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Mapping Global Trends in Teacher Competencies

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ABSTRACT

Teacher Competencies (TC), as a pivotal dimension of teacher effectiveness influencing teachers' professional growth, has gained prominence in recent teacher education research. This article aims to define TC through literature review, examine the current status and future directions of TC research. Analyzing 1117 SSCI-indexed articles from the Web of Science database (2000-2023), a bibliometric analysis was conducted, exploring research areas, journals, countries, affiliations, authors, citations and keywords. The results, corroborated by the Mann-Kendall trend test, highlight a robust and influential Teacher Competencies literature indicating growing interest, with a notable increase in publications, especially in 2021-2022. While the United States of America leads the way, contributions from Germany, Spain, China, and Turkey show global participation. The findings affirm sustained growth, emphasizing the field's dynamism, global collaboration and a solid foundation. Among the influential authors, Pantic, Krueger, Pekrun, Blömeke and Kaiser stand out; "Sustainability", "Zeitschrift für Erziehungswissenschaft" and "Teaching and Teacher Education" stand out as the most prolific journals, and the most citations are mainly concentrated in "Teaching and Teacher Education". Leading institutions include 'Nanyang Technological University', 'Humboldt University' and 'Hong Kong University'. Diverse keywords signify comprehensive expertise, reflecting the field's multidimensionality. As a result of the thematic clustering analysis conducted with VOSviewer, six keyword clusters were identified: 'higher education and teacher training in the context of COVID-19', 'teacher education and professional development for sustainable STEM Teaching and creativity', 'assessment of competencies in preservice teachers', 'formative assessment in mathematics teacher professional development', 'teacher competence in science education and preparation' and 'motivation and self-efficacy in technology'. In summary, this study confirms the dynamic and globally collaborative nature of TA research and offers insights for future research. Therefore, it is recommended that future studies focus on prominent themes such as digital competence, self-assessment, sustainable teacher education, and cross-cultural comparisons. Furthermore, fostering greater interdisciplinary and international collaboration in teacher education will increase the scope and impact of the field.

Öğretmen Yeterliliklerindeki Küresel Eğilimlerin Haritalanması

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ÖZET

Öğretmenlerin mesleki gelişimini etkileyen önemli bir unsur olan Öğretmen Yeterlikleri (ÖY), son yıllarda öğretmen eğitimi araştırmalarında önem kazanmıştır. Bu makale, ÖY araştırmalarının mevcut durumunu ve gelecekteki yönelimlerini inceleyerek, bir literatür taraması yoluyla ÖY'yi tanımlamayı amaçlamaktadır. Web of Science (WoS) veri tabanından (2000-2023) Social Science Citation Index (SSCI) veri tabanındaki 1117 makale incelenerek araştırma alanları, dergiler, ülkeler, bağlantılar, yazarlar, atıflar ve anahtar kelimeler araştırılarak bibliyometrik bir analiz yapılmıştır. Mann-Kendall eğilim testi ile desteklenen sonuçlar, özellikle 2021-2022 yıllarında yayınlarda kayda değer bir artışla birlikte, artan ilgiyi gösteren sağlam ve etkili bir ÖY literatürünü vurgulamaktadır. Amerika Birleşik Devletleri başı çekerken, Almanya, İspanya, Çin ve Türkiye'den gelen katkılar küresel katılımı göstermektedir. Bulgular, alanın dinamizmini, küresel işbirliğini ve sağlam temelini vurgulayarak sürdürülebilir büyümeyi teyit etmektedir. Etkili yazarlar arasında Pantic, Krueger, Pekrun, Blömeke ve Kaiser öne çıkarken; 'Sustainability', 'Zeitschrift für Erziehungswissenschaft' ve 'Teaching and Teacher Education' en üretken dergiler olarak dikkat çekmiş, en fazla atıf ise 'Teaching and Teacher Education' dergisinde yoğunlaşmıştır. Önde gelen kurumlar arasında ise 'Nanyang Teknoloji Üniversitesi', 'Humboldt Üniversitesi' ve 'Hong Kong Üniversitesi' yer almaktadır. Farklı anahtar kelimeler, alanın çok boyutluluğunu yansıtan kapsamlı uzmanlığa işaret etmektedir. VOSviewer ile yapılan tematik kümeleme analizi sonucunda, 'COVID-19 bağlamında yükseköğrenim ve öğretmen eğitimi', 'sürdürülebilir STEM ve yaratıcılık için öğretmen eğitimi ve mesleki gelişim', 'hizmet öncesi öğretmenlerde yeterliliklerin değerlendirilmesi', 'matematik öğretmeni gelişiminde biçimlendirici değerlendirme', 'fen eğitiminde öğretmen yeterliliği ve hazırlığı' ile 'teknolojide motivasyon ve öz yeterlilik' olmak üzere altı anahtar kelime kümesi belirlenmiştir. Özetle, bu çalışma ÖY araştırmalarının dinamik ve küresel iş birliğine dayalı yapısını teyit etmekte ve gelecekteki araştırmalar için fikirler sunmaktadır. Bu nedenle, gelecekteki çalışmaların dijital yeterlilik, öz değerlendirme, sürdürülebilir öğretmen eğitimi ve kültürlerarası karşılaştırmalar gibi öne çıkan temalara odaklanması önerilmektedir. Ayrıca, öğretmen eğitiminde disiplinlerarası ve uluslararası iş birliğinin artırılması, alanın kapsamını ve etkisini artıracaktır.

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INTRODUCTION

Teacher Competencies (TC) refer to the integrated set of knowledge, skills, values, and attitudes that teachers need to facilitate effective teaching and student learning. These competencies encompass pedagogical, technological, assessment-related, and socio-emotional dimensions that enable teachers to adapt to contemporary educational challenges (Caena, 2011; Zhu et al., 2013). In recent years, TC has become a central focus in teacher education policy and research, given its critical role in improving teacher quality and, consequently, student achievement (Karacaoğlu, 2008; Mincu, 2015). Studies confirm that factors such as teachers' self-efficacy, motivation, and professional knowledge are among the most influential variables influencing learning outcomes, while non-teacher-related factors have limited explanatory power (Creemers and Kyriakides, 2015).

Despite growing interest, there remains a lack of comprehensive analysis addressing global patterns, thematic focuses, and collaboration networks in TC research. With the increased emphasis on digital literacy and educational resilience, particularly following the COVID-19 pandemic, the need for large-scale, systematic mapping of teacher competencies has become even more evident (Karacaoğlu, 2025; Balıkçı et al., 2024; Gökdaş et al., 2024). In response to this need, the current study aims to uncover the evolution, scope, and international trends in TC research by conducting a bibliometric analysis of 1,117 SSCI-indexed articles from the Web of Science (WoS) database (2000-2023).

Previous bibliometric studies have laid the groundwork in related fields. For example, Bolat and Bolat (2023), analyzing 967 articles on Technological Pedagogical Content Knowledge (TPACK), revealed an annual growth rate of over 32% and highlighted the rapid rise of technology-integrated competency frameworks in teacher education. Similarly, Pham et al. (2023) identified an increasing trend in publications focusing on professional development in science education and a thematic convergence in STEM-based teacher education. These studies highlight the methodological importance of bibliometric mapping in understanding evolving competency areas in teacher education.

Other studies have focused on specific competency areas. For example, Rodrigues et al. (2021) and Gökdaş et al. (2024) analyzed the expanding literature on digital teacher competencies, particularly in the wake of the pandemic. Their findings highlight the growing importance of digital competency, ICT integration, and virtual pedagogy in shaping educational equity and resilience. These developments align with the focus of this study, particularly in terms of the distribution of keywords related to digital transformation and the resulting clusters.

Furthermore, a number of subfield-specific bibliometric analyses have emerged in recent years. Castillo-Allendes et al. (2023) examined research on teachers' verbal complaints, providing insights into occupational health themes. Pan (2020), examining teacher leadership, highlighted cross-cultural contributions, particularly from Asian countries. Wang and Jia (2023) conducted a bibliometric study of critical thinking competencies, and this competency has also emerged as a key concept in studies on critical thinking. These focused studies reveal the increasing fragmentation and specialization within the teacher competency literature and further reinforce the need for a unifying bibliometric framework to map broader trends.

The current study builds on these approaches by providing a comprehensive, thematic review of teacher competency research in global contexts. By analyzing trends in publication volume, geographic distribution, institutional collaborations, and conceptual clusters, it offers insights into how key themes such as digital literacy, professional development, and assessment have evolved over time. These insights aim to inform future education policies, guide teacher preparation programs, and highlight thematic gaps worthy of further research, such as cultural diversity, interdisciplinary frameworks, and comparative education.

