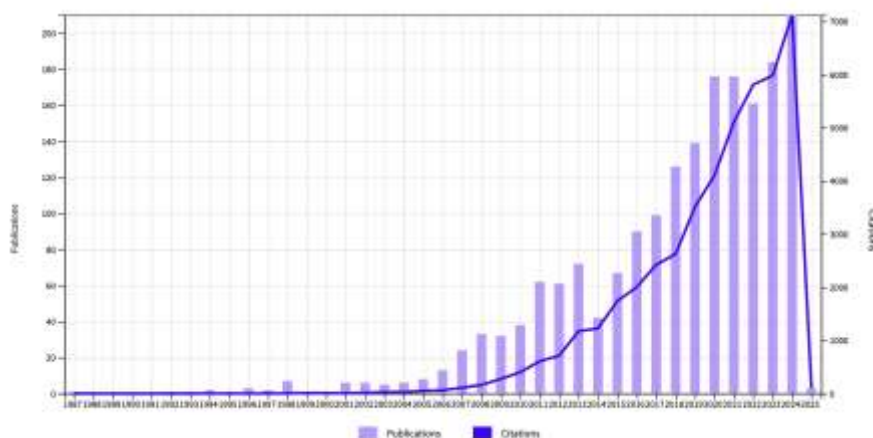


Figure 2 Growth of Research

Evolution of Research in Teacher Professional Development (1975-2025)

Bibliometric analysis demonstrates the evolution of research in the areas of teacher qualification improvement, continuous professional development, and professional standards over the past fifty years. From 1975-1985, professional development was viewed as a tool for addressing deficiencies in teacher preparation (Eraut, 1977). Research focused on studying the effectiveness of centralized professional development courses, which were typically conducted in the format of one-time seminars and lectures without long-term support (Joyce & Showers, 1980).

Research from 1985-1995 is characterized by contextualization and an emphasis on reflective practice. The works of Donald Schön (1987) and Lawrence Stenhouse (1985) contributed to the popularization of the "teacher-researcher" concept, according to which educators were viewed not simply as implementers of educational directives but as active researchers of their own practice. The first studies of collaborative teacher learning and emerging professional communities appeared (Little, 1993).

During the period 1995-2005, professional standards for teachers were developed and implemented in various countries worldwide, defining key competencies and criteria for evaluating pedagogical activities (Ingvarson & Kleinhenz, 2003). Research during this time emphasized measurable outcomes of professional development and establishing connections between teacher professional development and educational achievements of students (Guskey, 2002). The concept of "evidence-based practice" began to exert significant influence on the field of teacher education (Cochran-Smith, 2005).

In 2005-2015, there was a transition toward personalization and the development of networked communities in teacher professional development. Research during this period focused on individualized trajectories of professional growth, taking into account the personal needs and interests of educators (Desimone, 2009). Interest grew in studying informal and non-formal teacher learning occurring outside official professional development programs (Richter et al., 2011). Significant attention was paid to Professional Learning Communities, which created space for collective professional development (Stoll et al., 2006). The integration of digital technologies into professional development systems became the subject of numerous studies (Borko et al., 2009). During this period, large-scale international comparative studies were conducted, such as TALIS (Teaching and Learning International Survey), allowing comparison of various approaches to teacher professional development across different countries (OECD, 2014).

The contemporary period of 2015-2025 is characterized by a focus on adaptability and global challenges in the professional development of educators in a rapidly changing world (Darling-Hammond & Hyler, 2020). Attention is given to the integration of artificial intelligence technologies in professional development and the formation of global 21st-century competencies - collaboration, critical thinking, creativity (Schleicher, 2018), teacher well-being, and prevention of professional burnout (Day & Gu, 2014).

Throughout all five decades, there has been a transition from episodic to continuous professional development throughout the career; from centralized universal programs to personalized trajectories (Kennedy, 2016); from passive reception of information to active, research-based learning (Timperley, 2011); from isolated work to networked forms of interaction; from general approaches to consideration of specific educational contexts (Opfer & Pedder, 2011), reflecting a deep understanding of the complexity and multifaceted nature of teacher professional development that has formed as a result of half a century of research in this field.

