Digital Transformation in Higher Education and Teacher Professional Development: Systematic Mapping of Institutional, Technological, and Psychosocial Factors (2015–2025)

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ABSTRACT:
The digitalization of higher education, driven by virtual learning environments and artificial intelligence, has reshaped pedagogical practices; however, infrastructure alone does not guarantee sustainable innovation. Faculty professional development (FPD) is the critical axis for this transition, yet the current literature exhibits a conceptual fragmentation that prioritizes individual competencies over systemic approaches. This study aimed to map and synthesize scientific evidence (2015–2025) on the institutional, technological, and psychosocial factors that shape FPD in the context of digital transformation. Using the Joanna Briggs Institute framework and PRISMA-ScR guidelines, a scoping review was conducted in Web of Science and Scopus. The corpus was analyzed through bibliometric analysis (ScientoPy and VOSviewer) and qualitative content analysis. The findings reveal an exponential growth in scientific output since 2020 and consolidate four lines of research: digital competence, FPD in digitalized environments, technopedagogical integration, and institutional digital transformation. It is concluded that the success of university digitalization depends on a systemic perspective that articulates organizational and human dimensions, transcending technocentric visions.

Keywords: Digital transformation; Faculty professional development; Digital competence of educators; Educational technology integration; Artificial intelligence; Bibliometric analysis; Scoping Review.

INTRODUCTION

Higher education is immersed in a process of change related to the growing adoption of digital technology in the academic and organizational functions of universities. The accessibility and use of learning platforms, educational analytics systems and artificial intelligence applications have improved the possibilities in teaching, institutional management and knowledge production. However, evidence shows that technological infrastructure alone does not generate improvements in educational processes. In many cases, new technologies add to pre-existing pedagogical practices and do not produce

changes in teaching and learning models. (Imran y Almusharraf, 2024; Sutton y DeSantis, 2016; Englund et al., 2017; Walker y Voce, 2023)

The teacher professional development (DPD) framework is situated in the context of educational changes in digital spaces. The DPD involves continuous updating in training, professional reflection and collaborative learning, in which teachers develop and reinforce, throughout their career, different competencies that cover the pedagogical, technological and disciplinary areas. The literature has shown that the operations carried out within the framework of the continuous training of teachers are of a decisive nature with respect to the pedagogical integration of digital technologies in university teaching.(Phuong et al., 2017; Peters et al., 2022; Sullivan et al., 2018)

The available research, however, has conceptual limitations. A large part of academic production has focused on assessing individual digital competencies or studying the adoption of specific technologies. This centrism takes away from the organizational, cultural, and institutional mediations that affect teacher professional development. As a consequence, an analytical fragmentation is maintained that does not allow for a holistic approach to the processes of transformation of education in the university environment, which in turn limits the generation of proposals regarding institutional policy on digital transformation.(Mercader y Gairín, 2020; Peters et al., 2022; Silva, 2023)

Recent literature also suggests that the incorporation of technologies in higher education responds to the interaction of different analytical levels. Institutional factors, including academic leadership, educational innovation policies, and teacher training programs, shape the organizational conditions that favor pedagogical change. .(Shibankova et al., 2019)

In turn, technological factors, related to digital infrastructure and access to educational tools, delimit the possibilities of implementing innovative practices. Added to this are psychosocial factors, such as teacher self-efficacy and attitudes towards technology, which influence teachers' willingness to adopt new pedagogical practices. Together, these dimensions make up a complex system that conditions the processes of teacher professional development in contexts of educational digitalization.(Sailer et al., 2021; Tondeur et al., 2023; Zhang y Chen, 2025)

Despite the sustained growth of the literature on digital transformation in higher education, there are still gaps in research regarding the integration of these dimensions into broader analytical frameworks. In particular, the number of studies that systematically summarize the scientific evidence on the interaction of institutional, technological, and psychosocial factors in the professional development of teachers remains limited. This is especially pertinent in the contemporary context characterized by the rapid proliferation of emerging technologies such as generative artificial intelligence, which introduce new challenges in the training of university teaching staff.(Mah y Groß, 2024; Imran y Almusharraf, 2024)

Analyzing the literature from a theoretical position allows us to identify patterns, areas of analytical convergence, and gaps in research in the area of teacher professional development in digital environments. Practically, this synthesis of the literature can inform strategic and tactical decisions related to digital investments and Teacher Professional Development (DPD) programs. Without this relational knowledge, institutions will likely offer a technocentric approach with a negligible impact on pedagogical innovation (. (Peters et al., 2022; Silva, 2023)

Based on this, the present study aims to carry out a scientific mapping to synthesize the existing research on teacher professional development in higher education between 2015 and 2025. The chosen timeframe is significant because of the growing number of international digital competence frameworks for teachers, online learning platforms, and the recent integration of artificial intelligence (AI) into university teaching.(Imran y Almusharraf, 2024; Walker y Voce, 2023)

Literature review

Digital transformation in higher education

Higher education can be a field where digital transformation is a structural phenomenon that alters many university activities. It has been the result of the incorporation of digital advances, online educational platforms, educational data, and artificial teaching and learning management systems. Even beyond access to digital technologies, it relates to the changes that must

occur in the creation and distribution of knowledge in universities. (Wibowo y Irmawaty, 2022; Imran y Almusharraf, 2024; Walker y Voce, 2023)

Many factors impact the use of technologies in educational settings. However, using new technologies does not necessarily lead to changes in teaching and learning. Educational technologies do not change the dominant model of teaching in schools: the transmission model. The use of educational technologies can also reinforce dominant educational models and teaching practices, especially when their use is not integrated with organisational changes or innovations in pedagogy and teaching. (Sutton y DeSantis, 2016; Englund et al., 2017; Cutajar, 2019)

For this reason, the most recent body of work argues that the digital transformation of higher education should be framed as a sophisticated structural change within the educational environment that includes the interaction of technology, structure, and people. Within this approach, the digitalization of higher education is not simply a factor of physical availability of technology, but also an interaction of institutional leadership, organizational culture, and the professional capacity of teaching staff. Therefore, the digital transformation of higher education is only possible with the implementation of relevant university policies to integrate the development of teaching staff, innovative pedagogy and educational technologies within the structural framework of the institution.(Farrell, 2024; Grant y Organ, 2020; Walker y Voce, 2023; Imran y Almusharraf, 2024; Wibowo y Irmawaty, 2022)

Professional development of teachers in digital contexts

The digitalisation of teaching and learning at the university has made the professional development of university teachers a central aspect of educational innovations. This concept includes formative, reflective and collaborative experiences, in which university teachers gradually advance in their pedagogical, technological and disciplinary competencies. Within the context of university pedagogy, the specialized literature has pointed out that these training processes should offer opportunities to reflect on digital technologies.(Phuong et al., 2017; Peters et al., 2022; Sullivan et al., 2018)