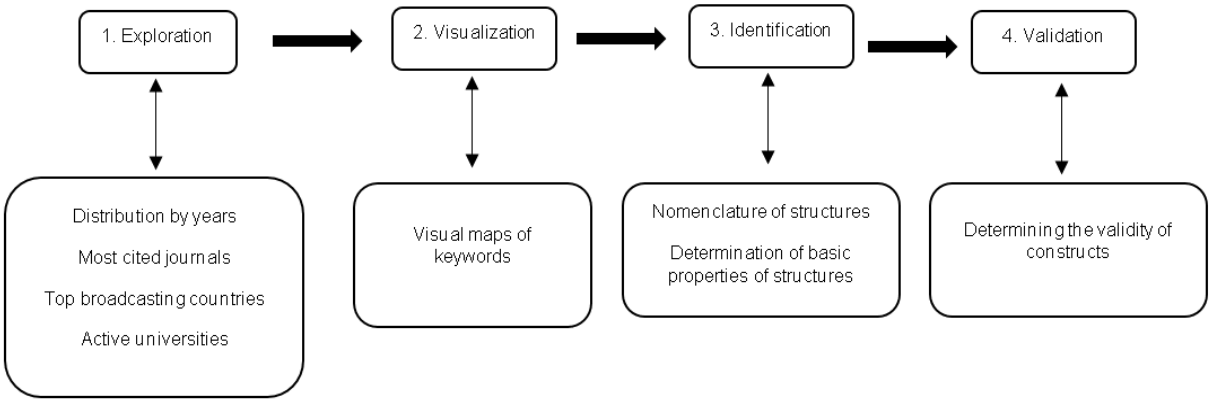
METHODOLOGY

In this study, the Web of Science (WoS) database was used for the bibliometric analysis of scientific articles in the field of teacher competencies (TC). WoS was preferred due to its wide network covering approximately 34,000 journals, strict indexing criteria, and comprehensive data required for bibliometric analyses. The SSCI index was selected due to its strong representation of TC research in the social sciences. (Birkle et al., 2020).

This study adopted a four-stage methodological framework: Exploration, Visualization, Description, and Validation. This framework aligns with previously implemented staged bibliometric analysis models in educational sciences (Hallinger & Kulophas, 2022; Kumar, 2025) and combines quantitative mapping with conceptual validation. In the exploration phase, the distribution of publications by year, journal, country, and institution was examined. In the visualization phase, instance maps were created based on keywords and abstracts. In the identification phase, themes were derived from prominent keywords. In the validation phase, the conceptual relationships among the themes were evaluated. The visualization presented in Figure 1 was originally designed by the authors and was inspired by this multi-stage framework and adapted to the scope and purpose of the study.

Figure 1

The Four-Phase Theoretical Framework of the Study



In accordance with the four-stage framework illustrated in Figure 1, the first step (Discovery) involved identifying relevant studies through a systematic search of the Web of Science (WoS)–SSCI database. A total of 11,608 records were obtained from the titles, abstracts, and keywords "teacher competence", "teacher competencies", "teaching competence", "teaching competency", and "professional teaching skills" between 2000 and 2023. To refine the dataset, inclusion and exclusion criteria were applied during the screening process, as shown in Figure 2 (PRISMA Flowchart). The inclusion criteria required that studies be peer-reviewed journal articles, published in English, indexed in SSCI, and explicitly focused on teacher competencies in an educational context. On the other hand, studies were excluded if they were not articles (e.g., books, conference proceedings), not indexed in SSCI, published in languages other than English, or focused on unrelated fields not directly related to teacher competencies, such as psychology, medicine, nursing, engineering, or workplace education. Interdisciplinary studies were evaluated on a case-by-case basis; if teacher competencies were a central theme, these studies were retained. Following this process, a total of 1,117 articles were included in the analysis. The selected records were downloaded in .bib format and imported into Biblioshiny and VOSviewer for further processing. A data cleaning protocol was implemented that included:

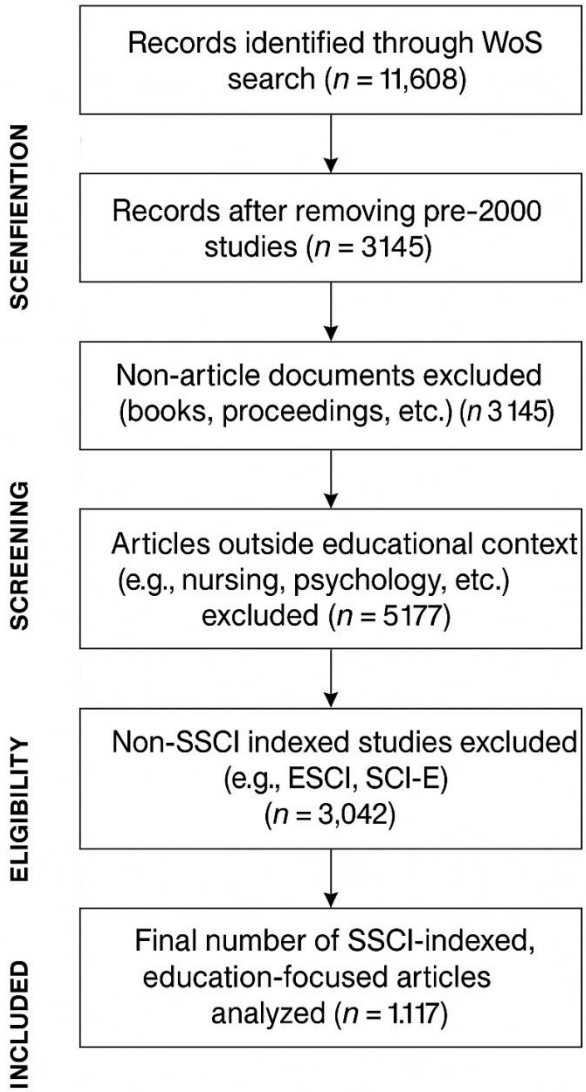
- Removal of duplicate entries based on DOI and author-title matching,
- Standardization of author names and affiliations (e.g., "University of Hong Kong" and "University of Hong Kong" were merged),

- Filtering of missing metadata (e.g., missing abstracts or publication years),
- Clustering of similar keywords through lemmatization and merging singular/plural forms.

Following this preprocessing step, descriptive statistics (e.g., annual publication counts, authorship data, citation averages) and advanced bibliometric mapping techniques were applied. Network visualizations were created using 'Biblioshiny' (Aria & Cuccurullo, 2017) and VOSviewer (Van Eck & Waltman, 2022) software; cluster analyzes were performed. The Mann-Kendall trend test was applied with R software. All steps of the analysis aligned with the four-stage structure shown in Figure 1, and the initial filtering process is detailed in Figure 2 (PRISMA Flowchart).

Figure 2

PRISMA Flowchart of the Exploration Phase of the Study



FINDINGS

The conducted bibliometric analysis is anticipated to offer valuable insights for future research on TC. The identified key figures, sources, and trends in the field are expected to serve as a guide for researchers, directing attention to important issues and potential collaborations. In addition, researchers and students in education fields can leverage this information to identify pertinent journals for publishing or referencing. The current results, spanning exploration, investigation, definition, and validation stages,

collectively contribute to a comprehensive understanding of TC research trends.

TC Research Main Information Data

The analysis involved examining data from 1117 articles on TC published between 2000 and 2023 in the SSCI of the WoS database. The objective was to assess how the number of articles on TC has changed over the years.

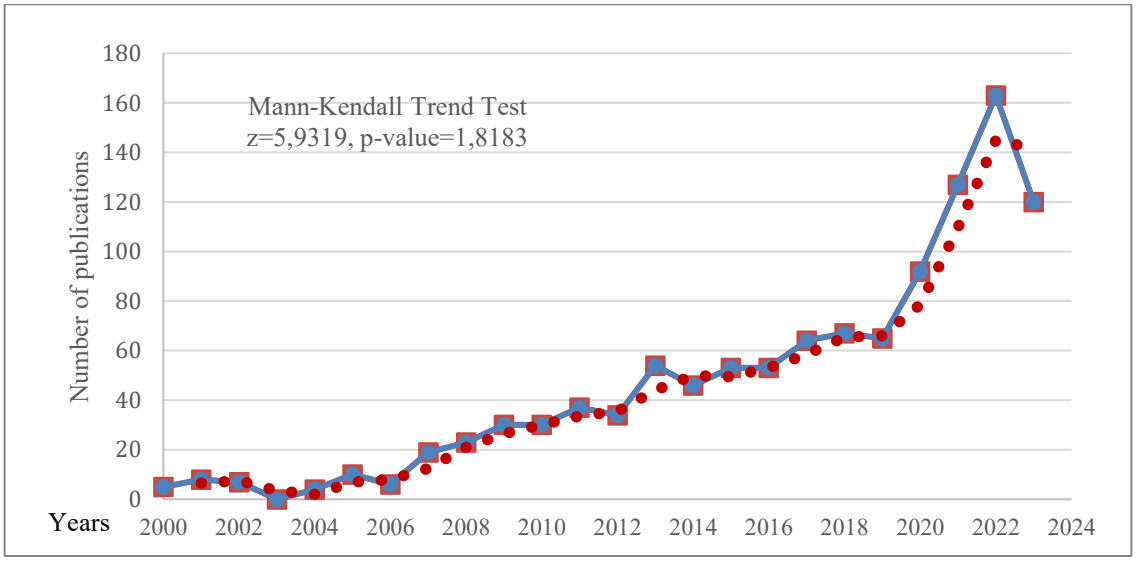
Table 1
The Main Information Data of TC

Description	Results
Timespan	2000-2023
Sources (journals)	295
Documents	1117
Annual growth rate %	14,82
Document average age	5,81
Average citations per doc	14,25
References	48821
Author's keywords (de)	3234
Authors	2843
Authors of single-authored docs	211
Single-authored docs	219
Co-authors per document	2,85
International co-authorships %	18,35