Productivity: Core journals' top research areas, leading authors, countries/territories, and others

Table 1

WOS Data Analysis

Criteria	Data	Records	% of 1,856
Leading researchers	Chai CS	15	0.81%
	Seidel T	13	0.70%
	Hardy I	12	0.65%
	Gröschner A	11	0.59%
Affiliations	Education University of Hong Kong EDUHK	47	2.54%
	University of California SYSTEM	46	2.48%
	Nanyang Technological University	44	2.37%
	State University System of Florida	43	2.32%
	National Institute of Education NIE SINGAPORE	40	2.16%
Publishers	Taylor & Francis	646	34.81%
	Springer Nature	325	17.51%
	Elsevier	321	17.30%
Web of Science Index	Social Sciences Citation Index (SSCI)	1,855	99.95%
	Science Citation Index Expanded (SCI-EXPANDED)	207	11.15%
	Arts & Humanities Citation Index (A&HCI)	90	4.85%
Web of Science categories	Education Educational Research	1,749	94.23%
	Education Scientific Disciplines	119	6.41%
	Psychology Educational	113	6.09%
	Linguistics	101	5.44%
Research Areas	Education Educational Research	1,806	97.25%
	Psychology	134	7.22%
	Linguistics	101	5.44%
Open Access	All Open Access	612	32.97%
	Gold-Hybrid	303	16.33%

	Green Published	198	10.67%
Countries/Regions	USA	618	33.30%
	Peoples R China	205	11.05%
	Australia	199	10.72%
	England	163	8.78%
Document Types	Article	1,773	95.53%
	Early Access	132	7.11%
	Review Article	83	4.48%
Languages	English	1,826	98.38%
	Spanish	16	0.86%
	German	8	0.43%
	Italian	3	0.16%
Sustainable	04 Quality Education	1,639	88.31%
Development Goals	03 Good Health and Well Being	137	7.38%

The analysis of WoS publications on teacher professional development identified several key trends in this research area. At the individual level, Chai CS made the most significant contribution, publishing 15 papers (0.808% of the total). Among research institutions, the Education University of Hong Kong leads with 47 publications (2.532%). In the publishing sector, Taylor & Francis dominates, having published 646 papers, which accounts for more than a third (34.806%) of all research in this field. The high scientific significance of these studies is confirmed by their predominant indexation in the Social Sciences Citation Index (SSCI), comprising 1,855 publications (99.946%). Thematically, most works (1,749 publications, 94.235%) fall under the *Education Educational Research* category, with *Teaching and Teacher Education* emerging as the leading journal, publishing 133 papers (7.166%).

The analysis of scientific knowledge dissemination shows the significant role of Open Access, which accounts for nearly one-third of all publications (612 papers, 32.974%). Geographically, the United States leads in research output, contributing 618 publications (33.297%). The publication landscape is marked by a strong preference for articles as the primary format of scientific communication (1,773 publications, 95.528%), with English serving as the dominant language of discourse (1,826 publications, 98.384%). Notably, the vast majority of studies (1,639 publications, 88.308%) align with the sustainable development goal of *Quality Education*, underscoring the relevance of this research area within global educational priorities.

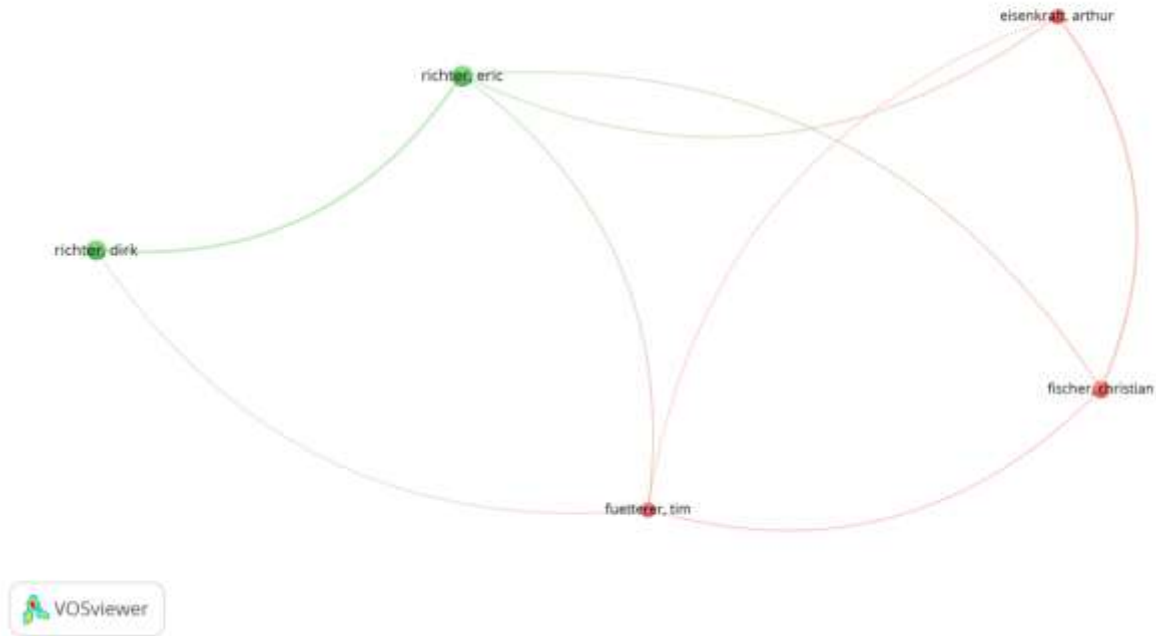
Social structure: Networks of scientific collaboration between authors and countries