At the same time, training models based on temporary workshops or interventions have been criticized. It has been argued that these models offer training in digital tools, which leads to minor and temporary changes in the ways university teachers teach. On the contrary, approaches that emphasize technological mentoring, educational communities of practice, and collaborative learning have been shown to have a positive impact on the integration of technology into teaching and learning processes. (Baran, 2016; Dysart y Weckerle, 2015; Sullivan et al., 2018)

More recent evidence shows that university staff go beyond requiring training related to the technical aspect of digital tools. Many teachers place a higher value on training related to digital pedagogy and technology-enhanced learning design. This demonstrates that teacher training must include a combination of the three interrelated domains: pedagogy, technology and practice, to encourage the design of educational practices aligned with the needs of today's digital age. (Englund et al., 2017; Churchill, 2024; O'Neil y Pegrum, 2018; Peters et al., 2022; Phuong et al., 2017)

(Prosen, 2024) They identify various approaches to understand the processes and challenges of digitalization in universities. The analysis of the integration of digital tools in the teaching-learning process in higher education has developed several conceptual models through which the incorporation of digital tools in teaching is defined. One of the most cited models in this regard is the TPACK model (Mishra & Koehler, 2006), which proposes that the teaching of a discipline using technology is based on three interrelated domains: discipline, pedagogy, and technology. This model has been used to reflect on the digitalisation of teaching staff and to analyse the integration of technology in staff education.(Akram et al., 2021; Koh, 2020; Cubeles y Riu, 2018)

The analytical applicability of the model in the university context is understandable based on the evidence. The interaction between pedagogical knowledge and technical knowledge plays a crucial role in the development of competences related to online teaching. From this perspective, some tools have been developed to assess teachers' digital competence, as well as their ability to integrate technology into curriculum

design and teaching strategies. (Akram et al., 2021; Peters et al., 2022)

In addition, there is some literature that takes a broader perspective to consider the role of institutional contexts in the integration of technology. More recent attempts to explain the integration of technology in higher education have tried to take into account teaching, organizational structure, and context. In this area, the development of the digital competence of higher education teachers is understood as the individual potential of a teacher, together with the relevant institutional factors that, in a positive or negative sense, support or restrict educational innovations in higher education.(Sailer et al., 2021; Tondeur et al., 2023; Peters et al., 2022)

Factors influencing teachers' professional development

Recent publications on the professional development of university teachers in the context of digital transformation have documented a variety of factors that impact the success of university teacher training programs. Analyzing this body of work allows us to categorize the factors into three dimensions: institutional, technological, and psychological. This offers some clarity on the complexity of educational transformation in universities and provides a better understanding of the interaction of different levels of the university system in the adoption of technology-mediated pedagogical practices.(Mercader y Gairín, 2020; Peters et al., 2022; Silva, 2023)

Institutional elements

The category of institutional elements recognizes the specific conditions of the organization that can enable or limit the integration of technology in the teaching and learning processes in higher education. They include institutional regulations, support from academic leaders, and the organization of structures to accommodate innovation in teaching. The existence of coherent institutional policies in the university is a significant basis for promoting and sustaining the transformation of education in the digital space.(Shibankova et al., 2019; Chenhui et al., 2024)

Another important factor that has received considerable attention is the support and role of leaders within the institution in the digitization of the university. The presence of academic authorities, the provision of digital resources, and the organization of training and professional development activities for university staff have been shown to be significant in the widespread adoption of digital tools by teachers.(Phan et al., 2025; Zhang y Chen, 2025)

In addition to policy and leadership, universities have established organizational structures that facilitate teaching. One such example is teaching and learning centres, where units offer academic counselling, training and education. These units promote the professional development of interns and support the implementation of in-service training programs within higher education institutions.(Elçi y İşeri, 2022; Grant y Organ, 2020)

Technological elements

Technological elements refer to the availability of digital infrastructure, digital resources, and the appropriate digital skills needed to integrate technology into teaching and learning processes in higher education. Although the availability of digital technology is necessary, the authors argue that infrastructure, by itself, is not a sufficient condition for educational innovation to occur.(Mercader y Gairín, 2020; Ahmed, 2020)

The research indicates various technological obstacles that prevent the effective use of digital pedagogical tools: the workload of teachers, lack of time and lack of training in the use of educational technology. The development of new technologies, such as artificial intelligence, mobile learning, and gamification, poses new challenges for technology. These require ongoing professional development processes to help educators integrate technology into a modern digital learning environment.(Mercader y Gairín, 2020; Akgunduz y Topalsan, 2024)(Maqbool et al., 2024; Imran y Almusharraf, 2024)

Psychosocial factors

These include attitude toward technology, professional and academic self-efficacy, and professional and academic identity. Research shows that technology adoption depends largely on educators' beliefs about the degree of their self-efficacy and professional confidence.(Casillas-Martín S. et al., 2020; Yukhymenko-Lescroart et al., 2021)

In addition, several studies have shown that resistance to change is a major factor affecting the digitalization of education. Perceptions of

technology as beneficial and easy to use encourage the adoption of technology, although the adoption of new tools may decrease if teachers feel that their pedagogical practices are being threatened. In addition, the rapid digitalisation of education has the potential to lead to conflicts in teachers' professional identity when new technologies are used to replace traditional pedagogical practices without the support of an education system or the provision of new pedagogical practices.(Singh et al., 2023; Roumbanis Viberg et al., 2021)(Alexandrova et al., 2023; Mah y Groß, 2024)

Unexplored areas of teacher professional development in digitalised environments

The body of literature on the impacts of digital technology on teaching continues to grow, however, there are still many unexplored areas of teacher professional development. A key example of such an unexplored area is digital integration in the workplace. Many researchers segment their studies to present findings only on certain aspects of digital components, neglecting to address institutional, technological, and psychosocial aspects within the same framework. (Peters et al., 2022; Silva, 2023)

This problem is compounded by the dominance of research that focuses on the personal aspects of technology. This approach does not consider the organizational and cultural aspects of the digital transformation of universities. Along these lines, some researchers have highlighted the importance of developing studies that use mixed methods to investigate teachers' professional development, institutional contexts, and teachers' professional perceptions.(Sutton y DeSantis, 2016; Cutajar, 2019)(Sailer et al., 2021; Peters et al., 2022)

The rapid growth of novel technologies, especially artificial intelligence, has created new questions for the training of university teachers. In this context, several authors have pointed out the need to develop training opportunities for teachers that include digital literacy in AI, digital ethics and new pedagogical techniques designed to support the objectives and practices of the so-called Education 4.0.(Mah y Groß, 2024; Imran y Almusharraf, 2024; Peters et al., 2022; Silva, 2023)

METHODOLOGY

The study aimed to systematically identify and summarize research on the intersection of teacher professional development and digital transformation in higher education. The exploratory review method is suitable for identifying and mapping existing research in an emerging field.

