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Systematic Review

Standards of Teacher Digital Competence in Higher Education: A Systematic Literature Review

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Abstract: In a society marked by continuous technological changes in favor of education, digital competence is an unavoidable feature in the professional profile of the university teaching staff. This systematic literature review aims at answering the following questions: what basic standards are established by the literature for teacher training in digital competence to strengthen their work inside and outside the classroom? What models or frameworks do they use as references? What are university professors' training needs? What contributions have been made in this line of study and what technologies are recommended for teacher training in digital competence? Based on the four phases of the PRISMA flowchart: identification, selection, eligibility, and inclusion, the articles indexed in the Web of Science, Scopus, and Scielo databases, both in English and Spanish, and published in 2015 until the end of May 2022, were analyzed. The initial search resulted in a total of 187 potentially useful articles, 26 of which met the inclusion and quality criteria. The authors of the selected papers concur in identifying the dimensions of competence and, subsequently, in establishing the standards, direction, and focus of training.

Keywords: teacher digital competence; teacher training; competence dimensions; digital competence standards; higher education; systematic review; digital competence models

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1. Introduction

One of the main characteristics of the 21st century is the development of the knowledge society through the use of information and communication technologies (ICT). Connectivity, immediacy, speed, asynchrony, synchrony, cooperation, collaboration, dynamism, and interconnection are characteristics that represent today's society [1] and lead to continuous transformations in the educational, cultural, economic, and social structures, requiring citizens a constant change to adapt to new circumstances [2].

In 2006, the European Parliament and the Council of the European Union identified digital competence as one of the eight key competencies to strengthen lifelong learning [3]. In teaching practice, digital competence is conceived as one of the necessary skills to develop innovative education, typical of the new millennium [4], where ICTs have a greater role [5] and teachers have the challenge of guiding their students through the new techno-pedagogical paradigm.

In the last decade, this line of research has marked a growing trend in scientific production and denotes the transition from a recommended training stage to a necessary one. In the university context, studies related to conceptual characterization, the design of diagnostic instruments, evaluation, and teacher training in digital competence are found more frequently [6–9]; however, university professors' training is based on digital competence models and frameworks that focus on the pre-university level, such as the UNESCO ICT Competency Framework for Teachers; the Digital Competence Framework

for Educators (DigCompEdu); the International Society for Technology in Education (ISTE) Framework for teachers; and the Common Digital Competence Framework for Teachers (INTEF) [10].

In a limited way, some studies define a training model for university teachers as one focused on the four substantive functions in higher education: teaching, research, management, and community engagement [11–13]. One of the most relevant problems in this area is the lack of an explicit consensus on what competencies higher education professionals should master, hence the need to conduct a systematic literature review (SLR), also known as a systematic review, which aims to apply a rigorous and defined methodology to identify, analyze, and evaluate the primary studies about a specific research question [14].

This research focuses on analyzing the latest publications regarding the digital competence of university professors, available on the Web of Science, Scopus, and Scielo databases, so that universities will be able to implement teacher training proposals that combine teacher professional knowledge with ICT tecno-pedagogical integration, which will allow them to strengthen their work inside and outside the classroom.

2. Materials and Methods

This systematic review is based on the Kitchenham guidelines [14], Petersen et al. [15], and Sinoara et al. [16]; Figure 1 details the process and the three phases of this study.

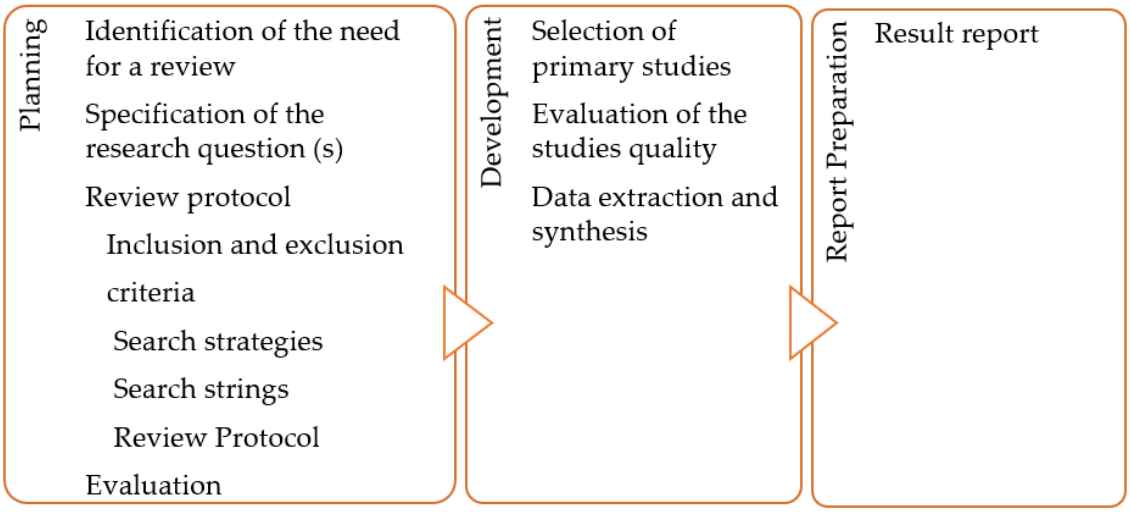

Figure 1. Process and phases of the systematic review.

2.1. Phase 1: Planning

The mapping of the main activities and the systematic literature review were established in this phase.

2.1.1. Significance of the Study

A previous literature review reveals the existence of several models or digital competence frameworks that try to define and characterize the new profile of the teacher centered on information and communication technologies. However, in Latin America, dimensions and training standards in digital competence are scarce, contrary to Europe and the United States, which have teacher digital competence (TDC) standards and their respective accreditation instances [17].

According to Instefjord and Munthe [18], two of the most common strategies to train university professors on the use of ICT in their professional practice focus on technological use and practical exhibition (daily teaching activities) with it. In previous periods, the teacher with the highest level of digital competence was the one who had a greater ICT knowledge and mastery of it; currently, the most competent is the one who, mastering

the technologies, manages to make students develop their digital competencies and use them skillfully, efficiently, and effectively to achieve new and better knowledge. Hence, a methodological shift in teaching and the development of teacher digital competencies or e-skills is essential to effectively solve the techno-pedagogical requirements that university students, now considered as digital natives, demand [19].

2.1.2. Research Questions

The driving research question for this study was: what are the dimensions and basic standards that teacher training in digital competence in higher education must meet to strengthen their work inside and outside the classroom? Prendes and Gutiérrez [12] express that a standard is "a pattern or reference model that allows, on the one hand, to determine and assess those teachers who are competent in terms of such competencies and, on the other hand, to drive and guide the design and preparation of teacher training proposals regarding these technologies" (p. 199).

The systematic literature review aims to answer the following questions regarding the objective of the study.

- RQ1. What basic standards do studies establish for digital competence training?
- RQ2. What standards, models, or frameworks are used as references to implement teacher training in digital competence?
- RQ3. What are university professors' training needs regarding digital competence?
- RQ4. What is the contribution of the study in this area?
- RQ5. What technologies are recommended for teacher training in digital competence?

To define the scope of the systematic review (Table 1), the PICOC (population, intervention, comparison, outcome, context) method proposed by Kitchenham et al. [14] was used.

Table 1. Terms of PICOC.

Term	Description
Population (P)	Teacher digital competence standards.
Intervention (I)	Proposals for teacher training in digital competence.
Comparison (C)	No comparison is made, but the training proposals found will be categorized.
Results (O)	Digital competence standards, models, or frameworks.
Context (C)	Digital competence in university professors. International, national, and local scope.