Figure 3 Networks of Scientific Collaboration Between Authors

The analysis of scientific collaboration among authors in the fields of teacher professional development, continuous professional development, and professional standards identifies two primary collaborative structures. The first cluster, marked in green, includes researchers such as Richter Eric and Richter Dirk, who exhibit intensive scientific interaction. The second cluster, marked in red, comprises scholars like Eisenkraft Arthur, Fischer Christian, and Fuetterer Tim, demonstrating stable patterns of collaborative research activity. Inter-cluster connections, visualized on the graph, suggest the presence of cross-group collaboration, indicating ongoing integration processes within the research community on this topic.

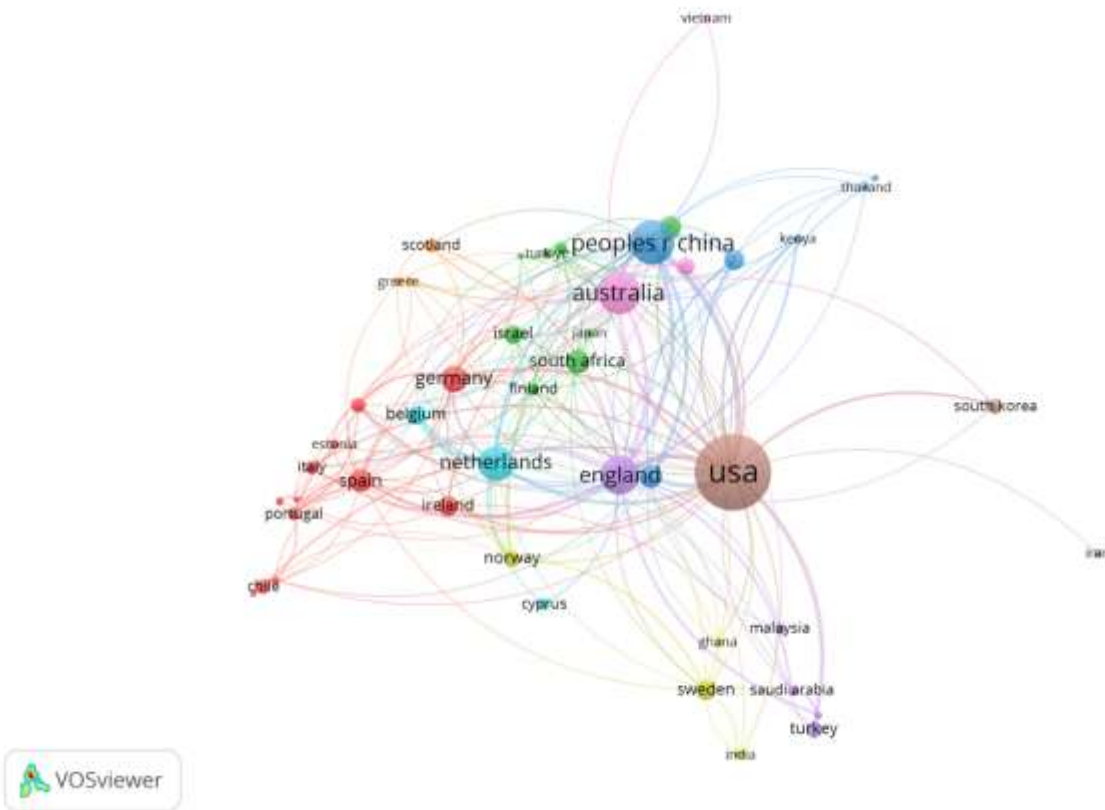


Figure 4 Networks of Scientific Collaboration Between Countries

The brown cluster, with the United States as the dominant node, holds a central position in the analysis of international scientific collaboration in teacher professional development research, demonstrating the highest density of international connections. The gray-blue cluster, centered in England, plays a complementary role, forming a significant segment of transatlantic scientific interaction. The blue cluster, concentrated around the Netherlands and Belgium, reflects intensive scientific cooperation among Benelux countries, while the red cluster unites Mediterranean research centers, including Spain, Italy, and Portugal. The green cluster, with China and Turkey as key nodes, signifies the increasing influence of the Asian region in this field of research. The purple cluster, centered around Australia, highlights the intensification of scientific interaction in the Asia-Pacific region. The orange cluster, including Scotland and Greece, and the yellow cluster, linking Sweden and India, illustrate the expansion of intercontinental research connections. The pink cluster, involving Vietnam, represents emerging directions in international scientific collaboration. The overall topology of the network structure reveals a high degree of integration