The review was conducted according to the Joanna Briggs Institute (JBI) exploratory review method. Its report followed the PRISMA-ScR guidelines for transparency and traceability of the review process with respect to the identification, selection, and synthesis of studies. The review process and the results obtained were clearly presented, and the reproducibility of the review process was improved through the adoption of these guidelines.(Page et al., 2021)

From an analytical point of view, the research combined bibliometric analysis and qualitative content analysis. The first was the basis for examining a broad corpus of literature to identify patterns in literary production and thematic development, as well as networks of authorship and academic collaboration in the field of study. The second provided the basis for a conceptual interpretation of the selected literature, as well as the identification and mapping of the order and interrelationships of the institutional, technological, and psychosocial components of teacher professional development.

The theory of sociotechnical systems was another basis to which the study subscribed. From this point of view, the digital transformation of education is the result of the combined interaction between organizational, technological and human elements.

Search methodology and sources of information

The bibliometric search used the Web of Science (WoS) and Scopus databases, due to their wide access to peer-reviewed scientific journals, as well as their popularity in bibliometric analyses. WoS and Scopus describe scientific journals and provide content in a continuous, consistent, and high-quality manner, making it easier to systematically examine scientific output and recognize patterns in a given academic field. (Mongeon y Paul-Hus, 2016; Singh et al., 2023)

The analysis covers the years 2015 to 2025. The selected period is valid as it captures the years of a rapidly developing digital transformation in

higher education and the promotion of international structures to enhance the digital skills of university teachers.

Only original, empirical, peer-reviewed articles published in journals were selected. The search strategy was organized around three conceptual blocks: (i) teacher professional development; (ii) higher education, and (iii) digital transformation and educational technologies. In the identified blocks, search phrases were formulated by combining terms with Boolean operators and searched in the title, abstract, and keywords.

Search equation in Scopus

TITLE-ABS-KEY (("faculty development" OR "professional development" OR "academic staff development") AND ("higher education" OR universit* OR "tertiary education") AND ("digital transformation" OR digitalization OR "digital innovation" OR "digital change" OR "digital maturity" OR "educational technology" OR "digital technologies" OR "technology integration" OR "artificial intelligence" OR "generative AI"))AND PUBYEAR > 2014 AND PUBYEAR < 2026 AND (LIMIT-TO (DOCTYPE , "ar")).

Search equation in Web of Science

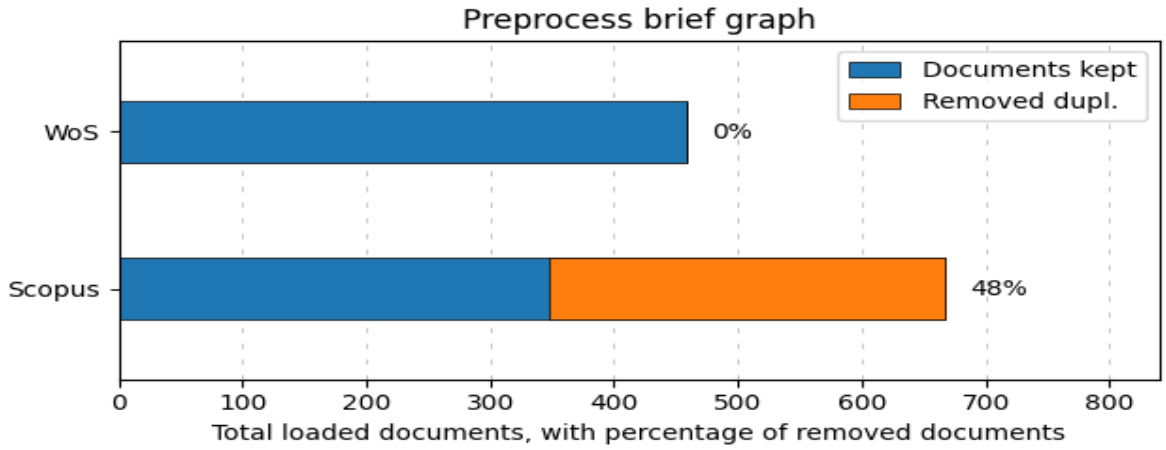
TS=(("faculty development" OR "professional development" OR "academic staff development")) AND TS=(("higher education" OR universit* OR "tertiary education")) AND TS=(("digital transformation" OR digitalization OR "digital innovation" OR "digital change" OR "digital maturity" OR "educational technology" OR "digital technologies" OR "technology integration" OR "artificial intelligence" OR "generative AI")) AND DT=(Article) AND PY=(2015-2025).

Study selection process

The selection and identification of the documents consisted of several stages. In the first stage, data were collected from 1,125 records from the inclusion databases. Of these, 458 correspond to Web of Science (40.7%) and 667 correspond to Scopus (59.3%). In the second stage, ScientoPy software was used to remove duplicates. This is a software developed for the integration and analysis of bibliographic data in the variety of scientific databases. As a result of this process, 320 duplicate records were eliminated, and when there were multiple matches in both databases, the Web of Science information was preserved, as this database was generally used to prioritize the organizational version related to Web of Science. After this process, the bibliographic corpus was composed of 805 documents, of which 458 were from Web of Science (56.9%) and 347 from Scopus (43.1%). (See Figure 1.) The deduplication process was one of the most important steps of the review, as it improved the dataset and the results were less likely to be overestimated. (Ruiz-Rosero et al., 2019)(Hammer et al., 2023).

Figure 1.

Database *purge* *process*



Note. Crafting with ScientoPy

Then, a second phase was implemented. Here, the Sentence-BERT (SBERT) model used an automatic pre-selection process based on semantic similarity. Methods based on language

models allow the retrieval of relevant literature, using the semantic analysis of literature reviews, both of the titles of the articles and of their abstracts.(Mitrov et al., 2024; Terzic et al., 2025)

The procedure created a set of 426 records containing the required semantic content. Then, using the same framework, the automated ranking system identified 65 highly relevant articles and 143 articles of medium relevance. We decided to review 86 articles based on these results. After confirming the availability of the full texts and the relevance of their content, 74 articles were selected for in-depth qualitative review.