Based both on the established PICOC method and the research questions, exploratory searches were made to evaluate the keywords and identify their relationship with the field of study. The ERIC and UNESCO thesauri were used to define the terms or synonyms that are of the keywords in the information search (Table 2).

Table 2. Keywords for information search.

Term	Synonyms or Related Terms in Literature
Standards (Estándares)	Framework (marco de referencia); digital competence framework (marco de competencia digital); model (model)
Digital competence (Competencia digital)	Digital literacy (alfabetización digital); digital skills (habilidades digitales)
Higher Education (Educación Superior)	University (universidad)
Teacher training (Formación docente)	

2.1.3. Review Protocol

The review protocol presented in Figure 1 consists of three phases: (a) the inclusion and exclusion criteria; (b) search strategies, and (c) search strings.

2.1.4. Inclusion and Exclusion Criteria

To select the most relevant studies that allow us to answer the research questions, seven inclusion criteria (IC) were established:

IC1. The research is published between the years 2015 and 2022.

IC2. The document is open access.

IC3. The document is in English or Spanish.

IC4. The document is published in journals, conference proceedings, books, or a series of books.

IC5. The document is the final version.

IC6. The document answers the research questions.

IC7. Training in digital competence is aimed at university professors.

The exclusion criteria correspond to all the documents that do not match the above inclusion criteria.

2.1.5. Search Strategies

Three databases accessible from the virtual library of Universidad Técnica del Norte were selected to search the information: Web of Science (WoS), Scopus, and Scielo. These databases are relevant in the field of study and have similar characteristics when using search strings.

2.1.6. Search Strings

Once the research questions, the PICOC, the keywords (search terms), and the inclusion and exclusion criteria were established, the search strings used in each database were structured. The keywords were integrated through Boolean operators AND and OR to combine different queries in the search, and an asterisk (*) was used in some words to include both singular and plural terms.

Subsequently, the inclusion criteria were added: the time of publication (2015 to 2021), the language it was written in (English or Spanish), being the final version of the paper, the paper being open access, and the type of document. The customized search string for each database is presented in Table 3.

Table 3. Search string for each database.

Database	Search String
Web of Science (WoS)	TS = ((“teacher training standards”) AND (“higher education”) AND (university) AND (“digital literacy”) OR (“digital competence”)) refined by: open access: (OPEN ACCESS) Timespan: 2015–2022
Scopus	TITLE-ABS-KEY (“digital competence framework”) OR TITLE-ABS-KEY (standard*) OR TITLE-ABS-KEY (framework*) OR TITLE-ABS-KEY (“digital competence model”) OR TITLE-ABS-KEY (model*) AND TITLE-ABS-KEY (“digital literacy”) OR TITLE-ABS-KEY (“digital competence”) OR TITLE-ABS-KEY (“digital skills”) AND TITLE-ABS-KEY (“teachers’ training”) OR TITLE-ABS-KEY (university) OR TITLE-ABS-KEY (“higher edu-cation”) AND (LIMIT-TO (SRCTYPE, “j”) OR LIMIT-TO (SRCTYPE, “p”) OR LIMIT-TO (SRCTYPE, “k”) OR LIMIT-TO (SRCTYPE, “b”)) AND (LIMIT-TO (PUBSTAGE, “final”)) AND (LIMIT-TO (SUBJAREA, “SOCI”) OR LIMIT-TO (SUBJAREA, “COMP”)) AND (LIMIT-TO (PUBYEAR, 2022) OR LIMIT-TO (PUBYEAR, 2021) OR LIMIT-TO (PUBYEAR, 2020) OR LIMIT-TO (PUBYEAR, 2019) OR LIMIT-TO (PUBYEAR, 2018) OR LIMIT-TO (PUBYEAR, 2017) OR LIMIT-TO (PUBYEAR, 2016) OR LIMIT-TO (PUBYEAR, 2015)) AND (LIMIT-TO (ACCESSTYPE(OA))) AND (LIMIT-TO (LANGUAGE, “English”) OR LIMIT-TO (LANGUAGE, “Spanish”))
Scielo	TS = ((“teacher training standards”) AND (“higher education”) AND (university) OR (“digital competence”)) refined by: LANGUAGES: (SPANISH OR ENGLISH) AND PUBLICATION YEARS: (2022 OR 2021 OR 2020 OR 2019 OR 2018 OR 2017 OR 2016 OR 2015)

2.1.7. Review Protocol Evaluation

A protocol "is an essential component of the systematic review process; it ensures that a systematic review is carefully planned and that the planning is explicitly documented before the review begins" ([20], p. 1).

The systematic review was developed based on the review protocol guidelines of the research specialized in this methodology [21] to make the research process transparent; therefore, the review protocol evaluation is essential, and it was validated by experts in educational innovation. This consisted of reviewing the searching process, selecting the sources to be analyzed, and the systematization of knowledge.

2.2. Phase 2: Development

The conducting of the systematic review was carried out according to three phases: the selection of the primary studies; the assessment of the study quality; and the data extraction and synthesis.

2.2.1. Selection of Primary Studies

All searched documents were condensed and organized using Microsoft Excel 365. The data extraction from the Web of Science (WoS) and Scielo databases was carried out through Win tabulator, which downloads data in a text file (savedrecs.txt), while Scopus files were downloaded as a .csv format (comma-separated values). The selection of the primary studies was based on the PRISMA flowchart [22], presented in Figure 2, which shows four phases: the identification, selection, eligibility, and inclusion.

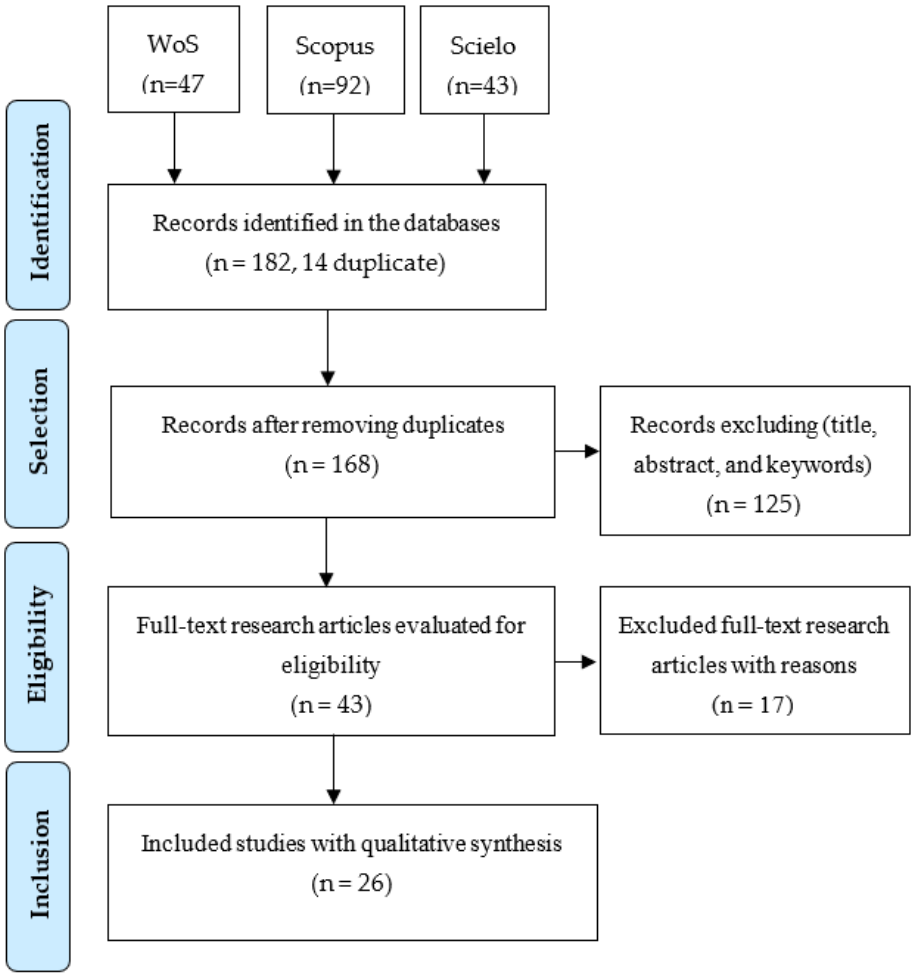

Figure 2. PRISMA flow diagram.