between clusters, albeit with varying intensities of inter-cluster connections. These patterns define the contemporary landscape of international scientific cooperation in the field of teacher professional development, emphasizing regional research strengths and emerging global linkages.

Intellectual structure: Disciplines underlying the foundation of research in the field

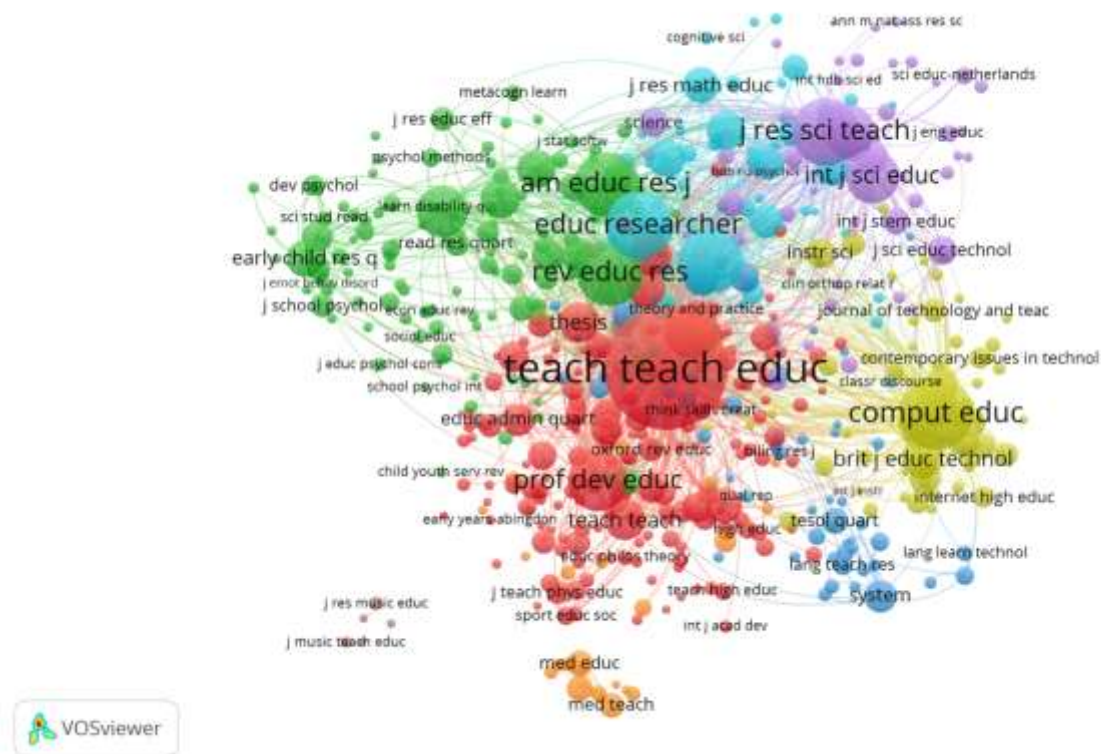


Figure 5 Co-Citation Analysis of Journals

The red cluster occupies a central position in the network of scientific journals related to teacher professional development, with Teaching and Teacher Education and Professional Development in Education serving as dominant nodes. These journals are closely integrated with Oxford Review of Education, Theory and Practice, and Educational Philosophy and Theory, forming the core of the research field. The methodological green cluster, represented by American Educational Research Journal, Educational Researcher, and Review of Educational Research, maintains strong connections with the central cluster, emphasizing the foundational role of methodological research. The natural science-oriented blue cluster, which includes Journal of Research in Science Teaching, Journal of Research in Mathematics Education, and Science Education, exhibits intensive

collaboration with the purple international cluster, where International Journal of Science Education and International Journal of STEM Education serve as key nodes. The technological yellow cluster, centered around Computers & Education and British Journal of Educational Technology, demonstrates multiple connections with all other clusters, highlighting the integration of technological advancements across various areas of pedagogical education. The specialized orange cluster, featuring Medical Education and Medical Teacher, maintains a relatively autonomous position while still exhibiting stable connections with the central cluster. The network topology of scientific journals reflects a high degree of integration across research directions. The strongest connections are observed between the methodological and central clusters, as well as between the natural science and international clusters. This interconnected structure indicates the formation of a comprehensive and cohesive system of scientific communication in the field of teacher professional development.