Table 1 shows 1117 documents published in the field of TC between 2000 and 2023 and that they are included in 295 different sources. The annual growth rate of 14.82% reveals that interest in the subject is steadily increasing. The average document age of 5.81 years indicates the up-to-dateness of the literature; the average citation of 14.25 per document indicates the impact of the field and that it is a frequently referred research topic. The use of a total of 48,821 references shows that TC research is based on a solid literature base.

While the 3234 keywords used in the studies reflect the multidimensionality of the subject; the contributions of 2843 different authors indicate a wide range of expertise in the field. The fact that 211 authors produced publications alone also reveals the importance of individual contributions. The average number of co-authors per publication of 2.85 reflects the tendency for collaboration in studies; the international co-authorship of 18.35% reflects academic interaction at the global level. The results reveal that TC research is relatively recent, citation-rich, and internationally collaborative on a global scale. Figure 3 visually presents the results of the Mann-Kendall trend test for TC publications between 2000 and 2023.

Figure 3
Mann-Kendall Trend Test Results for the Publications in Different Years about TC



Between 2000 and 2023, interest in TC research continued to increase, with the number of publications reaching their peak in 2021 and 2022. The Mann-Kendall trend test presented in Figure 3 reveals a significant increasing trend at the 99% confidence level, confirming the steady growth in TC research ($z \geq 2.58$).

Citations to Authors

To understand the overall structure of TC research, it is important to examine critical indicators such as authors, citation counts, and total link strength. Table 2 shows the leading contributors to the field, highlighting the most influential authors and their citation data:

Table 2
Information on Authors and Citations

Author	Documents	Citations	Total link strength
"Pantic, Natasa"	2	158	2
"Krueger, Dirk"	5	102	0
"Pekrun, Reinhard"	2	101	2
"Wong, Jocelyn L. N."	3	95	0
"Engels, Nadine"	2	80	0
"Wubbels, Theo"	2	76	2
"Bovee, H. Nicholas"	2	61	2
"Bloemeke, Sigrid"	6	60	11
"Kaiser, Gabriele"	8	59	14
"Hong, Huang-Yao"	2	43	1
"Biemans, Harm J. A."	3	41	3

Table 2 highlights influential authors in TC research and their citation rates. Notably, "Pantic, Natasa," with only 2 documents, has made a highly impactful contribution, accumulating 158 citations. Similarly, "Krueger, Dirk" garnered 102 citations across 5 documents, and "Pekrun, Reinhard" received 101 citations from 2 documents. "Bloemeke, Sigrid" holds 60 citations with 6 documents and significant impact with 11 link strengths. "Kaiser, Gabriele" received 59 citations from 8 documents, showcasing 14 link strengths. These authors have conducted important studies in the TC field, receiving substantial

citations and link strength. Their significant contributions are evident in the development of TC research, placing them at the forefront.

Productivity of Countries, Journals and Universities

Figure 4 illustrates the cumulative growth of journals publishing TC studies, presenting findings related to the published TC articles. The journal "Sustainability" leads with the highest number of TC articles (f=47), followed by "Zeitschrift Fur Erziehungswissenschaft" (f=36) and "Teaching and Teacher Education" (f=34). Subsequent journals include "Frontiers in Psychology" (f=28), "Education and Information Technologies" (f=22), and "European J. of Teacher Education" (f=22). The increase of articles in “Sustainability”, “Frontiers in Psychology” and “Education and Information Technologies” journals indicates a strong interest in sustainability, psychology and educational technologies in the TC context. Figure 4 presents the cumulative graph of journals on TC research and the Mann-Kendall Trend test results.

Figure 4

Cumulative Graph of Journals Publishing and MK Trend Test about TC

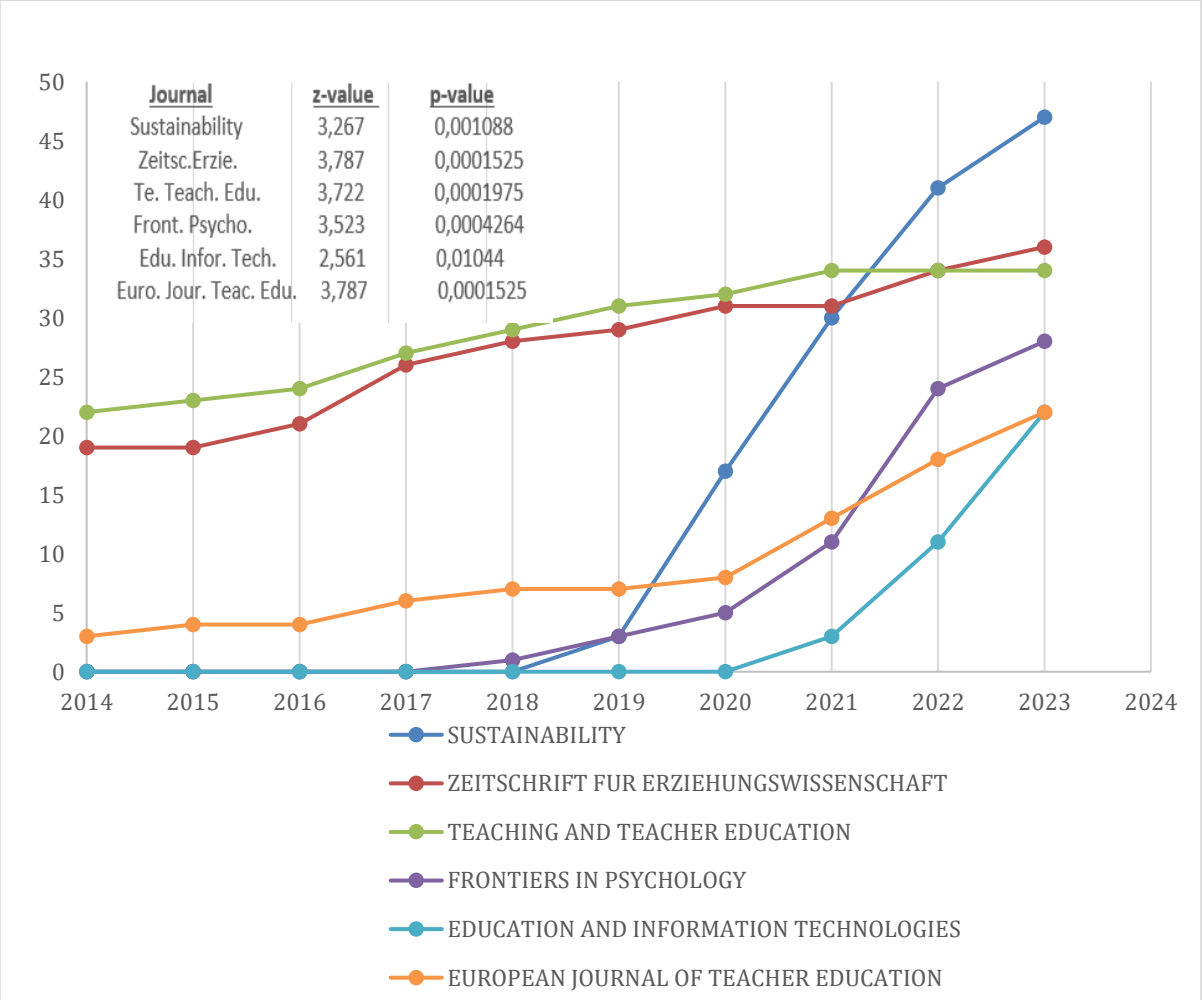
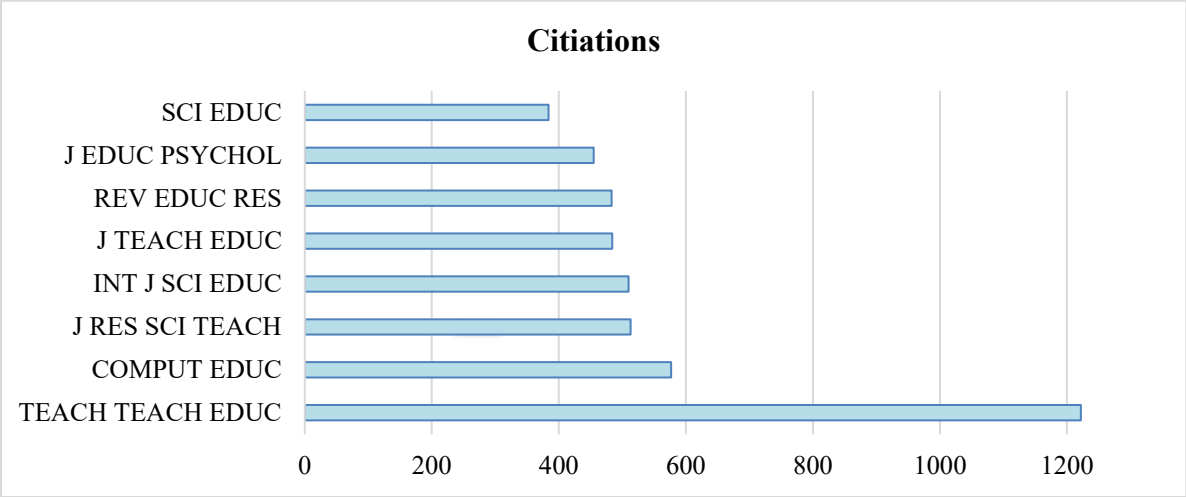