The identification phase obtained 182 documents, of which 92 were Scopus-indexed articles, 47 were WoS, and 43 were Scielo. In the selection phase, duplicated documents were eliminated (n = 14) with the help of the remove duplicates option in Excel. Then, during the eligibility phase, the titles, abstracts, and keywords of each document were analyzed, considering the exclusion criteria and the search strings that were previously established (n = 125).

Subsequently, the documents were evaluated according to the inclusion and exclusion criteria. Seventeen studies were excluded due to any of the following reasons: it does not answer the research questions, the context is different from that of higher education, and it is impossible to download the document. In the last phase, 26 articles were included for in-depth reading and the respective analysis. It is stated that there is no conflict of interest.

2.2.2. Quality Assessment of the Studies

A rigorous quality assessment was conducted using three methods: (1) a quantitative quality checklist. None of the selected studies are qualitative, therefore they were evaluated with the quantitative checklist, shown in Table 4. This checklist is based on the questions suggested by Kitchenham et al. [14], Petticrew and Roberts [23], and Riaz et al. [24]. The questions were reformulated according to the needs of this study, (2) an expert from Universidad Técnica de Norte (Ibarra-Ecuador) verified the information and analyzed the articles that were included in the review, and (3) the AMSTAR systematic review assessment proposed by Shea et al. was conducted. (https://amstar.ca/Amstar_Checklist.php, accessed on 11 September 2022).

Table 4. Quantitative checklist of study quality.

N°	Questions	Criteria
Q1	Are the objectives related to teacher training in digital competence?	Yes/No/Partial
Q2	Is the methodology understandable?	Yes/No/Partial
Q3	Are the study population higher education professors?	Yes/No/Partial
Q4	Is the type of study identified?	Yes/No/Partial
Q5	Does the study establish a purpose?	Yes/No/Partial
Q6	Does the study establish basic standards for teacher training in digital competence?	Yes/No/Partial
Q7	Does the study refer to models or frameworks for teacher training in digital competence?	Yes/No/Partial
Q8	Does the study establish the aspects that should be included in teacher digital competence training?	Yes/No/Partial
Q9	Are data presented on teacher training assessment based on standards, models, or frameworks of digital competence?	Yes/No/Partial
Q10	Do the research guiding questions lead to solving the study problem?	Yes/No/Partial

The checklist contains 10 questions, each with a score of 1 point and three options on the Likert scale: yes, no, and partial, with scores of 1, 0, and 0.5, respectively. The final score of 7 was established as a cut-off point; that is, all studies with a score greater than or equal to 7 were included and those that do not meet this condition were excluded because they did not provide reliable evidence. Table 5 presents a summary of the 26 selected studies and their corresponding assessment, which are organized according to the reference for a better understanding of the results.

Table 5. Assessment of selected studies.

Rerence	Authors	Title	Year	Score
[7]	Chou, R., Valdés, A., & Sánchez, S	Training Program of Digital Competences on University Professors	2017	8
[10]	Basantes-Andrade, A., Cabezas-González, M., Casillas-Martín, S., Naranjo-Toro, M., & Benavides-Piedra, A.	NANO-MOOCs to train university professors in digital competences	2022	9
[11]	Pozos, K., & Tejada, J	Digital Competences in Higher Education Professors: Proficiency Levels and Training Needs	2018	9.5
[13]	Prendes, M., Porlán, I., & Sánchez, F	Digital competence: a need for university teachers in the 21st century	2018	8.5
[25]	Fernández-Márquez, E., Leiva-Olivencia, J., & López-Meneses, E.	Digital Competences on Higher Education Professors	2018	7
[26]	Zempoalteca, B., Barragán, J., González, J., & Guzmán, T	ICT Training and digital competence in professors of public higher education institutions	2017	8
[27]	Yazon, A., Ang-Manaig, K., Buama, C., & Tesoro, J	Digital literacy, digital competence, and research productivity of educators	2019	9
[28]	Cabero-Almenara, J., & Martínez, A	Information and Communication Technologies and Initial Teachers Training: Models and Digital Competences	2019	9
[29]	Colás-Bravo, P., Conde-Jiménez, J., & Reyes-de-Cózar, S	The development of the digital teaching competence from a sociocultural approach	2019	8.5
[30]	Kullaslahti, J., Ruhalahti, S., & Brauer, S.	Professional development of digital competences: Standardized frameworks supporting evolving digital badging practices	2019	9
[31]	Sjöberg, J., & Lilja, P	University teachers' ambivalence about the digital transformation of higher education	2019	8.5
[32]	Handley, F	Developing digital skills and literacies in UK higher education: Recent developments and a case study of the digital literacies framework at the University of Brighton, UK	2018	7
[33]	Langset, I., Jacobsen, D., & Haugsbakken, H	Digital professional development: Towards a collaborative learning approach for taking higher education into the digitalized age	2018	8.5
[34]	Hepp, K., Fernández, M., & García, J	Teacher training: Technology helping to develop an innovative and reflective professional profile	2015	9
[35]	Caena, F., & Redecker, C	Aligning teacher competence frameworks to 21st-century challenges: The case for the European Digital Competence Framework for Educators (DIGCOMPEDU)	2019	8.5
[36]	Mengual-Andrés, S., Roig-Vila, R., & Mira, J	Delphi study for the design and validation of a questionnaire about digital competences in higher education	2016	8.5
[37]	Mirete, A. B., Maquilón, J. J., Mirete, L., & Rodríguez, R	Digital competence and university teachers' conceptions about teaching. A structural causal model	2020	8.5

Table 5. *Cont.*

Rerence	Authors	Title	Year	Score
[38]	Domingo-Coscollola, M., Bosco-Paniagua, A., Carrasco-Segovia, S., & Sánchez-Valero, J.-A.	Fostering teacher's digital competence at university: The perception of students and teachers	2020	9
[39]	Cabero-Almenara, J., Barroso-Osuna, J. M., Rodríguez-Gallego, M. R., & Palacios-Rodríguez, A. D. P.	Digital Competence for Educators. The case of Andalusian universities.	2021	8.5
[40]	Rojas, V., Zeta, A., & Jiménez, R	Digital competencies in a Peruvian public university	2020	8
[41]	Ruiz, A., Medina, M., Pérez, E., & Medina, A.	University teachers' training: the Digital Competence	2020	9
[42]	Viñoles-Cosentino, V., Esteve-Mon, F. M., Llopis-Nebot, M. Ángeles, & Adell-Segura, J.	Validation of a Platform for Formative Assessment of Teacher Digital Competence in Times of COVID-19	2021	8.5
[43]	Cabero-Almenara, J., Barroso-Osuna, J., Palacios-Rodríguez, A. & Llorente-Cejudo, C.	Digital competency frames for university teachers: Evaluation through the expert competence coefficient	2020	8.5
[44]	Pérez, L., Jordano, M., & Martín-Cuadrado, A.	NOOCs for the development of university teachers' digital competences. A pilot experience by the UNED (Universidad Nacional de Educación a Distancia)	2017	8.5
[45]	Roa, K., Rojas, C., González, L., & Ortiz, E.	Teacher 4.0: A digital training proposal to strengthen the teaching and learning process	2021	9.5
[46]	Barragán, R., Llorente, C., Aguilar, S., & Benítez, R.	Initial self-perception and level of digital competence of university teaching staff	2022	8

2.2.3. Data Extraction and Synthesis

The data extraction of the primary studies was organized in two stages: (1) the metadata of each primary study is considered as the general data, it is categorized by the author(s), title or subject of the document, abstract (abstract), keywords, digital object identifier (doi), year of publication, database, type of document and language, and (2) categories to classify the primary studies selected are defined, these are: the purpose, type of study, country in which the study was developed, training standards and models or frameworks used as references to implement teacher training in digital competence.