Conceptual structure: Topical foci (i.e., knowledge base)

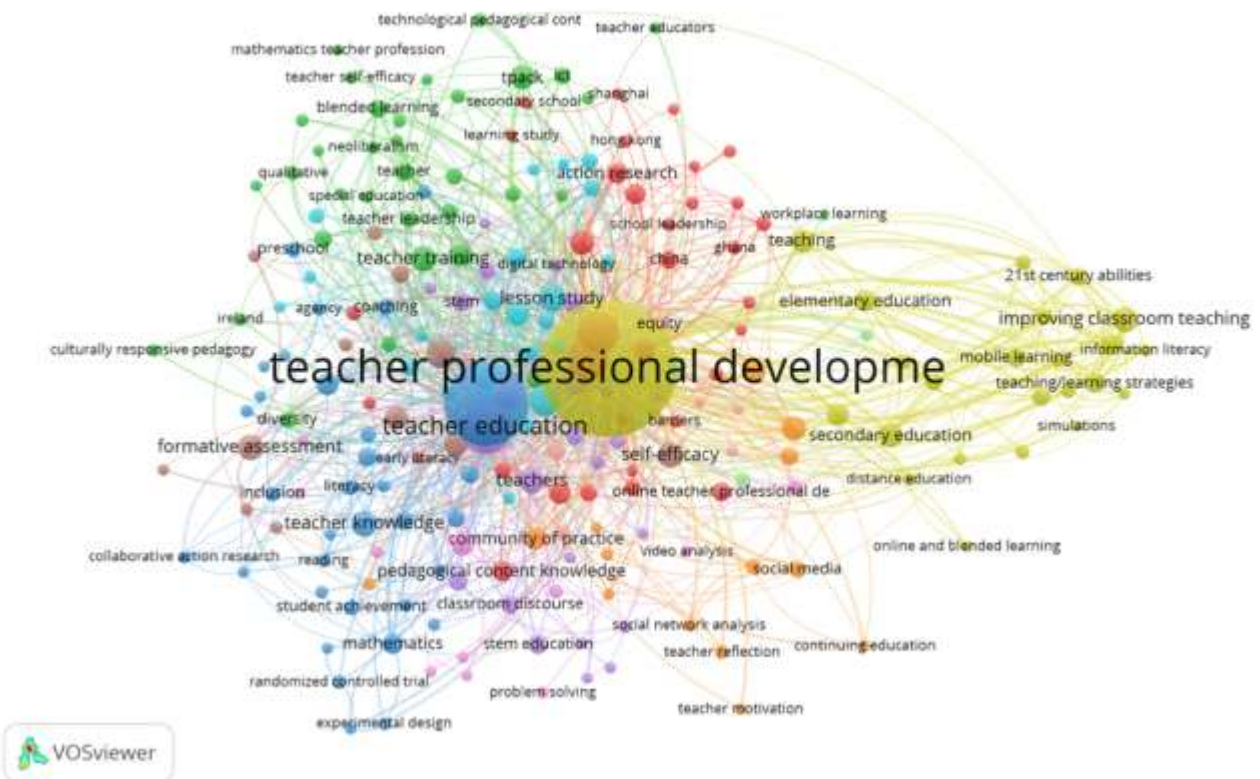


Figure 6 Co-Occurrence Analysis of Authors' Keywords (N=218)

Co-occurrence analysis of author keywords (n=218) identified key research directions through major concepts. The central golden-yellow cluster integrates terms such as teacher professional development, teacher education, teacher training, barriers, and self-efficacy, representing the field of teacher professional development. The red cluster consolidates descriptors like school leadership, equity, and workplace learning alongside geopolitical markers such as China, Hong Kong, and Ghana, forming the domain of educational policy and practice. The blue cluster, which includes methodological terms like randomized controlled trial, experimental design, mathematics, early literacy, and reading, defines the direction of educational research methodology. The green cluster conceptualizes modern educational technologies and learning through terms such as technological pedagogical content, blended learning, TPACK, ICT, and secondary school. The light blue cluster integrates descriptors like classroom discourse, pedagogical content knowledge, teaching/learning strategies, lesson study, and teacher leadership, forming the research direction of pedagogical interaction in the educational process.