Figure 4 shows annual publication trends in the field of TC in the six most active journals from 2014 to 2023. The analysis was supported by the Mann-Kendall trend test, a nonparametric statistical method used to detect monotonic trends in time-series data. The z-values in the figure indicate the direction and strength of the trend: all values are positive, reflecting an upward trend in TC-related

publications. More specifically, journals such as Sustainability, Teaching and Teacher Education and Zeitschrift für Erziehungswissenschaft. Education showed a very strong upward trend, as indicated by z-values above 2.58 and p-values below 0.01, indicating statistical significance at the 99% confidence level. Education and Information Technology also showed a statistically significant increase, albeit slightly below the 99% threshold ($z = 2.561$, $p < 0.05$). All other journals in the figure also showed significant upward trends. These results suggest an increasing concentration of TC-related research in a specific group of journals, particularly after 2020. This may correspond to broader shifts in educational priorities during and after the COVID-19 pandemic. The upward trendlines in these specific journals also highlight their growing importance and relevance as publication venues in the TC field.

Figure 5

Most Cited Journals on TC



As depicted in Figure 5, the most cited journal in TC is "Teaching and Teacher Education" with a frequency of 1222. Following closely are "Computer Education" (f=577), "J. of Research in Science Teaching" (f=513), and "International J. of Science Education" (f=210). Figure 6 presents information on the countries of the responsible authors and the corresponding number of articles in the TC research landscape.

Figure 6
The Countries of Responsible Authors and Number of the Articles

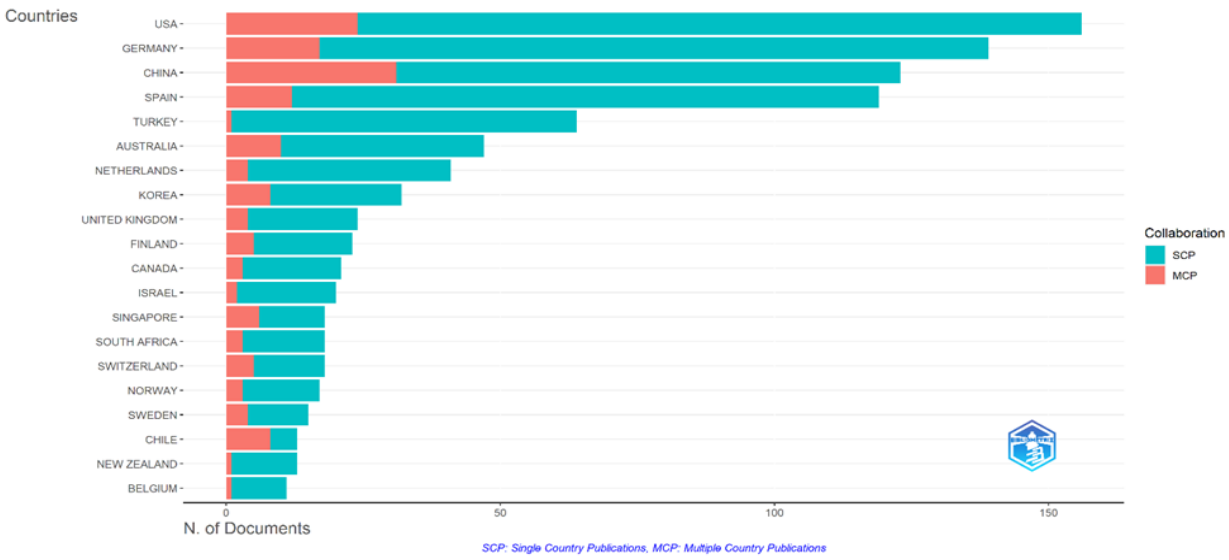


Figure 6 shows that the United States ranks first globally in terms of publications by researchers from the same country and from more than one country in the field of TC. Following the US, countries that have made significant contributions in this field are Germany, China, Spain and Turkey.

Figure 7
Scientific Productivity of Countries on TC

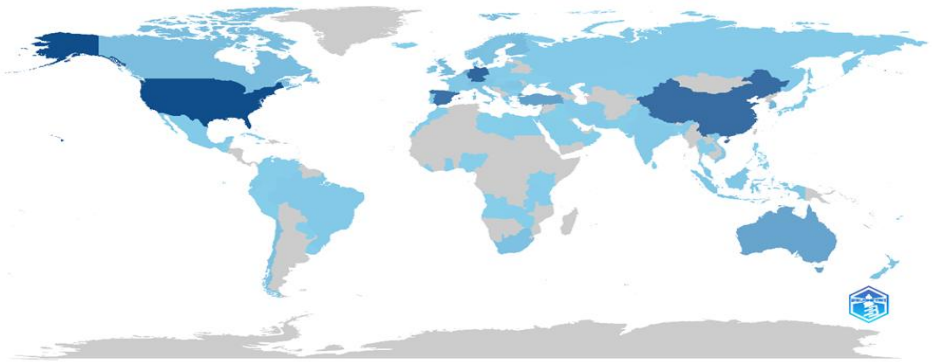
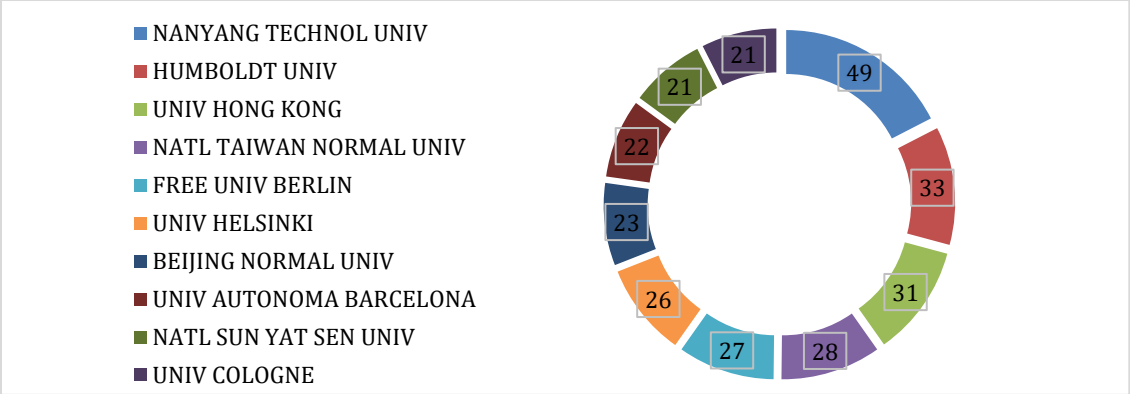


Figure 7 shows the scientific productivity of countries in TC research. The United States, shown in the darkest blue, has the highest number of publications, followed by Germany, China, and Spain. Turkey and Australia are in lighter shades and have medium contributions.

Figure 8
Top Affiliation/Institution



According to Figure 8, the institution with the most publications in TC research is Nanyang Technological University (49 publications), followed by Humboldt University (33) and the University of Hong Kong (31). These institutions are among the strongest academic centers in the field.