To categorize the type of study, six categories described by Morocho et al. [47] were considered: the correlational study (CS), descriptive study (DS), descriptive and correlational study (DCS), exploratory study (ES), systematic review studies (SR), and non-experimental study (NES). Regarding the purpose of each study, it was based on the guidelines proposed by Tonella et al. [48], which describe and identify the study purpose under seven categories (Table 6).

To classify the contribution made by each study, seven categories were considered: the standard (E), conceptual framework (CF), model (M), assessment instrument (AI), training program (TP), training dimensions (TD), strategy (S), and it does not contribute (NC); the latter refers to studies that do not present any of the first three categories. The data synthesis of the review is detailed in the Section 3 to answer each of the research questions described above.

Table 6. Category according to the purpose of a study.

Purpose	Description
Concept Proposal (CP)	The authors propose a concept, process, or theory; there is neither feasibility demonstration nor evaluation.
Proof of concept (PC)	The authors demonstrate the feasibility of the proposal.
Quantification (Q)	The authors quantify a variable concerning a given approach.
Comparison (C)	The authors determine quantitative differences between the properties of a proposal and at least one alternative.
Conditional Comparison (CC)	The authors determine quantitative differences between the properties of a proposal and at least one alternative in at least two conditions. (Proposal A is better than proposal B in condition C1, but the reverse is true in condition C2).
Review (R)	The authors present a summary of the literature.
Post-facto (PF)	The authors review the existing data and decide on a correlation between the two dimensions.

2.3. Phase 3: Results Report

The results report of the systematic literature review is detailed in the following section, and it presents the findings of this article.

3. Results

Next, the research questions for the systematic literature review are answered based on the data extracted from the selected papers.

The first question, RQ1. What basic standards do studies establish for digital competence training? Of the 26 studies, 5 describe the standards in an organized way as competency dimensions, in accordance with Table 7, while 9 studies show the importance of establishing standards for digital competence training and suggest taking existing models or frameworks as a basis to outline training standards according to the context in which they are developed.

Table 7. Basic standards for teacher training in digital competence.

Dimension of Competence	Basic Training Standards in Digital Competence	Study
Technological	Understands and effectively uses new technologies (ICT) in the teaching and research work. Uses technological tools to produce and disseminate knowledge. Uses content management tools for learning and collaborative work.	[7]
Professional Commitment	Uses different digital channels systematically to improve communication with students, parents, and colleagues (emails, blogs, the school website, apps). Uses digital technologies to work together with colleagues inside and outside of the educational institution. Actively develops digital teaching skills. Participates in online training opportunities (online courses, MOOC, webinars).	[27]
Digital Resources	Uses different Internet sites and search strategies to find and select a variety of different digital resources. Creates his own digital resources and modifies the existing ones according to his needs. Effectively protects sensitive content (exams, student grades, personal data).	
Teaching–learning	Carefully considers how, when, and why to use digital technologies in class, to ensure their use with added value. Monitors the students' activities and interactions in collaborative online settings. When students work in groups or teams, they use digital technologies to acquire and document evidence. Uses digital technologies to enable students to plan, document, and monitor their learning (questionnaires for self-assessment, e-Portfolios for documentation and display, online journals/blogs for reflection).	
Learning assessment	Uses digital assessment formats to monitor student progress. Analyzes all available data to timely identify students who need additional support.	
Empowerment of students	When creating digital assignments for students, considers and addresses potential digital issues (access to digital devices and resources; interoperability and conversion problems; lack of digital skills). Uses digital technologies to offer students personalized learning. Uses digital technologies for students to actively participate in class.	
Facilitates the student's digital competence	Teaches students how to assess the reliability of information and identify misinformation and bias. Sets up assignments, which require students to use digital media to communicate and collaborate with each other or with an external audience. Sets up assignments, which require students to create digital content (videos, audios, photos, digital presentations, blogs, wikis). Teaches students how to behave safely and responsibly online. Encourages students to use digital technologies creatively to solve specific problems, and overcome obstacles or challenges that arise in the learning process.	

Table 7. *Cont.*

Dimension of Competence	Basic Training Standards in Digital Competence	Study
Planning and design of learning experiences in face-to-face and/or virtual settings	Understands the features, languages, and basic functioning of the most common digital tools to integrate them into face-to-face learning situations supported by ICTIdentifies the didactic possibilities of basic digital tools and existing teaching materials. Designs mechanisms to identify students' learning needs using digital tools or materials. Selects the most appropriate digital tools for their strategic integration in the design of face-to-face learning experiences, according to the student's learning goals. Designs face-to-face learning experiences enriched with ICT searching for the most appropriate didactic methodology(s) to guide students' learning.	[11]
Development and management of face-to-face and/or online collaborative learning experiences	Manages creative learning experiences in face-to-face settings with the support of basic digital tools to motivate and guide student learning. Uses the current teaching–learning methodologies to integrate the basic digital tools at the appropriate moments of the didactic act. Encourages communication and collaborative work through basic digital communication and digital collaboration tools. Manages research projects and student work with the support of basic digital tools.	
Orientation, guidance, and evaluation of students' knowledge construction processes in face-to-face and/or virtual settings	Analyzes the learning needs, prior knowledge, and motivations of students with the support of digital tools or materials. Continuously assesses the learning and knowledge construction processes of students in face-to-face learning settings mediated by ICT. Applies and adjusts the necessary support to guide learning with ICT in face-to-face learning settings. Uses digital tools to build instruments for the evaluation and self-assessment of students' learning. Uses the virtual platforms to manage institutional academic content to administer the course evaluation system and monitor students' learning.	
Management of the professional growth and development with the support of ICT	Uses ICT, especially in the acquisition of complementary knowledge about subjects and pedagogy-didactics, which contribute to professional development. Uses the basic technological tools of academic management in the usual professional fields to support professional performance. Participates in proposals for basic training in/with CT to improve the usual professional activity. Values the importance and need for lifelong learning in various fields and ICT to improve the professional development.	
Research, development, and pedagogical innovation with ICT and for the use of ICT in education	Consults relevant information through basic digital tools for the development of daily professional activities of teaching, research, and management. Reflects on practice, on the benefits of using basic digital tools in face-to-face educational experiences. Participates in research projects with the support of basic digital tools.	
Diversity, ethics, and responsible use of ICT in teaching professional performance	Understands the implications and potential risks of digital tools in social segregation and exclusion. Acts with ethical criteria for the responsible integration of ICT in the curriculum and student learning activities. Guarantees equitable access to the use of ICT for students during face-to-face learning experiences, especially in collaborative activities Provides experiences and digital learning materials considering the cultural and linguistic diversity of students.	
Environment, health, and occupational safety with the use of ICT in the pedagogical teaching profession	Manages adequately stress and emotions in the acquisition of new knowledge and development of competencies around ICT in daily practice. Uses ICT properly together with the corresponding installation and use manuals. Knows the implications of the use of technologies in education and their possibilities to support the curricular area. Plans and designs ICT learning settings for curriculum development. Uses ICT in the preparation of teaching materials to support pedagogical practices to improve future job performance. Implements learning experiences with the use of ICT to teach the curriculum. Evaluates technological resources to incorporate them into pedagogical practices. Evaluates the results obtained in the design, implementation, and use of technology to improve learning and development of cognitive skills. Supports teaching and learning processes through virtual settings.	
Social, ethical, and legal	Learns about aspects related to the impact and role of ICT in the way of understanding and promoting inclusion in the Knowledge Society: Identifies and understands ethical and legal aspects associated with digital information and communications through data networks (privacy, software licenses, intellectual property, information, and communications security).	