The dark green cluster combines concepts such as mathematics teacher profession, teacher self-efficacy, special education, neoliberalism, and qualitative, defining the field of professional standards and educational development. The purple cluster integrates terms like community of practice, social network analysis, STEM education, and problem solving, representing the research direction of social-educational communities and communications. The brown cluster consolidates formative assessment, student achievement, agency, and coaching, forming the theme of assessment and learning practice. The turquoise cluster includes action research, collaborative action research, preschool, Ireland, and culturally responsive pedagogy, shaping the field of educational practice research methods. The orange cluster integrates teacher reflection, teacher motivation, continuing education, and social media, addressing issues related to educational reform effectiveness. The peripheral yellow cluster, with concepts such as 21st-century abilities, information literacy, simulations, mobile learning, improving classroom teaching, and distance education, defines the direction of innovative technologies in education. The clustering of these terms highlights the formation of eleven interconnected research directions, reflecting the systemic development of pedagogical science over the past fifty years.

The analysis of methodological limitations revealed that relying solely on bibliometric analysis without qualitative methods restricted the depth of understanding of the studied processes. The focus on English-language publications and the exclusion of gray literature reduced the

representativeness of the sample. Additionally, the absence of meta-analytical procedures and incomplete coverage of regional sources affected the comprehensiveness of the assessment. Given these limitations, the following recommendations are made: conducting empirical research on the effectiveness of professional standards using mixed methods; expanding the language coverage of sources and incorporating gray literature; implementing qualitative studies to explore teachers' perceptions of standards and conducting comparative analyses of different standardization models; and performing meta-analyses of professional development approaches while considering regional specifics. Adopting this comprehensive approach will provide a fuller understanding of the impact of standardization on education quality.

Discussion

Literature analysis shows significant evolution in understanding teachers' professional development over recent decades. As noted by Van Veen, Zwart, and Meirink (2012), traditional forms of professional development characterized by lectures, seminars, and conferences not connected to the workplace, where teachers played a passive role, are gradually giving way to innovative forms. In new approaches, "teachers play an active role, and issues in their own pedagogical practice determine the content." Examples of such innovative forms include colleague collaboration, study and book clubs, mentoring, coaching, intervision, and research conducted by teachers. These findings are confirmed by our bibliometric research results, demonstrating steady growth in publications on this topic, particularly noticeable since 2015. The identified eleven research directions reflect the multifaceted nature of modern approaches to teachers' professional development.

The model described by Guskey (2002) illustrates the temporal sequence of changes in the professional development process: from professional experience to changes in teachers' practice, then to changes in student learning outcomes, and finally to changes in teachers' beliefs and attitudes. Guskey's model suggests that changes in teachers' beliefs occur predominantly after they see evidence of improved learning in their students. This approach corresponds with the thematic clusters identified in our research: "Assessment and Learning Practice" and "Effectiveness of Educational Reforms".

Literature analysis indicates a significant evolution in understanding teachers' professional development over recent decades. As noted by Van Veen, Zwart, and Meirink (2012), traditional

forms of professional development based on lectures, seminars, and conferences, where teachers played a passive role and which were weakly connected to their direct practice, are gradually giving way to innovative approaches. In new models, educators act as active participants, and the content of professional development is determined by current issues in their daily work. Such forms include collaborative learning (colleague collaboration, study and book clubs), mentoring, coaching, intervision, as well as research conducted by teachers themselves. These trends are confirmed by our bibliometric research results, which revealed steady growth in publications on this topic, particularly noticeable since 2015. The analysis identified eleven key research directions reflecting the multifaceted nature of modern approaches to teachers' professional development.

An important theoretical foundation for understanding this process is Guskey's model (2002), which describes the sequence of changes in teachers' professional development: acquiring new professional experience; changes in pedagogical practice; improvement in student learning outcomes; transformation of teachers' beliefs and attitudes. According to this model, changes in teachers' views occur predominantly after they observe positive shifts in their students' performance, correlating with the thematic clusters identified in our research: "Assessment and Learning Practice" and "Effectiveness of Educational Reforms," emphasizing the relationship between teachers' professional growth and the quality of educational outcomes.