Tools for bibliometric analysis

The bibliometric analysis was performed using the ScientoPy tool. This software analyzes scientific trends and integrates information from multiple bibliographic databases. Its application allowed the analysis of authors, institutions and their scientific impact, among other bibliometric aspects.(Ruiz-Rosero et al., 2019)

In addition, the VOSviewer software was used for the creation of bibliometric maps, as well as the visualization of scientific networks. This software allows the analysis of co-authorship, keyword co-occurrence and citation networks of a research area. The combined use of both allows the identification of thematic and collaborative patterns present in the scientific literature.(van Eck y Waltman, 2010)(Nandiyanto y Al Husaeni, 2021; Fu et al., 2022)

Content Analysis

After determining the final set of documents, a qualitative content analysis was conducted to uncover conceptual patterns and explore dimensions related to teacher professional development in the context of digital transformation. This method allowed the systematic interpretation of the approaches established in the selected corpus and facilitated the identification of the analytical dimensions that order the field of study.

The second describes the dimensions of institutional factors that include university policies, academic leadership, and organizational frameworks aimed at pedagogical support for teachers. The second dimension describes the availability of digital infrastructure, the presence of educational and classroom technologies. The third dimension describes teachers' attitudes towards technology, their perceived professional self-efficacy and the development of their academic identity.

Combining bibliometric and qualitative analyses helps to merge quantitative and conceptual evidence in a comprehensive literature review. This methodological approach, framed within the qualitative and quantitative scope of the literature, allows the identification of the intellectual structure of a given field and advances in the topological analysis of the current scientific production in the field.(Donthu et al., 2021; Khizar et al., 2024)

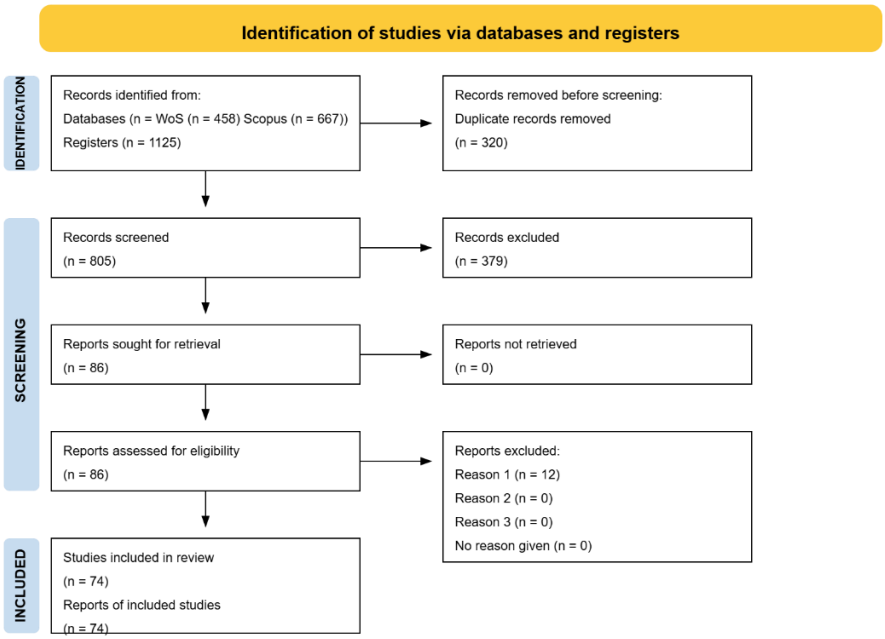
PRISMA Diagram

The process of identifying and selecting studies was summarized using a PRISMA diagram. A total of 1,125 records from Web of Science (n = 458) and Scopus (n = 667) were initially collected. Of these records, 320 were identified as duplicates through the ScientoPy software deduplication process. In cases where records were in both databases, the Web of Science version was retained.

The bibliographic corpus was composed of 805 documents after an initial deduplication effort. A semantic pre-selection step was performed based on text similarity, resulting in 426 relevant studies. The remaining 379 studies were judged irrelevant. Finally, 86 articles were selected for full-text evaluation.

We decided to exclude 12 studies from the final review as they did not sufficiently meet the inclusion criteria, after the full texts had been obtained and assessed for eligibility. The qualitative analysis of the study was based on the remaining 74 articles. A detailed description of the steps mentioned is available in Figure 2.

Figure 2. *PRISMA flow chart of the study identification and selection process.*



Note. Prepared by the author based on the PRISMA 2020 guidelines.(Page et al., 2021)

RESULTS

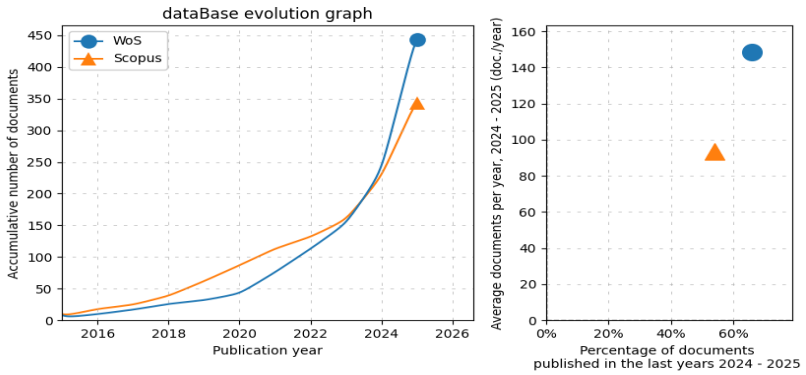
Annual scientific production

The study of the growth of teachers' professional development in higher education during the period of digital transformation between 2015 and 2025 shows that scientific research increased. Of the documents reviewed, 451 are in Web of Science (WoS) and 347 in Scopus, indicating that the topic is present in the first of these sources. This difference is also reflected in the h-index, which reaches 39 in WoS and 24 in Scopus, indicating that WoS is more concentrated in influential publications.

The analysis of the temporal evolution shows that the period between 2015 and 2019 had limited production, while the period from 2020 showed significant growth. In Web of Science, there is a growth from 11 documents in 2020 to 33 in 2021, 37 in 2022, 41 in 2023, and an increase to 84 in 2024 and 213 in 2025. At Scopus, there was a similar growth from 25 publications in 2020 to 119 in 2025. This surge of growth and publishing activity shows the interest that researchers have in this area and the relatively new nature of research on the relationships between digital transformation and teacher professional development in higher education.

The trend is supported by aggregate indicators. In WoS, the average annual growth rate (AGR) is 86.0, and in Scopus, 45.5. In both cases, the average number of documents per year (ADY) is 148.5 in WoS and 93.5 in Scopus. In addition, the percentage of documents published in the last year(s) of the period analyzed (PDLY) is 65.9% for WoS and 53.9% for Scopus. These figures show that most scientific output is published in the last years of the period under review (see Figure 3).