Table 7. *Cont.*

Dimension of Competence	Basic Training Standards in Digital Competence	Study
Technical–technological	Knows the concepts and basic functions associated with ICT and the use of personal computers. Uses productivity tools (Word Processor, Spreadsheet, presenter) to generate various types of documents. Knows concepts and uses tools of the Internet, Web, and synchronous and asynchronous communication resources, to access and disseminate information and establish remote communications.	
Management	Uses technologies to support administrative-teaching tasks. Uses technologies to support the administrative tasks of the institution.	
Professional development	Develops skills to reflectively incorporate technologies into the teaching practice. Uses technologies for communication and collaboration with peers and the educational community in general in pursuit of exchanging reflections, experiences, and products that contribute to the teaching performance.	
Pedagogical	Explorer: identifies new strategies and methodologies mediated by ICT, as a tool for their professional performance. Integrative: proposes projects and learning strategies with the use of ICT to enhance student learning. Innovative: leads meaningful experiences that involve differentiated learning settings according to the needs and interests of their own and of the students Investigative.	[28]
Investigative	Explorer: uses ICT to record and monitor what is being observed from a teacher and student perspective in practice and context. Integrator: leads his own research projects and with his students. Innovative: builds innovative educational strategies that include the collective generation of knowledge.	
Technological	Explorer: recognizes a wide spectrum of technological tools and some ways to integrate them into educational practice. Integrator: uses various technological tools in educational processes, according to their role, training area, level, and working context. Innovative: applies the knowledge of a wide variety of technologies in the design of innovative learning settings and proposes solutions to problems identified in the context.	
Management	Explorer: organizes activities related to professional work with the use of ICT. Integrator: integrates ICT in processes of dynamization of the directive, academic, administrative, and community management of the institution. Innovative: proposes and leads actions to optimize integrated processes of school management.	
Communicative	Explorer: uses various channels and languages of ICT to communicate with the educational community. Integrator: develops collaborative work strategies in the school context from the participation in networks and communities with the use of ICT. Innovative: participates in communities and publishes textual productions in various virtual spaces and through multiple digital media, using the languages that ICT enable.	

- Hepp et al. [34] claim that the standards will guide teacher performance since they integrate the knowledge and practices required for the development of their professional practice.
- Pozos y Tejada [11] point out that it is necessary to establish standards to examine teachers' ICT competence to improve the digital profiling of teachers in Higher Education.
- Chou et al. [7] refer to UNESCO's definition of standards (2008) where they are considered as a structure to identify and evaluate the elements that make up a competence.
- Yazon et al. [27] reveal that digital competence training standards allow a competence to be assessed and, based on it, enrich professional practice.
- Cabero-Almenara y Martínez [28] state that the improvement of teaching in Higher Education is related to the standards of digital competence since they allow assessing teachers' competence in this area through the evaluation of their standards, without limiting university professors' actions.
- Sjöberg y Lilja [31] state that the standards refer to the competencies that teachers must achieve and master at the end of their teaching training.
- Caena y Redecker [35] state that providing digital competence standards contributes to establishing teachers' professional profiles in Higher Education.
- Colás-Bravo et al. [29] base their research on a sociocultural approach composed of four dimensions: dominance, preference, reintegration, and appropriation; they establish teacher digital competence (TDC) standards through empirical evidence coming from its implementation in students, which is why this study is not considered within the basic standards for teacher training (Table 7).

- Cabero-Almenara et al. [43] states that standards allow for recognizing the use and integration of technologies in teaching, identifying training needs, and proposing personalized training itineraries.

Table 8 details the answer to research question 2, RQ2. What standards, models, or frameworks are used as references to implement teacher training in digital competence? The studies refer to two standards, nine models, and seven frameworks, all of which focus on the development of digital competence in different areas, one of which is teacher training in general.

Table 8. Referents of digital competence.

Standards, Models, or Frames in DC	Area of Competence	Levels	Study
UNESCO ICT Competency Standards for Teachers (2008)	1. Policy and vision. 2. Study plan and assessment. 3. Pedagogy. 4. ICT. 5. Organization and administration. 6. Teacher professional training.	1. ICT Basic notions. 2. Deepening of knowledge. 3. Generation of knowledge.	[7,11,25,29,36]
ICT National Educational Technology Standards for Teachers NETS-T (2008)	1. Professional growth and leadership. 2. Digital citizenship and responsibility. 3. Digital age work and learning. 4. Learning experiences and assessments, typical of the digital age. 5. Student learning and creativity.	1. Apprentice. 2. Leader. 3. Citizen. 4. Collaborator. 5. Designer. 6. Facilitator. 7. Analyst.	[11,29,34,36,45]
Model for teacher digital competence Krumsvik (2009)	1. Basic digital skills. 2. ICT didactic competence. 3. Learning Strategies. 4. Digital Literacy.	1. Low level, has no digital awareness or competence. 2. Digital awareness but not digital competence. 3. Digital awareness and digital competence. 4. High level of digital awareness and digital competence.	[28,33]
TPACK model (2009)	1. Knowledge of disciplinary content. 2. Pedagogical knowledge. 3. Technological knowledge.		[13,28,31,34,35,37]
JISC'S Digital literacy framework (2014)	1. Media literacy. 2. Communications and collaboration. 3. Identity development and management. 4. ICT literacy. 5. Learning skills. 6. Digital scholarship. 7. Information literacy.		[32]

Table 8. *Cont.*

Standards, Models, or Frames in DC	Area of Competence	Levels	Study
ICT Competence Model for teaching in Spanish Public Universities, Prendes (2010)	1. Teaching. 2. Research. 3. Management.	1. Level 1. 2. Level 2. 3. Level 3.	[11,13]
Model for digital competence integration in university teaching Pozos (2010)	1. Planning and design of learning experiences in face-to-face and virtual settings. 2. Development and management of face-to-face and online collaborative learning experiences. 3. Orientation, guidance, and evaluation of knowledge, construction processes in face-to-face and virtual settings. 4. Management of professional growth and development with ICT support. 5. Research, development, and pedagogical innovation with/for the use of ICT in education. 6. Diversity, ethics, and responsible use of ICT in teacher professional performance. 7. Environment, health, and occupational safety with the use of ICT in the teaching profession.	1. Basic. 2. Deepening. 3. Generation of knowledge.	[13]
UNESCO ICT Competency Framework for Teachers (2011)	1. Understanding ICT in education. 2. Curriculum and evaluation. 3. Pedagogy. 4. ICT. 5. Organization and administration. 6. Teacher professional learning.	1. Digital literacy. 2. Knowledge production. 3. Knowledge creation.	[30,34,38,43,45]
ALA-MUTKA digital competence model (2011)	1. Operational instruments related to the media. 2. Strategic application of digital tools. 3. Intercultural, critical, creative, autonomous, and responsible attitude.	1. Knowledge. 2. Advanced. 3. Attitudinal.	[11]
Common Digital Competence Framework for Teachers INTEF (2013)	1. Information. 2. Communication. 3. Content creation. 4. Security. 5. Troubleshooting.	1. Basic. 2. Intermediate. 3. Advanced.	[11,26]