Keyword Analysis

As this research is interested in uncovering themes in general and in specific periods, keyword analysis was conducted. Keyword analysis is instrumental in understanding the primary topics of interest among researchers and constructing a conceptual map that highlights major trends in TC research. Figure 9 presents the keyword cloud for TC.

Figure 9
Keyword Cloud for TC

The word cloud illustrates the keywords most frequently utilized by authors, with larger words at the center indicating higher frequency. The most commonly used keywords include "education," "knowledge," "students," and "teachers." Other words with relatively lower frequency are situated further away from the center and are smaller in size. Figure 10 provides insights into the trending topics in TC research.

Figure 10
Trending Topics Related to TC

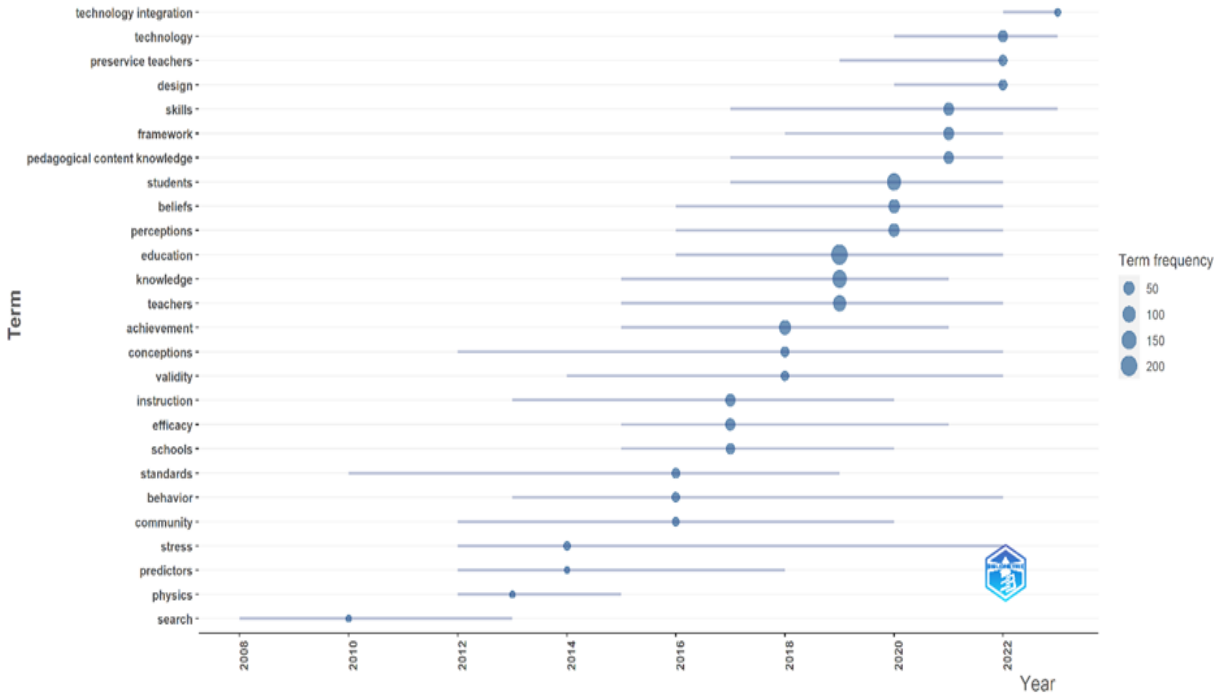


Figure 10 shows the distribution and frequency of use of prominent terms in TC research between 2000 and 2023. "Technology integration", "technology" and "pre-service teachers" are the most commonly used and increasingly important terms in recent years. The spread of the terms over time reveals that the field is particularly focused on technology and teacher education.

Figure 11
Thematic Evolution Map of the Keywords on TC by Years

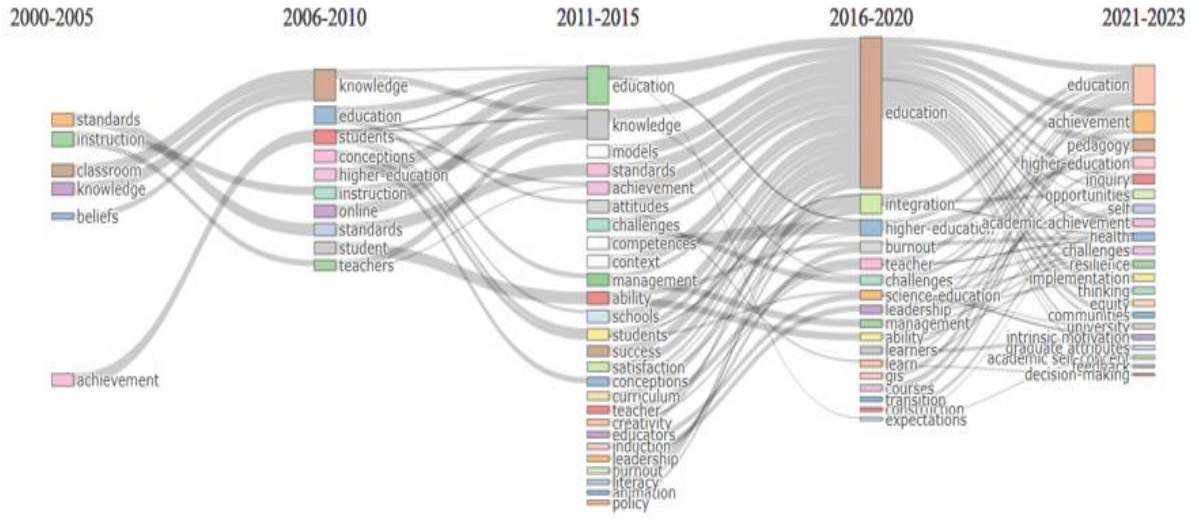


Figure 11 shows the change in the themes that emerged in TC research over time between 2000 and 2023. While “standards” and “instruction” were at the forefront in the 2000–2005 period, the focus shifted to the concepts of “knowledge” and “education” between 2006 and 2015. From 2016 onwards, concepts such as “integration”, “higher education” and “achievement” gained importance. The term “education” stands out as the most dominant keyword in all periods. This thematic development reveals that the TC field is increasingly diversifying and deepening.

Cluster Density of Keywords

As noted by Van Eck and Waltman (2022), visual structures such as overlap maps, cluster density maps and network maps are critical in the visualization process. At this stage, various findings and comments regarding the keywords of the studies were obtained. According to the bibliometric analysis results, the most frequently used keywords in the TC field were represented by three different graphical methods: "overlap visualization," "cluster density visualization," and "network visualization." The overlap map in Figure 12 is considered an important tool in determining the trends of research topics by visualizing the density of keywords over the years in TC studies.

Figure 12
Overlay Map of TC Studies

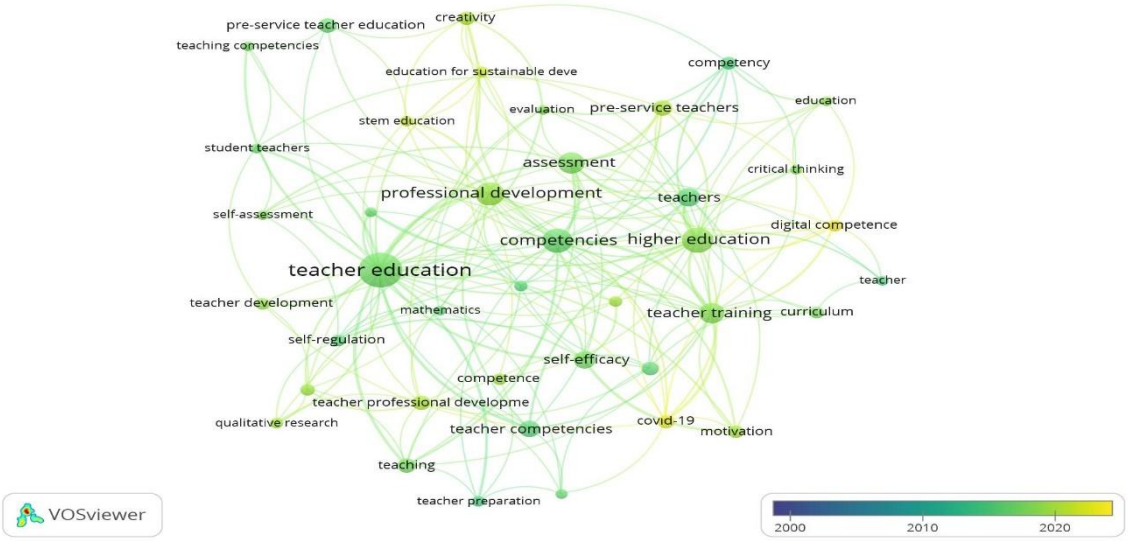


Figure 12 shows the relationships between prominent keywords in TC research on a time axis. Terms such as "teacher education," "professional development," "competencies," and "higher education" are central, while "digital competence," "COVID-19," "STEM education," and "creativity" are among the prominent themes in recent years. The map visualizes thematic diversity in the field and trends over time.