Figure 3 *Cumulative evolution of publications in both databases, with growth accelerating from 2023 onwards.*



Note. Own elaboration

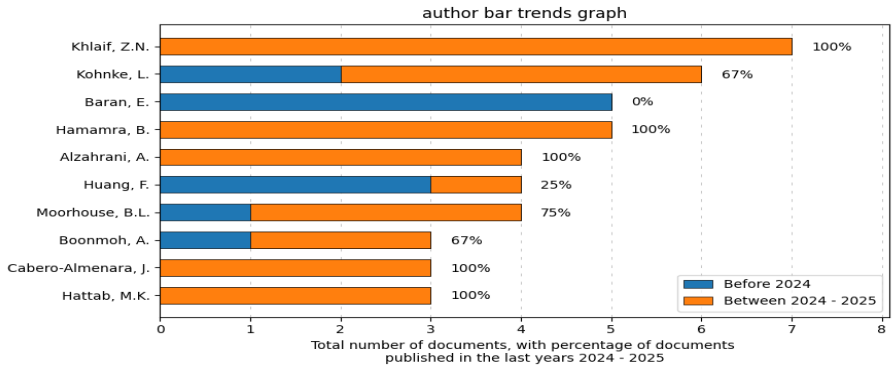
Most relevant authors

The authorship analysis identifies the most prominent authors in the literature related to the professional development of university teaching staff in situations of digital transformation. Khlaif, Z. N. has the highest number of publications (7) with an h-index of 6, in the period 2024–2025. His publications focus on AI literacy, AI ethics, and the use of generative AI in higher education institutions.

Kohnke, L. follows with 6 publications (h-index = 5) on the use of generative AI and ChatGPT in the training of university teaching staff. Likewise, Baran, E., and Hamamra, B. have 5 publications each on technological mentoring and professional development of teachers, and the integration of educational technologies.

Alzahrani, A., Huang, F., and Moorhouse, B. L. rank next with 4 publications each. Whereas, Boonmoh, A., Cabero-Almenara, J., and Hattab, M. K. have 3 publications each. Overall, the publication activity in the area reflects a focus on AI in education, digital teaching competencies, technology acceptance models, and the professional development of university teaching staff (see Figure 4).

Figure 4. *Authors with the highest scientific production in research on teacher professional development and digital transformation in higher education (2015–2025).*



Note. Own elaboration

Institutions with the most relevant countries

Most of the publications related to the professional development of university teachers in the context of the digital transformation of higher education are concentrated in a small group of universities with a lot of research activity in recent years. The highest-ranked institution is the Hong Kong University of Education (China), which has published 9 articles and has an h-index of 5. Most of his publications have been between 2024 and 2025. Most of his publications address generative artificial intelligence, digital teaching competencies and the TPACK framework and its derivatives.

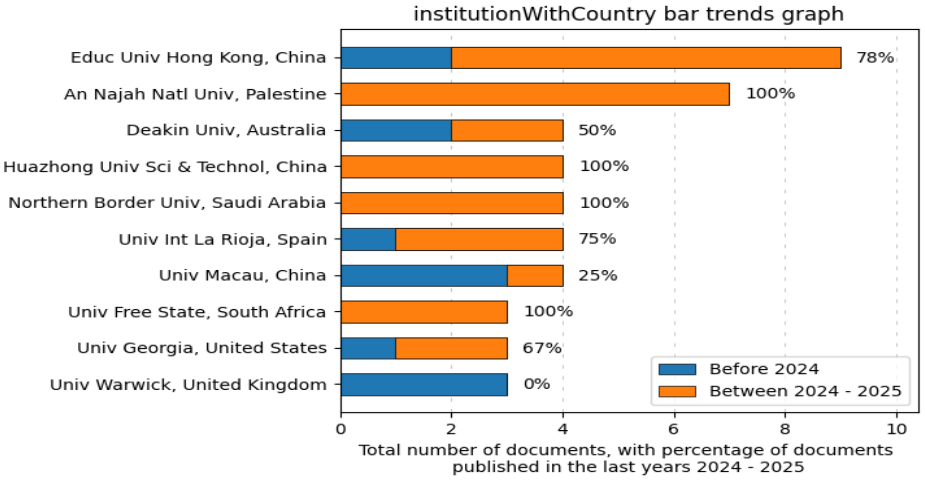
The second-ranked National University of An-Najah (Palestine) has an h-index of 5 and has

published 7 papers. Recent publications by the National University of An-Najah (Palestine) address issues of AI literacy, digital teaching by university teachers, ethics in digital university teaching and digital teaching by university teachers. Huazhong University of Science and Technology (China), Northern Rim University (Saudi Arabia), La Rioja International University (Spain) and Deakin University (Australia) also stand out for publishing 4 articles each.

The publications of these universities focus on the integration of AI and technology in higher education teaching. Publications from the University of Macau, the University of Georgia, the University of Warwick, and the University of the Free State also examine digital teaching, teacher professional development, and innovations in teaching/learning/faculty.

Taken together, the publications of these universities confirm the international nature of the field and the commitment of the three continents (Asia, Europe and Oceania) to innovative teaching and the impact of digital transformation and AI on university faculty (see Figure 5). Current research interest has been reported on transformation and AI specifically in university faculty.

Figure 5. *Institutions with the highest scientific production in research on teacher professional development and digital transformation in higher education (2015–2025).*



Note. Own elaboration

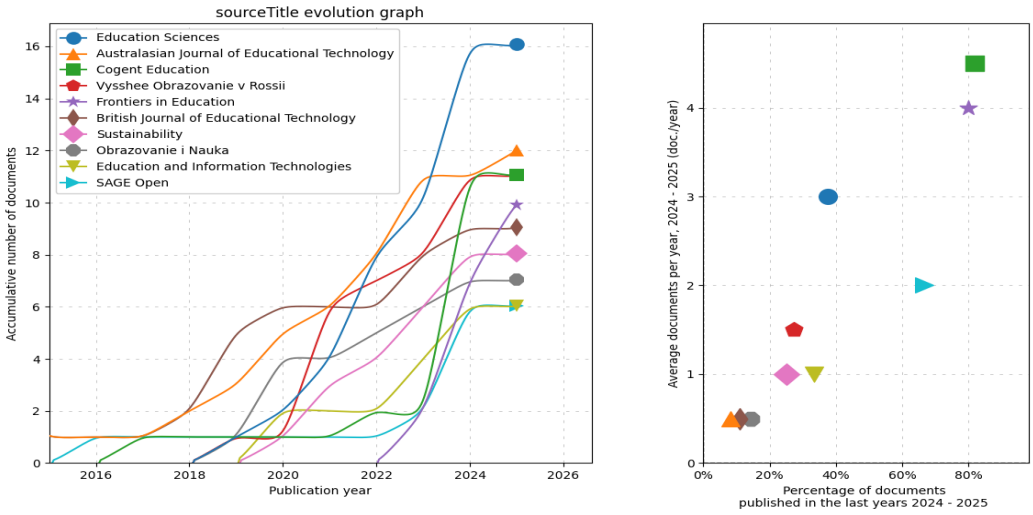
Most relevant journals

The evaluation of publication sources allows researchers to identify journals that target teacher professional development in higher education, encompassing digital transformation. The main journal is Education Sciences, which published 16 articles and has an h-index of 8. This demonstrates his prominence in the area and published articles on digital teaching competence, artificial intelligence literacy, online teaching, and professional development.