Table 8. *Cont.*

Standards, Models, or Frames in DC	Area of Competence	Levels	Study
European Digital Competence Framework for Citizens (DigComp) (2013)	1. Information. 2. Communication. 3. Content creation. 4. Security. 5. Troubleshooting.	1. Basic. 2. Intermediate. 3. Advanced.	[13,27–30,32,35,36,40,46]
Model of the Ministry of National Education of Colombia MEN (2013)	1. Technological. 2. Pedagogical. 3. Communicative. 4. Management. 5. Research.	1. Explorer. 2. Integrator. 3. Innovative.	[43,45]
Framework for 21st Century Learning ACT21s (2014)	1. Way of thinking. 2. Ways of working. 3. Ways to experience the world. 4. Tools to work with.		[35]
Model of the Ministry of Education of the Government of Catalonia (DEGC) (2016)	1. Design, planning, and didactic implementation. 2. Space and digital resources organization and management. 3. Communication and collaboration. 4. Ethics and digital citizenship. 5. Professional development.		[38]
European Digital Competence Framework for Citizens (DigComp 2.0) (2016)	1. Information and data literacy. 2. Communication and collaboration. 3. Creation of digital content. 4. Security. 5. Troubleshooting.	1. Basic. 2. Intermediate. 3. Advanced. 4. Highly specialized.	[13,29,30,35,44]
Common Digital Competence Framework for Teachers INTEF (2017)	1. Information and informational literacy. 2. Communication and collaboration. 3. Creation of digital content. 4. Security. 5. Troubleshooting.	1. Basic: A1 and A2. 2. Intermediate: B1 and B2. 3. Advanced: C1 and C2.	[10,13,28,29,38,41,43]
Digital Competence Framework for Educators DigCompEdu (2017)	1. Professional commitment. 2. Digital resources. 3. Teach and learn. 4. Evaluation and feedback. 5. Empower students. 6. Facilitate student digital competence.	1. Novice. 2. Explorer. 3. Integrator. 4. Expert. 5. Leader. 6. Pioneer.	[29,30,35,39,42,43]
Teacher digital competence model for university professors Prendes (2018)	1. Technical. 2. Informational and communicative. 3. Educational. 4. Analytical. 5. Socially ethical.	1. Level 1. 2. Level 2. 3. Level 3.	[45]

Figure 3 answers research question 3, RQ3. What are university professors' training needs regarding digital competence?

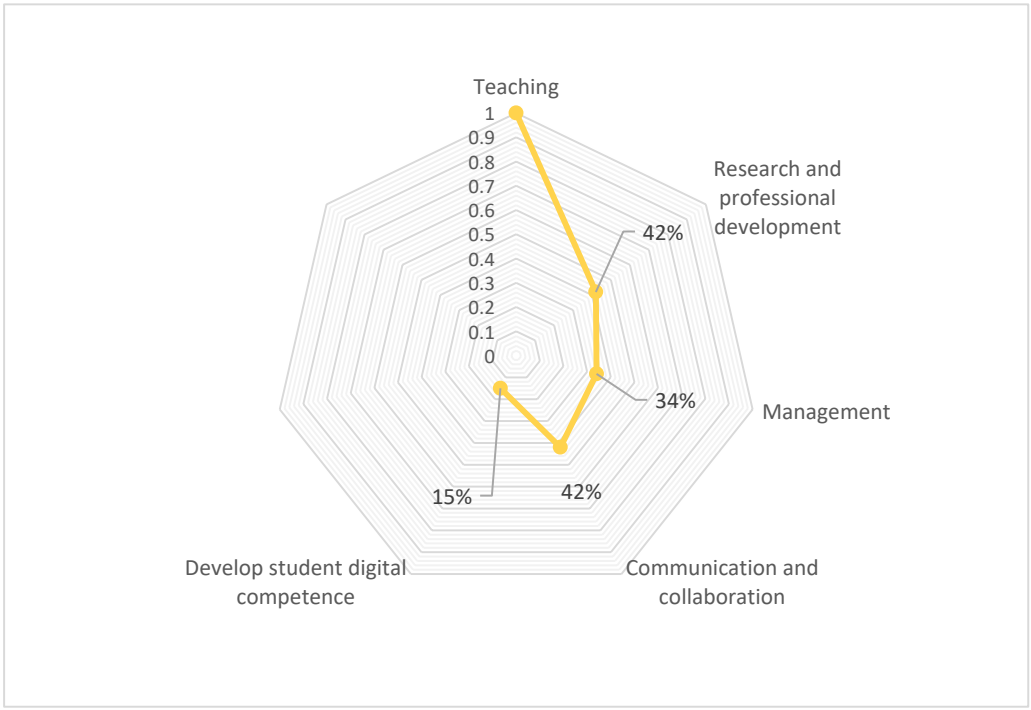

Figure 3. University professors' training needs.

All the studies in the systematic review highlight the training needs in teaching, which implies that teachers need to develop abilities to use ICT efficiently and didactically in their professional work, focusing on innovation and pedagogical leadership with ICT. With the same share of 42% for research and professional development, and communication and collaboration (42%), it reveals that teachers must develop skills to integrate ICT as a communication channel that promotes collaboration and collaborative learning through national communities and international networks, which could serve as points of reflection for the development of research and the co-creation of new training opportunities in their professional life. Management shows a 34% need, and the development of student empowerment in digital competence presents a 15% need.

Regarding research question 4, RQ4. What is the contribution of the study in this area? The majority of the studies, in the first instance, focused on the verification of evidence and, secondly, on conceptual proposals; therefore, the contribution that the selected studies have made to the scientific literature is considerable, since 36% of the studies proposed teacher training in digital competence (TP), 15% built four models (M) focused on teacher training for the development of digital competence (DC), while 19% developed instruments to assess the level of training that university professors have in DC (AI). Additionally, in the same proportion (15%), they developed training strategies (S) and a detailed and structured description of how to build a digital competence framework for training (CF). Table 9 shows the different contributions that were found through the systematic review.

Table 9. Contribution of each selected study in detail.

Type of Contribution	Study	It Is Based on Existing Referents	Objective	Detail
TP	[7]	UNESCO (2008)	Promote changes in the teaching practice of the university professor through a technological preparation program.	The training program proposal has three modules: 1. Knowledge and skills in office automation applications. 2. Production of knowledge with technological tools. 3. Implementation of a content management system for learning and collaborative work.
	[28]	Krumsvik (2009) TPACK (2009) DigComp (2013) INTEF (2017)	Know and manage technically and technologically the instruments of the media galaxy, until the transformation of their educational practices.	The proposal for the ICT teacher training program is based on the development of four competency dimensions through three phases: 1. Design. 2. Educational Use. 3. Management and administration. 4. Research and ethics. Phases: 1. Initiation–instrumentation. 2. Incorporation–substitution. 3. Review–transformation.
	[10]	INTEF (2017)	Improve digital competence of university teachers through nano-MOOCs.	The training proposal is based on the PACIE instructional design to create courses in a nano-MOOC format in the following areas of competence: 1. Creation of digital content. 2. Security.
	[43]	DigCompEdu	Choose a teacher digital competence (TDC) framework as the axis for the design, production, and evaluation of t-MOOCs.	The proposal focuses on using the DigCompEdu model as a reference for teacher training through courses in t-MOOC format.
	[44]	DigComp 2.0	Improve university teaching staff training in the area of information on digital competence.	Teacher training in digital competence is based on open and online courses (NOOC) in the area of information with three levels of performance (basic, intermediate, and advanced): 1. Navigation. 2. Evaluation. 3. Storage.
	[45]	Prendes (2018) y MEN	Identify the level of digital competence and generate a training plan based on the needs.	The training plan is based on micro courses in the areas of competence from the MEN model.
	[46]	DigComp	Identify the level of digital competence in university professors and propose a training plan through the t-MOOC architecture.	The training proposal is based on the DigComp model areas of competence, under the t-MOOC architecture.