Figure 13
Cluster Density Map of TC Studies

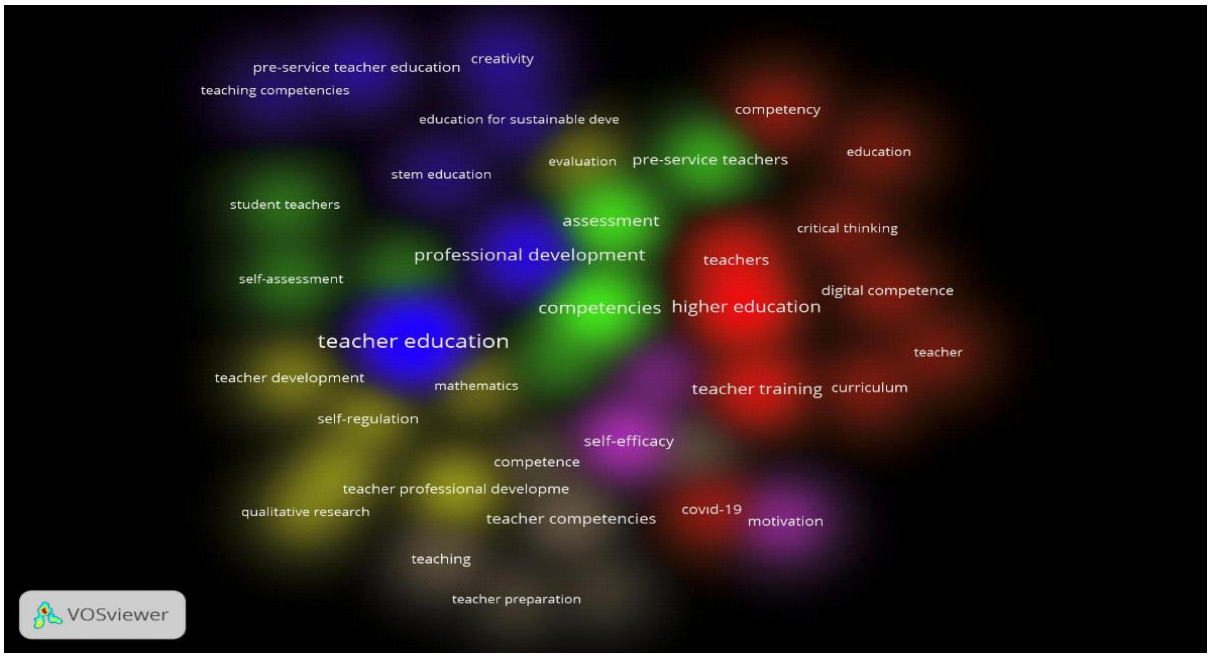


Figure 13 illustrates six thematic keyword clusters in teacher competence research. The red cluster centers on systemic and contemporary issues like "education," "digital competence," and "COVID-19." The blue cluster emphasizes "teacher education," "professional development," and "STEM education." The green cluster relates to assessment, including "self-assessment" and "preservice teachers." The yellow cluster addresses methodological terms such as "qualitative research" and "mathematics." The

brown cluster focuses on content-specific competences like “science education” and “teacher preparation,” while the purple cluster highlights psychological constructs like “motivation” and “self-efficacy.” This structure reflects the field’s interdisciplinary and multidimensional nature.

Figure 14
Network Map of TC Studies

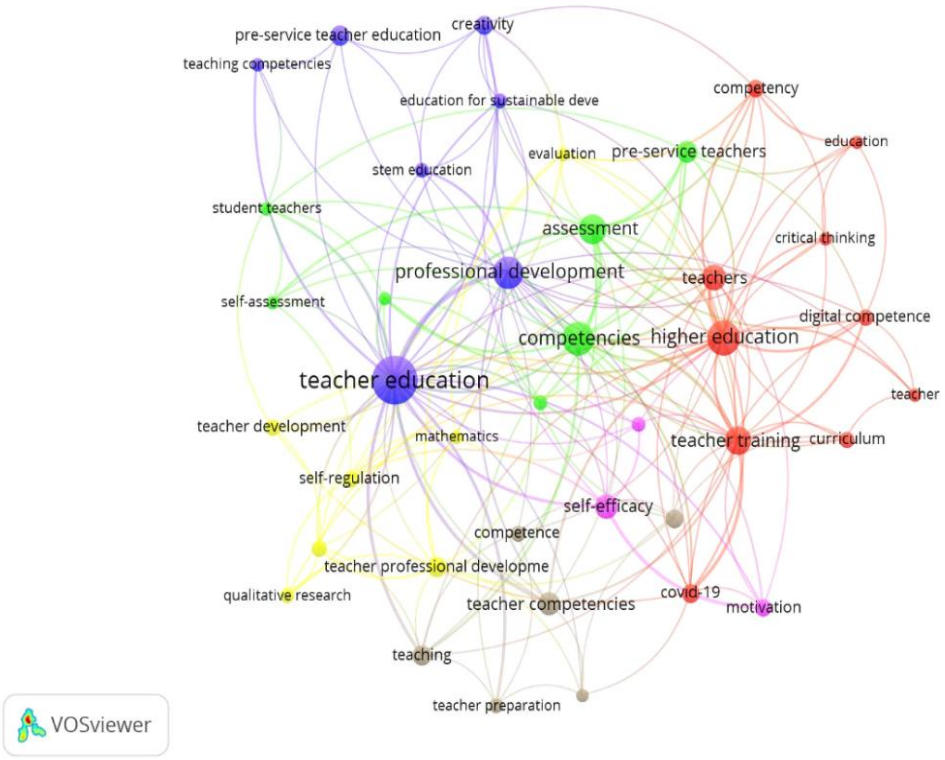


Figure 14 displays the keyword interaction network, where node size indicates conceptual prominence and link density reflects thematic connectivity. A bipolar structure emerges between the red cluster (focused on higher education and digital competencies in the COVID-19 context) and the blue cluster (emphasizing sustainable STEM and professional development). Peripheral clusters—green (assessment), brown (science education), yellow (mathematics/formative assessment), and purple (motivation/self-efficacy)—complement the central themes. "Teacher education" acts as a central hub, indicating its integrative role across subfields such as evaluation, competence, and digital transformation.

Table 3
Description of Clusters

Cluster color	Cluster name	Highly occurring keywords (number of occurrences)
Red	Higher Education and Teacher Training in the Context of COVID-19	competency (13), covid-19 (13), critical thinking (9), curriculum (11), digital competence (12), education (9), higher education (54), teacher (9), teacher training (34), teachers (29)
Blue	Teacher Education and Professional Development for Sustainable STEM Teaching and Creativity	creativity (15), education for sustainable development (10), pre-service teacher education (17), professional development (44), STEM education (10), teacher education (99), teaching

		competencies (9)
Green	Assessment of Competencies in Preservice Teachers	assessment (39), competencies (49), preservice teachers (21), self-assessment (9), student teachers (9), validity (9)
Yellow	Formative Assessment in Mathematics Teacher Professional Development	evaluation (9), formative assessment (12), mathematics (9), qualitative research (10), self-regulation (11), teacher development (11), teacher professional development (17)
Brown	Teacher Competence in Science Education and Preparation	competence (12), science education (15), TC (24), teacher preparation (10), teacher self-efficacy (9), teaching (19)
Purple	Motivation and Self-Efficacy in Technology	motivation (14), self-efficacy (25), technology (10)

Table 3 summarizes six thematic clusters derived from keyword frequency, each reflecting a distinct research focus in teacher competencies (TC). The red cluster centers on post-COVID-19 shifts in higher education, including digital competence and curriculum reform. The blue cluster links teacher education with sustainable STEM teaching and creativity. The green cluster emphasizes assessment of preservice teacher competencies, while the yellow focuses on formative assessment in mathematics education. The brown cluster addresses science education and teacher preparation, and the purple highlights motivation and self-efficacy in technological contexts. These clusters confirm the multidimensional structure of TC research, as further supported by abstract-based keyword analyses in Table 4.