Following this, the Australasian Journal of Educational Technology includes 12 articles and has an h-index of 7. Articles published in this journal include studies on technology integration, the Technology Acceptance Model, and the TPACK framework. In addition, both Cogent Education and Vysshee Obrazovanie v Rossii are identified as journals with 11 articles published in the area of teaching and educational technology with an orientation towards the digitalization of higher education.

In addition, Frontiers in Education, the British Journal of Educational Technology and Sustainability have articles on digital competences in teaching, the pedagogical process and the digital transformation of higher education. It is evident that the journals are focused on educational technology, pedagogical innovation and teacher professional development.

Figure 6 *Leading journals publishing research on teacher professional development and digital transformation in higher education (2015–2025).*



Note. Own elaboration

Keyword Cloud

Keyword cloud analysis reveals key thematic areas for investigating the professional development of university teachers in the context of digital change. The term 'higher education' appears most frequently, 213 times, suggesting that most research interest is focused on university education. This has a close correlation with 'professional development', which appears 165 times, indicating that the literature underscores the importance of ongoing professional development for teachers as they face and adapt to the educational challenges that accompany digital changes.

Among the terms that appear most frequently, 'artificial intelligence' (150 mentions) and 'generative AI' stand out. The increase in the use of these terms suggests that research, which examines the role of these technologies in university education and the development of digital teaching competences, has begun to take shape and is well received. Its application in this field is at the forefront of incorporating emerging technologies into education.

Simultaneously, the presence of keywords such as 'educational technology', 'technological integration' and 'digital transformation' points to the importance of technology in educational innovations. The keyword cloud as a whole demonstrates that the literature in this field integrates teacher professional development in the context of digital technologies and the transformative dynamics of higher education. (See Figure 7).

Figure 7 *Scientific word cloud on teacher professional development in higher education (2015–2025).*

Note. Own elaboration

Country network with vosviewer

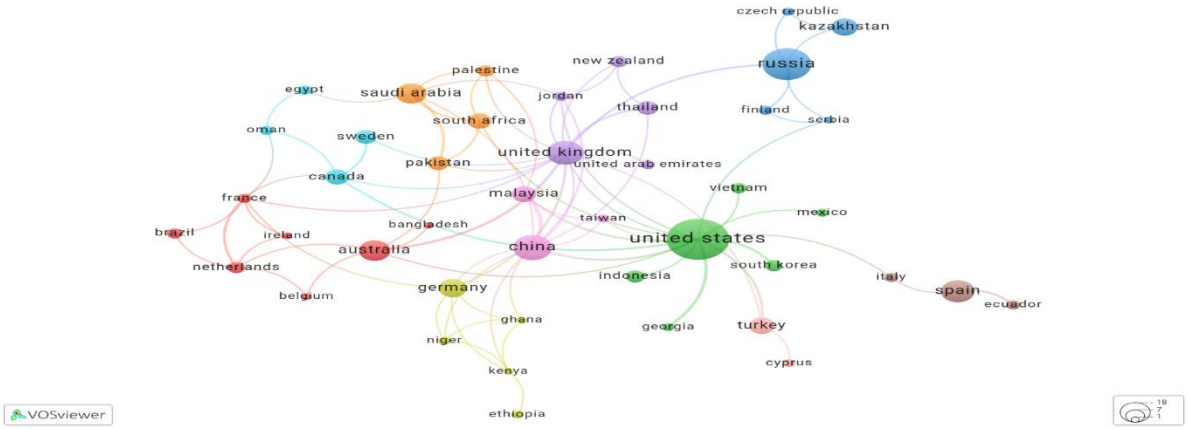
The analysis of the global network of research partnerships shows research patterns in countries in relation to international collaboration in the professional development of higher education teachers in relation to digital transformation. Using VOSviewer software for network mapping, the main national actors in international research on teacher professional development are identified, with the United States located at the center of the network. He has published 79 articles on the subject and has 1,833 citations.

The countries surrounding the core of the network are China, the United Kingdom, and Spain, with China with 30 articles and 900 citations, the United Kingdom with 27 articles and 1,095 citations, and Spain with 23 articles and 832 citations. Academic leadership is evident in countries with developed university systems and high levels of investment in educational and technological research.

Australia, Saudi Arabia and Germany have a comparatively smaller number of publications, which are significantly cited, indicating their central role in international research collaboration networks. Using VOSviewer, ten research collaboration clusters have been created that group 44 countries according to their co-authorship. This spatial structure of the collaboration networks within the area of interest shows the existence of research communities that are organized according to a certain linguistic, institutional or academic proximity.

The analysis of the key terms related to the most prominent countries shows a convergence around artificial intelligence, technological integration, TPACK, teacher professional development and higher education. The agenda of the field, focused on the consequences of digital technologies and artificial intelligence on the training and updating of teachers in higher education, frames this pattern. The network of countries emphasizes the system of global scientific collaboration in which some regions function as central nodes for the circulation of knowledge and the establishment of new research priorities (see Figure 8).

Figure 8 *Network of scientific collaboration between countries in research on teacher professional development in higher education (2015–2025).*



Note. Prepared by the author using VOSviewer based on data from Web of Science and Scopus.

Predominant lines of research

The analysis of the bibliographic corpus reveals four main categories of research that organize the relationship between teacher professional development and the digital transformation of higher education. These categories indicate the conceptual development in the area and the different methods used to study the nexus between technology, university teaching and change in institutions (see Table 1).