Literature review demonstrates significant consensus regarding the characteristics of effective professional development. Darling-Hammond, Hyler, and Gardner (2017), in their analysis of 35 methodologically rigorous studies, identify seven key features: content focus, incorporation of active learning, support for collaboration, use of models of effective practice, provision of coaching and expert support, as well as feedback and reflection with sufficient program duration. These conclusions align with the position of Kedzior and Fifield (2004), who emphasize the importance of integrating professional development into teachers' daily practice, its coherence with general educational goals and initiatives, and consideration of teachers' own needs. Wilson (2013) extends this discussion by highlighting the necessity of a systematic approach to science teachers' professional development, noting that "interventions based on a systematic approach to reform can increase the effectiveness of professional development." This thesis corresponds with the conclusions of our bibliometric research, which revealed the interdisciplinary nature of this field, formed at the intersection of pedagogy, psychology, and linguistics.

In the literature, special attention is given to reconceptualizing teaching as a collective rather than purely individual activity. As noted by Hiebert, Gallimore, and Stigler (2003), progress in teaching is possible only when transitioning from isolated practice to open professional interaction, where teaching becomes the subject of collaborative analysis and improvement. This idea is reflected in modern models of professional development, such as Content-Based Collaborative Inquiry (CBCI) and Cognitively Guided Instruction (CGI), Lesson Study, where teachers jointly analyze student thinking and improve lessons.

Despite the literature's emphasis on the importance of collaboration among educators, our bibliometric research revealed fragmentation within the scientific community itself: researchers in this field demonstrate weak interconnections between their works. Thus, a contradiction emerges: while scholars actively promote collaboration among teachers, they themselves do not always follow these principles in their professional activities. This imbalance indicates the need for a more systematic approach not only to organizing pedagogical development but also to coordinating research in this field.

A key aspect of professional development is its impact on pedagogical practice and students' educational outcomes. As Kennedy (1998) emphasizes, programs focused on deepening subject knowledge and teaching methodology of specific disciplines have a more significant positive impact on student performance compared to programs focusing exclusively on general teaching methods. This thesis is supported by empirical data: teachers who participated in the Cognitively Guided Instruction (CGI) program much more frequently used problem-solving methods, reducing the proportion of mechanical memorization. As a result, their students not only better mastered the material but also demonstrated higher levels of confidence in solving non-standard problems.

Similar conclusions are contained in the large-scale study by Birman et al. (2001), covering 1,027 mathematics and science teachers. It was established that active forms of professional development (such as lesson modeling, collaborative analysis of practices) not only enhance teachers' competence but also directly influence their classroom work. The greatest effectiveness is achieved when program content aligns with specific educational and institutional goals.

These findings correspond with the conclusions of our bibliometric analysis, which identified thematic clusters "Assessment and Learning Practice" and "Methods of Educational Practice Research," reflecting a stable research trend: effective professional development transforms not

only teaching methods but also educational outcomes, requiring further study of the relationships between teacher training, classroom practice, and student performance.

Modern research confirms that systematic, content-rich professional development can become a catalyst for qualitative changes both in teachers' work and in student learning. However, to achieve maximum effect, it is necessary to consider contextual factors, including curricula and institutional priorities.

Despite growing understanding of the key characteristics of effective professional development, its implementation faces significant barriers. As noted by Kedzior and Fifield (2004), one of the main obstacles is the structure of professional development and teachers' lack of time: many educators reluctantly participate in programs that extend beyond the standard academic schedule. School factors create significant difficulties, as developing and implementing quality professional development requires consideration of multiple aspects. As the authors emphasize, administrators and educational policy developers need to remove organizational barriers that prevent teachers from improving their practice. Factors at the district level are equally important: teachers often perceive reforms as uncoordinated and fragmented, which reduces their motivation to participate in additional training. Financial costs remain a serious limitation: high-quality professional development requires significant investments, often twice the standard district expenditure per teacher. These findings correspond with the ideas of Postholm (2012), who in his theoretical review emphasizes the need to consider both individual and organizational factors in teacher learning. The researcher notes that teachers' professional development is influenced not only by their personal involvement but also by school culture, the atmosphere of collaboration within the team, and interaction with external experts.