Table 4

Information on the Words in the Abstract

Term	Occurrences	Relevance score
Effect	223	1.0484
Belief	192	0.6086
Instrument	173	1.1407
Test	159	0.2398
Ability	142	0.9063
Class	139	0.5575
Motivation	129	0.3927
Self-efficacy	128	0.4675
Pre-service teacher	125	0.6383
Mathematics	119	1.2697
Scale	116	0.7224
Child	112	0.9629
Characteristic	104	0.3523
Inquiry	102	0.4438
Feedback	99	0.6333
Item	94	0.7403
Validity	91	1.6747
Standard	90	2.9885
Student teacher	86	1.3609
Variable	83	0.9024
Score	83	0.5122
Country	82	1.3537
Evidence	81	0.644
Teacher educator	77	3.439

Table 4 highlights the most prominent terms in TC research abstracts and their contextual relevance. "Teacher educator" ranks highest, underscoring the centrality of teacher training processes. Keywords such as "standard" and "validity" reflect a focus on quality assurance, while "mathematics," "student teacher," and "country" indicate attention to subject-specific and comparative research. Terms like "instrument," "evidence," and "score" point to the significance of measurement and evaluation. These findings align with the broader keyword analysis, illustrating key thematic areas shaping the TC literature.

DISCUSSION

The bibliometric analysis conducted in this study reveals that TC has evolved into a multidimensional construct, with prominent themes such as technology integration, creativity, STEM, self-assessment, and digital competence emerging particularly in recent years. This thematic diversity highlights the field's increasing complexity and depth.

A striking finding of the analysis is the discrepancy between publication volume and citation impact across journals. For example, while some journals publish a large number of articles on TC, they may not receive proportionately high citations. Conversely, others with fewer publications demonstrate stronger citation impact. This distinction illustrates the classic quantity-quality paradox in scholarly communication, where higher publication numbers do not always translate to greater academic impact. Therefore, citation-based metrics should be used to complement raw publication counts when assessing a journal's or author's impact in the TC field.

Another important finding is the centrality of digital skills in teacher development, especially in the post-COVID-19 era. With the rapid transition to digital platforms, competencies related to digital self-confidence, pedagogical flexibility, and intrinsic motivation have become critical components of effective teaching (Corry and Stella, 2018; Paraskeva et al., 2008). Studies have also highlighted the growing importance of 21st-century skills such as creativity, empathy, digital literacy, critical thinking, and problem-solving for teachers in contemporary classrooms (Karacaoğlu, 2025). These overlapping trends suggest that TC research is increasingly converging on both cognitive and socio-emotional dimensions, reflecting the changing demands of education systems.

The cluster analyses conducted in this study further enrich this perspective by identifying several interconnected thematic areas. For example, STEM and sustainability-focused research is often associated with teacher education and professional development initiatives (Evcimik et al., 2025; Chiu et al., 2021; Nguyen et al., 2020). In pre-service teacher evaluation research, themes such as "self-assessment," "validity," and "measurement tools" are frequently encountered, highlighting the methodological focus of evaluation studies (Altan and Özmusul, 2022; Tondeur et al., 2017). Studies focusing on mathematics teacher development emphasize pedagogical strategies such as formative assessment and self-regulation (Granberg et al., 2021; Van der Kleij, 2019). In science education, the role of teacher self-efficacy and preparation processes continues to be extensively researched (Posnanski, 2002; Roelofs and Sanders, 2007).

Furthermore, the prominence of concepts such as "teacher educator," "standards," and "validity" among high-context clusters demonstrates the field's interest in teacher quality assurance and structural integrity in education systems (Blanton et al., 2006; Koster et al., 2005). These findings suggest that teacher education is no longer viewed solely through pedagogical content knowledge but increasingly through systemic and policy-based frameworks.

While incorporating several important contemporary sources, the discussion would benefit from greater engagement with systematic reviews or meta-analyses in the field, which could provide broader

conceptual consolidation and reinforce the robustness of interpretations. Reviews that synthesize research on digital competence, professional development models, or pre-service teacher education (e.g., Tondeur et al., 2017) could deepen the analytical perspective and contextualize existing findings within long-term academic trajectories.

In conclusion, this analysis suggests that teacher competence research is shifting from narrowly defined teaching skills to a more holistic framework encompassing technical, pedagogical, digital, and emotional abilities. As Karacaoğlu (2025) notes, these competencies not only influence individual teacher performance but also contribute significantly to students' overall development. In this context, adopting a skills-based and multidimensional approach in teacher training programs is a critical step to ensure both quality and effectiveness in education.

CONCLUSION

This study presents a comprehensive bibliometric analysis that reveals the thematic diversity and evolving trends in research in the field of teacher competencies (TC). The findings indicate that TC research is concentrated in key areas such as teacher education, assessment, professional standards, digital competencies, and discipline-based skills, particularly in STEM and mathematics education.

In the post-COVID-19 era, technology integration and digital pedagogical competencies have become central to teacher development efforts. This shift is consistent with recent findings by Göktaş et al. (2024) and Karacaoğlu (2025). These findings emphasize that equipping teachers with 21st-century skills such as creativity, empathy, digital literacy, and problem-solving enhances not only individual performance but also the quality of education systems.

Keyword analysis and clustering results indicate that concepts such as "teacher educator," "standards," "validity," "mathematics," and "pre-service teacher" remain central to TC research. These findings reflect both fundamental concerns (e.g., teacher preparation, quality assurance) and the dynamic evolution of teacher roles in contemporary classrooms.

A key finding is the increasing use of comparative perspectives. The rise in cross-country studies points to a clear trend toward analyzing teacher competencies in a globalized context. For example, Spain, Germany, the United States, and some Asian countries (especially in digital competence and leadership research) have emerged as leading contributors to this field. This reflects how different education systems approach the design, implementation, and assessment of teacher competencies based on local needs and policy orientations, while also engaging in global discussions on teaching quality.

However, the analysis also shows that regional emphases vary:

- European countries tend to focus on policy-driven standards and teacher evaluation systems;
- Asian countries frequently emphasize leadership, discipline-specific competencies, and the role of technology;
- Anglophone countries, on the other hand, emphasize self-efficacy, creativity, and innovation in teacher development.

This international diversity demonstrates that, despite common core themes, the interpretation and prioritization of teacher competencies are often shaped by cultural, institutional, and political differences. Understanding these differences is crucial for creating globally relevant yet locally adaptable teacher education models.

As a result, the TC literature now extends beyond instructional strategies to encompass multidimensional areas such as assessment, self-efficacy, creativity, and digital transformation. This analysis not only provides a snapshot of the field's current state but also offers a forward-looking

framework to guide policymakers, curriculum designers, and educational researchers in creating teacher education programs that are both globally informed and context-sensitive.

RECOMMENDATIONS

Based on the findings of this study, the following recommendations are offered for future research, educational practice, and policy development in the field of teacher competencies (TC):

Thematic Focus for Future Research

Future studies should examine emerging and under-researched dimensions of TC:

- The long-term effects of digital pedagogy on interdisciplinary teaching effectiveness.
- The interaction between self-assessment practices and actual classroom performance.
- The integration of the sustainable development goals (SDGs) into teacher competencies, particularly in STEM education.

Sample research questions:

- How do teachers' self-assessment scores relate to student outcomes across cultural contexts?
- Which specific digital competencies predict higher teaching effectiveness in blended classrooms?

Methodological Developments

To better capture the evolving and contextual nature of TC, the use of mixed-methods, longitudinal, or international comparative designs is recommended. Longitudinal studies can track changes in teacher competencies over time (e.g., before and after digital education). Cross-cultural comparisons can highlight how TC is influenced by national standards, teacher education policies, or technological infrastructure.

Teacher Education Program Development

Curriculum designers should integrate digital literacy, assessment literacy, and socio-emotional skills (e.g., empathy, resilience) as core modules in teacher education programs. Simulated digital environments (e.g., VR/AR) can be integrated to enhance technological pedagogical content knowledge (TPACK). Self-assessment tools and reflective practices should be systematized across teacher education programs to increase metacognitive awareness among preservice teachers.

Policy Implications

Develop national teacher competency frameworks that incorporate future-ready skills, particularly in the context of digital transformation and sustainability. Support teacher professional development through continuous digital skills development programs and institutional mentoring systems. Develop global benchmarking mechanisms to evaluate the effectiveness of teacher education programs using common international indicators (e.g., OECD TALIS, UNESCO frameworks).

Interdisciplinary and Global Collaboration

Encourage interdisciplinary collaborations (e.g., among education researchers, cognitive psychologists, and data scientists) to develop advanced assessment tools for TC. Encourage global research networks and collaborative projects to advance comparative knowledge across education systems and improve policy transfer.

Ethics Statement

This research adheres to ethical principles, using publicly available data without involving confidential information. The analysis is conducted with integrity, proper citations, and transparency. The authors disclose any potential conflicts of interest and ensure no harm is done to individuals or entities. Respecting privacy and citing sources, the study is for academic purposes, maintaining high ethical standards, and follows institutional guidelines.