Table 1. *Predominant lines of research in the field*

Line of research	Main focus	Representative studies
Teaching digital competence	Evaluation and development of technological and pedagogical skills of teachers	(Scott y Nimon, 2020; Ličen y Prosen, 2024; Casillas-Martín S. et al., 2020)
Digital Teacher Professional Development	Continuing education programs, technological mentoring and learning communities	(Phuong et al., 2017; Baran, 2016; Keese et al., 2023)
Pedagogical integration of technologies	Pedagogical use of digital tools and models such as TPACK	(Akram et al., 2021; Koh, 2020; Cubeles y Riu, 2018)
Institutional digital transformation	University governance, technological leadership and educational innovation policies	(Barger et al., 2021; Walker y Voce, 2023; Zhang y Chen, 2025)

Note. Own elaboration

The first line refers to the study of teachers' digital competence. Within this area, the literature was concerned with the assessment of teachers' digital skills and the development of assessment instruments based on the TPACK framework or digital literacy frameworks. Some of these works are supported by self-assessment frameworks for teachers, which consider the pedagogical implications of these competencies in teaching practices, which is an area of great interest. (Scott y Nimon, 2020; Ličen y Prosen, 2024)(Peters et al., 2022)

The second strand focuses on the use of educational technologies and pedagogical professional development. This group of studies includes research on continuous training, accompaniment in technology and professional learning communities, which are aimed at supporting pedagogy and teaching practice. From the results reported, it seems that the conceptual framework of the strategies implies the establishment of institutional support and collaborative work spaces for teachers, from which more effective results are obtained.(Phuong et al., 2017; Baran, 2016; Keese et al., 2023)

The third line focuses on the use of digital technologies for university teaching. Research within this line of focus includes technology-mediated teaching practices, and the interaction between the three domains of pedagogy, technology, and discipline. Within this context, the TPACK model is one of the most referenced frameworks for understanding the incorporation of digital technologies by teachers in order to design and implement teaching and learning strategies (Akram et al., 2021; Koh, 2020).

The fourth line proposes an organizational perspective and deals with an institutional approach to digital transformation. In this case, the studies consider academic leadership and university policies and structures in the field of educational innovation. In general, these studies highlight the need for university digitalization to incorporate structural changes that encompass all dimensions: pedagogical, organizational and technological.(Barger et al., 2021; Walker y Voce, 2023; Zhang y Chen, 2025)

Institutional, technological and psychosocial aspects

The thematic analysis of the reviewed articles provided an opportunity to identify three interconnected dimensions of the digital transformation of education, within which teacher professional development can be examined. They are: institutional, technological and psychosocial. (see Table 2).

Table 2. *Dimensions of factors influencing teacher professional development*

Dimension	Main elements	Representative studies
Institutional	University leadership, innovation policies, digital infrastructure, academic incentives	(Zhang y Chen, 2025; Chenhui et al., 2024; Phan et al., 2025)
Technology	LMS platforms, digital tools, institutional technical support	(Karkouti, 2023; Roy y Al-Absy, 2022)
Psychosocial	Teacher self-efficacy, professional identity, perceptions of technological usefulness	(Mah y Groß, 2024; Alexandrova et al., 2023; Singh et al., 2023)

Note. Own elaboration

It has been demonstrated time and again that various institutional factors serve as key components of educational transformation. For example, university leadership, policies on pedagogical innovation, and the availability of technologies within various resources directly affect the level of participation and engagement of university staff in training and support programs. In addition, the absence of institutional or financial support dramatically influences the reluctance of university staff to face digital transformation in the Global South.(Zhang y Chen, 2025; Chenhui et al., 2024)(Nakaziba y Ngulube, 2024)

Considering the technological dimension, the literature has recognized the importance of learning platforms and educational management systems (LMS) as fundamental elements in support of pedagogical innovation in higher education. However, the mere presence of technology does not equate to an improvement in learning outcomes. Tools must be integrated and captured in the teaching and learning process to create instructional impact.(Karkouti, 2023)(Roy y Al-Absy, 2022)

In relation to psychosocial factors, the focus of the latest studies is on teachers' perceptions and attitudes towards digital technology. Digital self-efficacy and the perceived usefulness of digital technologies, along with teachers' professional identity, are critical factors in the adoption of digital technologies. They also play an active role in implementing changes in practices in the process of educational innovation. However, some research indicates that the absence of appropriate support strategies, combined with the digitalization of the workplace, can be detrimental to professional identity, especially in the teaching discipline.(Mah y Groß, 2024; Singh et al., 2023)(Alexandrova et al., 2023)

Techniques used in the studies

The methodological analysis of the corpus shows a variety of practices that mainly include quantitative empirical studies and mixed-methods designs, see table 3.

Table 3. *Methodologies used in the studies analyzed*

Type of methodology	Features	Representative studies
Quantitative	Surveys, factor analysis, structural equation modeling	(Ličen y Prosen, 2024; Singh et al., 2023)
Qualitative	Interviews, case studies, thematic analysis	(Englund et al., 2017; Cutajar, 2019)
Mixed methods	Integration of questionnaires and qualitative analysis	(Arslan et al., 2022; Moreira-Choez et al., 2024)
Systematic reviews	Structured synthesis of scientific literature	(Peters et al., 2022; Lan et al., 2024)

Note. Own elaboration

The research of the methodology of the studies analyzed indicates an overwhelming presence of quantitative studies related to the assessment of digital competence among teachers and the identification of factors that influence the use of educational technology. In general, these studies employ multivariate statistical techniques, the most prominent being confirmatory factor analysis and structural equation modeling, which help to define the relationships between variables and constructs of technological integration in university pedagogical practices.(Ličen y Prosen, 2024)

Qualitative studies, on the other hand, attempt to understand the teacher's perception and the dynamics of the pedagogical changes that accompany the implementation of digital technology. In this sense, the research uses interviews, case studies of a given educational institution and thematic analyses of teachers' digital educational experiences.(Englund et al., 2017; Cutajar, 2019)

A significant portion of studies adopt a mixed-methods approach, combining quantitative and qualitative methods. This strategy provides evidence of different types, allowing us to explore and understand educational innovations at the university level, both from the lens of quantitative results and the qualitative narratives of teachers.(Arslan et al., 2022; Moreira-Choez et al., 2024)

Finally, some studies focus on systematic reviews of the literature with the aim of synthesizing existing evidence and analyzing the conceptual changes that have influenced the field of academic research in recent years.(Peters et al., 2022; Lan et al., 2024)

Trends in Teacher Professional Development Research

From the data analyzed, several trends can be discerned related to the advancement of research on teacher professional development and the digital transformation of higher education (see Table 4).