The barriers identified in the literature may also explain the limited interaction between research groups discovered in our bibliometric analysis. The fragmentation of the scientific community reflects similar problems in professional development practice, highlighting the need for more systematic and coordinated approaches both in research and in the implementation of educational initiatives. Modern studies of teacher professional development emphasize the need for a systematic approach to organizing this process. As King's research (2016) shows, successful implementation of innovative practices in schools requires comprehensive support, carefully designed educational initiatives, and activation of teachers' own professional agency. These

conclusions are confirmed by Wilson's work (2013), which notes the particular effectiveness of systematic approaches to reforming teachers' professional development.

The relevance of continuous professional growth for educators is especially increasing in the context of modern educational challenges. Darling-Hammond and her colleagues (2017) emphasize that today teachers need to master qualitatively new teaching methods that allow students to develop critical thinking, complex problem-solving skills, collaboration abilities, and learning independence. These requirements naturally lead to rethinking traditional models of professional development and searching for new, more effective formats.

The conducted analysis of scientific literature combined with the results of bibliometric research allows us to identify several key directions for further work in this field: First, there is interest in an in-depth study of the mutual influence between personal factors of teachers' professional growth and the organizational conditions of their work. As Postholm (2012) notes, the school environment creates the most favorable opportunities for teachers' continuous professional development. Second, an important task is the comparative analysis of the effectiveness of various professional development models in different national educational systems. Of particular interest in this context are the practices of such leading countries in this field as the USA, China, and Australia. Third, there is a need to develop integrative models that allow overcoming the existing fragmentation both in research work and in the practical implementation of professional development programs. In this regard, the systematic approaches proposed by Wilson (2013) and King (2016) are especially valuable.

Conclusion

The results of the bibliometric mapping of scientific discourse identified major trends and fundamental patterns in academic publications related to the interrelated phenomena of teacher professional development, continuous professional learning, and the standardization of pedagogical requirements. The empirical research base, encompassing a substantial body of scientific works from 1975 to 2025, enabled a comprehensive analysis of the evolution of scientific thought in this field and the identification of key patterns in the development of research paradigms.

Quantitative assessment of publication activity demonstrates a systematic increase in scientific interest in the studied issues, with a steady growth trend since 2015 and a dominance of research

contributions from scholars in the USA, China, and Australia. The observed fragmentation of research teams highlights the need to strengthen international scientific collaboration in this field. Analysis of the thematic landscape of scientific publications identified key research directions, encompassing both fundamental aspects of pedagogical science methodology and applied issues related to the implementation of innovative educational technologies. Significant emphasis is placed on assessing educational reform effectiveness, developing professional pedagogical communities, and exploring the potential of digital technologies in teachers' professional development.

Extrapolating the results of the bibliometric analysis to the process of improving the Professional Standard for Teachers in the Republic of Kazakhstan allows for the formulation of several strategic imperatives. It is advisable to adopt successful practices of pedagogical activity standardization from countries leading in publication activity while considering the national specifics of Kazakhstani education. Special attention should be given to Australia's experience, as it has demonstrated success in developing and implementing comprehensive professional standards for teachers. Australia's approach effectively balances national educational priorities with contemporary international trends in teacher professional development, making it a valuable reference for Kazakhstan.

The interdisciplinary nature of the analyzed publications highlights the need to integrate competencies from related scientific fields into the professional standard, particularly in the context of Kazakhstan's multilingual education. Additionally, the identified trends in the digital transformation of the educational space emphasize the necessity of incorporating an expanded spectrum of digital competencies for teachers within the standard.

A crucial aspect of modernizing the standard is establishing mechanisms to encourage Kazakhstani teachers' active participation in professional network communities at different levels while creating flexible adaptation strategies for universal requirements to suit regional contexts. Additionally, developing an indicator system to assess teachers' compliance with professional standard requirements, based on international best practices in evaluating educational reform effectiveness, is essential for ensuring meaningful and practical implementation.

Integrating the patterns identified through bibliometric analysis into the enhancement of the Professional Standard for Teachers in the Republic of Kazakhstan will help align it with modern international requirements while maintaining the national identity of the education system. This

approach will ensure the standard's relevance and competitiveness in the global educational landscape.

Limitations

A methodological limitation of this study is the use of only the WoS database for bibliometric analysis, resulting in a predominant focus on English-language publications (98.384%), despite no language filters being applied in WoS query. Additionally, the exclusive use of bibliometric analysis without supplementary qualitative methods limited the depth of understanding regarding the processes under study.

Acknowledgment

This article was prepared within the framework of grant funding for scientific and (or) scientific-technical projects for 2024-2026 (AP23489008 Research on the implementation of the new professional standard "Teacher" in Kazakhstan and detailing its content for the continuous professional development of teachers), led by Ye.N. Agranovich.

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