Table 9. *Cont.*

Type of Contribution	Study	It Is Based on Existing Referents	Objective	Detail
TP	[41]	INTEF (2017)	Train university teaching staff in the knowledge, mastery, and projection of digital competence for their own professional development and the improvement of teaching–learning processes.	The training proposal is based on the development of resources (mini videos) so that university professors have a greater understanding and encourage interaction and communication in the teaching–learning process. It focuses on three dimensions of digital competence: 1. Digital competence theoretical knowledge. 2. Digital competence and practical mastery. 3. Digital competence projection.
	[42]	DigCompEdu	Validate the design of a platform for self-assessment and training in TDC.	The self-assessment platform in digital competence allows teachers to know or identify their level of competence based on the DigCompEdu dimensions and derived from this, teachers can select their training according to their need and level of expertise.
	[34]	UNESCO (2008) NETS-T (2008)	Develop skills, techniques, attitudes, and habits in educators, in a way that the correct use of technological tools is evidenced through the success achieved in the training process.	The proposal for the training of educators includes the following dimensions of competence: 1. Educational policy and initial teacher training (use of ICT). 2. Change management (new ways of learning and accessing knowledge, ethics, and deontology). 3. Development of skills in teachers (promote pedagogical innovations, ICT in education).
S	[30]	DigCompEdu (2017)	Apply competency frameworks to improve and innovate teacher education programs through the potential of open digital badges.	The TDC training strategy is based on the development of the six phases of the DigCompEdu model and the awarding of badges according to the achievement of these objectives: 1. Professional commitment. 2. Digital resources. 3. Teaching and learning. 4. Evaluation. 5. Empowerment of students. 6. Facilitation of students' digital competence.

Table 9. *Cont.*

Type of Contribution	Study	It Is Based on Existing Referents	Objective	Detail
M	[11]	None	Identify current competencies and establish-prioritize training needs.	The model to develop digital competence in university professors considers the following competencies: 1. Planning and design of learning experiences in face-to-face and virtual settings. 2. Development and management of face-to-face and online collaborative learning experiences. 3. Orientation, guidance, and evaluation of knowledge construction processes in face-to-face and virtual settings. 4. Management of professional growth and development with ICT support. 5. Research, development, and pedagogical innovation with/for the use of ICT in education. 6. Diversity, ethics, and responsible use of ICT in the professional performance of teachers. 7. Environment, health, and occupational safety with the use of ICT in the teaching profession. Proficiency level: 1. Undeveloped competence. 2. Basic. 3. Medium. 4. High. 5. Expert.
	[11]	DigCompEdu (2017) INTEF (2017)	Propose a model for TDC development based on a sociocultural approach.	This model is developed through four constructs: 1. Domain. 2. Preference. 3. Reintegration. 4. Appropriation.
	[11]	Prendes (2010)	Approach university professors for ICT integration into teaching coherently through an original model.	This model is based on five dimensions: 1. Technique. 2. Informational/communicative. 3. Educational. 4. Analytics. 5. Socio-ethics. Scope of application: 1. Teaching. 2. Research. 3. Management.

Table 9. *Cont.*

Type of Contribution	Study	It Is Based on Existing Referents	Objective	Detail
M	[33]	None	Present a model with a collaborative learning approach (CLA) for the professional development of digital competences.	The model proposed by the authors is developed in four steps: 1. Preparation. 2. Production. 3. Implementation. 4. Maintenance and dissemination.
AI	[31]	TPACK (2009)	Develop an ad hoc instrument to assess the level of digital competence in teachers.	This evaluation instrument deals with three dimensions: 1. Technical knowledge. 2. Technological application. 3. Pedagogy.
	[39]	DigCompEdu	Identify the level of digital competence in university teaching staff and see if there are significant differences between self-perception before and after taking the questionnaire.	The level of digital competence in teachers is evaluated according to the DigCompEdu Check-In instrument adapted to the Spanish context.
	[36]	UNESCO (2008) NETS-T (2008) DigComp (2013)	Design and validate a questionnaire developed based on various digital competence standards for Higher Education.	The proposed questionnaire has the following dimensions: 1. Technological literacy. 2. Access and use of information. 3. Communication and collaboration. 4. Digital citizenship. 5. Creativity and innovation.
CF	[35]	DigCompEdu (2017)	Update the competence profile according to the challenges of the 21st century through a digital competence framework.	The DigCompEdu framework is sufficiently generic and can be applied in different educational settings, based on this framework the authors describe the creation of a digital competence framework considering the following aspects: 1. Challenges of the digital revolution in education systems. 2. Align teachers' profiles with 21st-century skills. 3. Design and implementation of competence frameworks for teachers. 4. Motivation to build the framework. 5. Framework generation. 6. Content and structure of the framework. 7. Framework implementation and self-assessment tools. 8. Conclusions.

Table 10 addresses research question 5 of this systematic review, RQ5. What technologies are recommended to implement teacher training in digital competence? Most studies do not report the use of a specific technology to address teacher training (69%), they rather focus on determining the competencies that university professors must have to develop teaching–learning processes through an effective and safe integration of different digital

resources. All the studies (100%) recommend continuous and permanent teacher training to improve their work practice.

Table 10. Recommended technologies for teacher training in TDC.

Study	Technology	Modality
[10,44]	Nano-MOOC o NOOC	Open access online courses. Teachers select the training course according to their training needs. Each course lasts 180 min.
[35]	cMOOC	Open access online courses. Teachers select the training course according to their training needs.
[35]	Mini videos	Use of mini videos for a better understanding of specific topics such as interaction and communication resources.
[34]	The authors recommend preparing techno-pedagogical handbook (TH) documents, so the teacher can check when required.	Autonomous online or offline.
[42]	A platform for self-assessment and institutional digital competence training.	It offers free options for online courses on the site according to the results obtained from the digital competence level self-assessment.
[43,46]	t-MOOC	Hybrid MOOC that adapts the characteristics of the xMOOC and cMOOC and integrates progressive development of tasks or activities for the student as the course progresses. The tasks can be developed individually or collaboratively among their peers.
[45]	Micro-courses	Structured course under the micro-course concept, by level, and by competence; it is based on the challenge-based learning pedagogical approach.
[7]	Use of Web 2.0 tools to develop lifelong learning.	Open Access Virtual Learning Environment. The training selection is according to teachers' needs.

Authors Caena and Redecker [35] concluded that the horizontal collaborative learning approach (CLA) in teacher training was essential because everyone's participation fostered reflection, autonomy, and improvement in their professional productivity. At the end of the preparatory stage, teachers prepared the courses that they believed were necessary for their teaching work. Participation in MOOC implementation created a sense of belonging and identity.

MOOC implementation for digital competence training did not reach the expected results: teachers did not finish completing the course. The content and materials of the MOOC served to form a bank of knowledge and contextualized ideas in the form of nodes, with these, they changed the rules and turned the MOOC into an xMOOC, a MOOC focused on experts, where the teacher directs the knowledge that the participants will obtain (the teacher is the central figure of learning).

After seeing the participation in this course, video production tools were improved into personal learning resources, the meticulously planned xMOOC was transformed into a cMOOC, a connectivist course that represents the creation of networks and the generation of knowledge in a participatory way. They strategically placed and selected the material that suited their educational needs and ideas, participants were free to explore new applications at their own pace, and even decided what technology to learn and implement and how to use it in their courses. This provided them with better results for university professors' training.

The training proposal of the studies [10,44] shows that nano-MOOCs or NOOCs configure a customizable training option in less time and it is adaptable to the needs and characteristics of teachers.