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Conflicts of Interest

The authors declare no conflict of interest regarding this study.

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GENİŞLETİLMİŞ ÖZET

Giriş: Öğretmen Yeterlilikleri, öğretim kalitesini ve dolayısıyla öğrenci başarısını şekillendirmede kritik bir rol oynar (Karacaoğlu, 2025). Mevcut araştırmalar öğretmenlerin öğrenme çıktıları üzerindeki merkezi etkisini vurgularken, dış faktörler ve öğrenci başarısı arasındaki ampirik bağlantılar sınırlı kalmaktadır (Creemers ve Kyriakides, 2015). Öğretmen kalitesi, özellikle öğretmen yeterlilikleri ile ilgili olarak, düşük performans gösteren öğrencileri desteklemek için özellikle önemlidir (Mincu, 2015). öğretmen yeterliliklerinin eğitimsel iyileştirmedeki temel rolünü kabul eden bu çalışma, 2000-2023 yılları arasında Web of Science (WoS) veritabanının SSCI'sinde dizinlenen öğretmen yeterlilikleri ile ilgili araştırmaların bibliyometrik analizini sunmaktadır. Çalışma, yayınları, yazarları, dergileri, ülkeleri, kurumları, anahtar kelimeleri ve özetleri analiz ederek öğretmen yeterliliklerindeki küresel eğilimleri ve gelişmeleri keşfetmeyi amaçlamaktadır. Bulguların, öğretmen yeterlilikleri araştırmalarının tematik ve coğrafi dağılımına ilişkin değerli bilgiler sunması, öğretmen eğitim programlarını, politika yapıcıları ve eğitim araştırmacılarını bilgilendirmesi beklenmektedir.

Yöntem: Bu çalışmada dört aşamalı bir bibliyometrik metodoloji kullanıldı: keşif, görselleştirme, tanımlama ve doğrulama. Keşif aşamasında, WoS-SSCI veritabanındaki öğretmen yeterlilikleri yayınları yıl, dergi, ülke ve kurum bazında tarandı. Görselleştirme aşaması, ağ ve yoğunluk haritaları oluşturmak için VOSviewer ve Bibliometrix'i (R/Biblioshiny) ve büyüme modellerini değerlendirmek için Mann-Kendall trend analizini içeriyordu. Tanımlama aşamasında, anahtar kelime ve özet analizi kullanılarak tematik yapılar tanımlandı. Son olarak, doğrulama aşaması bu yapıları kavramsal ilişkilere dayanarak doğruladı. Veri seti, 15 Kasım 2023'te indirilen, SSCI indeksli dergilerde 2000 ile 2023 yılları arasında yayınlanan öğretmen yeterlilikleri ile ilgili 1117 makaleden oluşuyordu. İlk arama 11.608 kayıt üretti. 2000 öncesi yayınlar, makale dışı türler (örneğin kitaplar, bildiriler), alakasız WoS kategorileri (örneğin hemşirelik, psikoloji) ve SSCI dışı endeksler (örneğin ESCI, SCI-Expanded) hariç tutulduktan sonra rafine edilmiş bir korpus oluşturuldu. Analiz, yayın eğilimlerinin, en iyi dergilerin, ülkelerin, kurumların ve anahtar kelime eş zamanlılık ağlarının tanımlayıcı istatistiklerini ve bibliyometrik haritalamasını içermiştir

Bulgular: 2000 ile 2023 yılları arasında, 295 kaynakta toplam 1.117 öğretmen yeterlilikleri ile ilgili makale yayınlanmış ve yıllık büyüme oranı %14,82 olarak bulunmuştur. Bu bulgu akademik ilginin istikrarlı bir şekilde arttığını göstermektedir. Literatür güncelliğini korumaya devam etmekte olup ortalama belge yaşı 5,81 yıl ve makale başına 14,25 atıf belirlenmiştir. Alan, 48.821 atıf, 2.843 benzersiz yazar ve 3.234 anahtar kelimeden oluşan sağlam bir referans tabanıyla desteklenmektedir. Makale başına ortalama 2,85 ortak yazar ve uluslararası işbirliğini içeren çalışmaların %18,35'i ile yüksek düzeyde bir işbirliği olduğunu ortay koymaktadır. En üretken yılların 2021 ve 2022 olduğu belirlenmiştir. Mann-Kendall trend analizi, %99 güven düzeyinde istatistiksel olarak anlamlı bir büyüme trendini doğrulamıştır. Etkili yazarlar arasında Pantic, Krueger, Pekrun, Bloemeke ve Kaiser yer almaktadır. Sustainability, Zeitschrift für Erziehungswissenschaft ve Teaching and Teacher Education en üretken dergilerken, Teaching and Teacher Education da atıflarda başı çekmektedir. Ülke düzeyindeki analiz, en aktif katılımcının ABD olduğunu, ardından Almanya, Çin, İspanya ve Türkiye'nin geldiğini ortaya koymuştur. Önde gelen kurumlar arasında Nanyang Teknoloji Üniversitesi, Humboldt Üniversitesi ve Hong Kong Üniversitesi yer almaktadır.

Anahtar kelime analizi, "dijital yeterlilik", "COVID-19", "sürdürülebilir kalkınma", "STEM eğitimi", "yaratıcılık" ve "öğretmen mesleki gelişimi" konularında güçlü bir araştırma ilgisini belirlemiştir. VOSviewer kullanılarak yapılan tematik kümeleme altı anahtar kelime kümesi üretmiştir. Bu kümeler aşağıda sıralnmıştır:

- COVID-19 Bağlamında Yüksek Öğrenim ve Öğretmen Eğitimi
- Sürdürülebilir STEM ve Yaratıcılık için Öğretmen Eğitimi ve Mesleki Gelişim
- Hizmet Öncesi Öğretmenlerde Yeterliliklerin Değerlendirilmesi
- Matematik Öğretmeni Gelişiminde Biçimlendirici Değerlendirme
- Fen Eğitiminde Öğretmen Yeterliliği ve Hazırlığı
- Teknolojide Motivasyon ve Öz Yeterlilik

Kümeler, pandemi dönemi öğretmen eğitimi ve sürdürülebilir STEM öğretimi merkezli iki kutuplu bir yapıyı yansıtmaktadır. Ara kümeler ise değerlendirme, fen eğitimi ve teknoloji kullanımını ele almaktadır. Bu yapı,

öğretmen yeterlilikleri araştırmasındaki çeşitli ve gelişen tematik odağı göstermekte ve akademik araştırmalar için yararlı bir çerçeve sağlamaktadır.

Tartışma ve Sonuç: Bu analiz, öğretmen yeterlilikleri araştırmalarının özellikle COVID-19'dan sonra giderek daha fazla dijital yeterlilik, yaratıcılık, STEM ve öz değerlendirmeye odaklandığını göstermektedir. Dijital beceriler, motivasyon ve pedagojik uyum yeteneği (Corry & Stella, 2018) tarafından desteklenen öğretmen gelişiminin merkezi haline gelmiştir (Gökdaş vd., 2024). Karacaoğlu (2025) da, son öğretmen yeterlilikleri temalarıyla uyumlu olarak empati, eleştirel düşünme ve dijital okuryazarlık gibi temel becerilere vurgu yapmaktadır. Kümeler ayrıca STEM tabanlı gelişim, hizmet öncesi öğretmen değerlendirmesi ve öğretmen eğitiminin kalitesine vurgu yapıldığını ortaya koymaktadır. Genel olarak, öğretmen yeterlilikleri araştırması teknik, pedagojik ve duygusal becerileri entegre ederek öğretmen eğitimine beceri ve yeterlilik tabanlı bir yaklaşıma olan ihtiyacı vurgulamaktadır.

Öneri: Gelecekteki öğretmen yeterlilikleri araştırmaları dijital teknoloji entegrasyonu, sürdürülebilir STEM eğitimi ve öz değerlendirme gibi temalara öncelik vermelidir. COVID-19 sonrası eğilimler dijital okuryazarlığın, motivasyonun ve öz yeterliliğin önemini vurgulamaktadır. Öğretmen eğitim programları, değerlendirme araçları ve kültürlerarası uygulamalar üzerine karşılaştırmalı çalışmalar da teşvik edilmektedir. Disiplinler arası ve uluslararası iş birliği araştırmaların etkisini ve kapsayıcılığını artıracaktır. Bu nedenle öğretmen eğitimi kurumlarındaki bilim insanlarının aynı ekiplerle benzer çalışmalar yayımlama eğiliminden vazgeçip uluslarası ilişkiler kurarak alana katkı sağlama çabası içerisinde olmaları beklenmektedir.