Table 4 *Emerging trends identified*

Trend	Description	Representative studies
Artificial intelligence in education	Using AI to analyze digital skills and support teaching	(Mah y Groß, 2024; Moreira-Choez et al., 2024)
Teaching technology mentoring	Accompaniment programs to strengthen the pedagogical integration of technologies	(Baran, 2016; Edouard, 2023)
Digital Governance and Leadership	Strategic role of university policies in educational innovation	(Zhang y Chen, 2025; Walker y Voce, 2023)
Digital education and educational quality	Integration of educational analytics and education 4.0 models	(Imran y Almusharraf, 2024)

Note. Own elaboration

The growing interest in the integration of artificial intelligence in higher education has become one of the most evident trends. This area of research covers the use of AI-based tools for the automated assessment of the digital competences of university teachers and the development of teaching aids for university teaching.(Mah y Groß, 2024; Moreira-Choez et al., 2024)

Another important line of research is the design of technology-based mentoring programs for university teaching staff. At the program level, they help develop academic mentoring practices to reinforce the use of digital pedagogical tools in real-world teaching environments, which helps sustain innovations in teaching.(Baran, 2016; Edouard, 2023)

Recent literature also highlights the importance of institutional leadership and digital governance in the context of educational innovation. This approach underscores the role of university policies and structures in consolidating digital transformation, emphasizing a gradual shift from a teaching-focused approach to an institutional approach to educational change.(Zhang y Chen, 2025; Walker y Voce, 2023)

Finally, some publications articulate the digital transformation of universities with the concepts of Education 4.0 and learning analysis. This perspective focuses on the integration of data and digital technologies to improve the quality of teaching and learning, as well as to optimize decision-making processes in the context of higher education.(Imran y Almusharraf, 2024)

DISCUSSION

The results of the study underline that teacher professional development in contexts of digital transformation is a sophisticated and complex phenomenon due to its interrelationship with institutional, technological and psychosocial factors. This supports studies that argue that digitalization in the educational context does not depend entirely on the available technological infrastructure, but also on the integration of organizational structures, teaching and learning practices, and teacher competence.(Imran y Almusharraf, 2024; Wibowo y Irmawaty, 2022; Walker y Voce, 2023)

The results of the study also show that much of the literature continues to analyse teacher professional development from the perspective of individual digital competences. These reviews have recently described this as a manifestation of the disconnect between the integration of the pedagogical, organisational and technological dimensions. However, there is a visible, albeit gradual, shift towards a more systematic way of thinking to understand the interrelationship of organizational dimensions, teachers' pedagogical and teaching practices, and the pedagogical opportunities that can be offered through the application of digital technologies.(Peters et al., 2022; Silva, 2023)(Sailer et al., 2021)

On the organizational side, the findings highlight the importance of academic leadership, university policies focused on teacher training, and organizational structures that support pedagogical practices to navigate digital transformation in higher education. The literature reviewed suggests that these elements structure how teachers integrate educational technologies into their teaching practices. This perspective

supports the literature that highlights the importance of institutional management and the role of pedagogical support units in fostering innovative teaching practices in higher education.(Phan et al., 2025; Zhang y Chen, 2025; Elçi y İşeri, 2022)

Considering the technological dimension, the results indicate that, although digital infrastructure is a necessary condition to support educational innovations, it cannot be considered sufficient to sustain such innovations. The literature reviewed indicates that the application of technologies in higher education is subject to several constraints, such as the teaching workload, the lack of time to redesign instruction, little or no training in teaching, and the lack or little training in the pedagogical use of digital tools.(Mercader y Gairín, 2020; Ahmed, 2020; Akgunduz y Topalsan, 2024)

The positive attitude towards the use of technologies in education is noteworthy. Recent publications report an increase in the number of studies on artificial intelligence, mobile learning, and other digital teaching methods. These lines of research reflect recent transformations in this area and pointed to the need for new types of professional upgrading for university teaching staff.(Maqbool et al., 2024; Imran y Almusharraf, 2024)

The analysis highlights psychosocial aspects in the process of adopting technology. The teacher's self-efficacy, attitude towards technology and professional identity shape their willingness to integrate digital technology into the classroom. In some cases, a lack of willingness to adopt can be a major impediment when technology is seen as a disruptor of traditional pedagogy and/or teacher professional identity.(Casillas-Martín S. et al., 2020; Yukhymenko-Lescroart et al., 2021)(Singh et al., 2023; Roumbanis Viberg et al., 2021)

The analysis pointed to some unexplored areas of teacher professional growth in digitalized environments. Although the body of literature on the digital transformation of higher education is expanding, there are still few publications that integrate a review of the psychosocial, technological and institutional dimensions. This absence in the literature has been pointed out in previous reviews and calls for research that attempts to describe the complexity of educational transformations in a systemic way.(Peters et al., 2022; Silva, 2023)

Taken together, the findings suggest the need for an integrated view of the organizational, technological, and human dimensions of digital transformation systems in higher education in teacher professional growth.

CONCLUSIONS

This evidence synthesis study elaborated on institutional, technological, and psychosocial factors related to the professional development of teachers in higher education in the context of digital transformation from 2015 to 2025. The combination of bibliometric and qualitative analysis revealed several patterns, including some of the more mature domains, emerging themes, and key gaps in the literature.

The literature on teacher professional development in the digital field has expanded substantially in the last decade. The growth of this literature corresponds to the advancement of educational technologies, new global frameworks of digital competence for teachers and the integration of artificial intelligence into pedagogical practices in higher education.(Imran y Almusharraf, 2024)

The analysis highlights the view that teacher professional development is a complex and multidimensional phenomenon, shaped by the interaction of various institutional, technological, and psychosocial factors. Within this context, academic leadership, institutional teacher training, and the availability of pedagogical support organizations are important drivers of educational innovation in higher education.(Zhang y Chen, 2025)

One of the important insights is that the presence of technological infrastructure, while necessary, is not sufficient to facilitate meaningful educational reform.(Mercader y Gairín, 2020)

Integrating digital technologies into university teaching depends on the pedagogical skills of the teaching staff, the institution's strategic approach to continuous development, and the professional attitudes of the staff towards technology. Among these, psychosocial factors such as teachers' self-efficacy, attitudes towards technology, and professional identity construction play a relevant role in the use of Digital Technology Innovations in Teaching and Learning (DTTL).(Casillas-Martín S. et al., 2020)

From a theoretical perspective, this research contributes to the literature on the integration of

teacher professional development within a systemic framework that encompasses institutional, technological, and psychosocial dimensions. It is this systemic approach that advocates going beyond the conceptual fragmentation of previous studies and offers the possibility of a better understanding of digital transformation processes in higher education.(Peters et al., 2022)

From a practical perspective, the results point to the need for universities to design means to affirm in their business strategies an intentional investment in technologies, a continuous commitment to the pedagogical training of the institution and the provision of support structures to assist teachers. The combination of these components strengthens the institution's ability to manage continuous educational innovations.

Within this study, perspectives for future research have been identified. In this sense, the development of empirical studies that investigate the interaction of institutional and technological elements together with psychosocial aspects in integrative methodological frameworks are of great importance. In addition, the rapid growth of certain emerging technologies, especially generative artificial intelligence, generates new challenges for pedagogy in higher education and deserves greater attention in the field of educational research.(Mah y Groß, 2024)

Finally, teacher training must be addressed together with the processes and elements of digital transformation in higher education. The integration of educational technologies is done primarily through the organization, technology, and people who support the universities' systems.(Shibankova et al., 2019)

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