4. Discussion

Teaching performance is essential in a knowledge society. Its continuous or permanent training is unavoidable to satisfy the requirements in a world where the exponential evolution of information and communication technologies prevails. All the studies selected for the systematic literature review suggest training based on techno-pedagogy and focus their attention on improving teaching as a substantive function in university work. This implies that teachers should develop abilities to use ICTs efficiently and didactically in their professional work; similar findings to that of Jiménez-Hernández et al. [49] after the systematic review of the most used models for TDC.

Of the 26 studies that were analyzed, only Prendes and Gutiérrez [12], Pozos [50], and Prendes et al. [13] refer to the need for teacher training in three of the four substantive functions of university professors: teaching, research, and management. In accordance with Esteve et al. [51] the lack of training in these three substantive functions of higher education is notorious: research, management, and community engagement (transferring), the latter understood as the application of teachers' knowledge and research into the social, economic, and cultural sphere, among others.

It should be noted that none of the selected studies refer to community engagement. Corroborating what was stated by Prendes et al. [13], the impact of digital competence on knowing how to use ICT critically, reflexively, and safely will affect the effective application of technology in the teaching–learning process (teaching methodologies), management, research, and community engagement.

The different investigations presented in this article, Basantes-Andradea et al. [10], Rojas et al. [40], Ruiz et al. [41], and Barragan et al. [46], among others, allow corroborating the need to redefine digital competence training in university professors from a holistic approach, which contemplates all the substantive functions and based on these, establish the dimensions, standards, and training. Likewise, it is confirmed that all the presented information does not remain in theory. Several studies demonstrate the viability of their proposals for teacher training in higher education [10,28,34,42,44,45], build or adapt instruments of evaluation to identify the level of competence that teachers have [31,36,39,41,42], and even one paper deals with how to develop a digital competence framework [35]; therefore, a growing trend is observed in this line of study.

The various models that are used as references for university professors' training show the importance of understanding the contextualization and relevance of digital competence in the teaching role. These models through their dimensions have the purpose of establishing teacher training standards considering the context and social need of the object of study. In many cases, the training has a technical–technological orientation, leaving aside the methodology that teachers must develop to incorporate and adapt ICT efficiently in their daily work; this is a starting point to becoming a digitally competent teacher.

Concerning the basic standards that TDC training must meet, Caena and Redecker [35] present two in their study: pedagogical and technical–technological, along with the purpose of establishing the guidelines for their evaluation. On their part, Lázaro and Gisbert [52] and Esteve-Mon et al. [52] add to these two, stating learning strategies and digital instruction or training. On the contrary, Chou et al. [7] consider teaching and research as the axis to establish three training standards from the technological dimension: (1) an understanding and the effective use of ICT for teaching and research, (2) the use of technological tools to produce and spread knowledge, and (3) the use of content management tools for learning and collaborative work.

Yason et al. [27] take the DigCompEdu framework competency dimensions as the reference and develop 22 basic standards for digital competency training for educators; Pozos and Tejada [11] establish 27 standards based on the seven competency dimensions of the ICT competency model for teachers proposed by Pozos [50]. Finally, Cabero-Almenara and Martínez [28] refer to the 16 standards for initial teacher training in ICT of the Ministry of Education of Chile (2006) and 17 standards of the Ministry of National Education of Colombia (2013).

To comprehensively plan teacher learning, accompaniment, and evaluation according to their needs and ICT appropriation level to strengthen their work inside and outside the classroom, all 26 authors of the studies selected in the systematic review propose in the first instance to identify the level of digital competence that university professors have based on the competence dimension, and after that, establish the standards, the direction, and focus of the training; these results coincide with Jiménez et al. [49] to achieve the universalization of digital competence in higher education.

On the other hand, the European Digital Competence Framework for Citizens (DigComp) is the most referenced by the selected studies. Although it is not a specific model for teacher training, it is adapted to the educational context, results that are similar to those of González et al. [53] and Pérez and Rodríguez [53] who use it as a reference for this purpose. In the field of teacher training, the DigCompEdu and INTEF (2017) frameworks have the same reference significance for the authors, a finding that is similar to the results of Cabero-Almenara et al. [39] who state that INTEF was based on the DigCompEdu project for its development [10]. Although these two frameworks address the training of educators in digital competence in a general way, neither of them specify the competencies of university professors, but they can be adapted for this context and even for non-formal training.

While only five studies mention the standards established by UNESCO in 2008 and the NETS-T standards (which have the same reference significance) regarding the development of digital competence, the TPACK model is the most cited as a proposal to guide teachers in technological integration from a pedagogical dimension in favor of improving the teaching–learning process. Such a result coincides with Heep et al. [34], who point out that the DigCompEdu model in its areas two through five has a more limited scope than TPACK due to its pedagogical dimension. In the university context and according to the results obtained by Miralles-Martínez et al. [54] and Mirete et al. [37], it is necessary to restructure the TPACK model with a series of necessary competencies for each of its dimensions according to the teacher's role (teaching and research).

The results presented in this study allow us to ratify the criterion of Viñoles et al. [42] and Prendes et al. [13]. The development of digital competence does not depend exclusively on the teacher. Universities must reconfigure their policies and strategic plans to redefine the work of university professors, in the sense of eliminating bureaucratic tasks (administrative paperwork) that limit their professional development. They must also establish comprehensive training plans that respond to TDC training needs.

There is a positive contribution in this area of study by the studies selected in the systematic review. The contributions are evidenced by the development of new digital competence models [11,13,29,33], teacher training proposals on TDC [7,10,28,34,41–46], instruments to assess the level of training that teachers have on digital competence [31,36,39,41,42], and even a detailed description on how to develop a digital competence framework [35].

In similarity with the results of Basantes et al. [10], Pérez et al. [44], Roa et al. [45], and Touron et al. [55] state that it is necessary to evaluate the level of digital competence in teachers to plan a personalized training based on the results obtained. In this sense, all studies recommend that teacher training should be continuous and permanent in an open manner, online, and with the possibility of letting teachers be the ones who choose what, when, and how to learn based on their training needs and in correspondence with the peculiarities and mastery of their competence.

Regarding the technological suggestions that could be used for TDC training, the range of options is wide: open access online courses with the nano-MOOC structure, also known as NOOC [10,44], cMOOC [7], mini videos [35], t-MOOC [43,46], online micro-courses [45], use of Web 2.0 tools [7], and online documents on techno-pedagogical handbooks (TH) so that the teacher can consult them when it is required in a personalized way [34], and even the design of the platforms that self-assess TDC and offer a training plan [42]. The similarity between the results obtained focuses on the reduction in dropouts from a training program, the elimination of repetitive content, which in many cases focuses on instrumentalized

technology training, and the main characteristic among them is the personalization of teacher training according to their needs.

5. Conclusions

Teacher digital competence (TDC) does not have a unified definition and it is recognized with different terminologies (skills, digital literacy, ICT literacy, among others); however, in the studies reviewed, similarities were found in two dimensions of TDC: the didactic–pedagogical approach and professional development. With this, TDC is defined as the teacher's ability to integrate ICT in the professional context with pedagogical-didactic, critical, and safe criteria.

The professional development of the university faculty is directly articulated to the four functions of higher education: teaching, research, management, and community engagement. The authors of the studies analyzed in this systematic review coincide that it is necessary to identify the level of knowledge that professors have in relation to the dimensions of competence and, after that, define the standards and the training approach.

The results presented allow us to establish the basic standards for teacher training in digital competence, in relation to three of the four substantive functions: teaching, research, and management. None of the selected studies refer to community engagement. The analyzed studies agree on the fact that the standards for teaching practice are oriented towards the integration of ICT in the teaching–learning process, the design and implementation of virtual learning environments, the searching of digital teaching resources, construction of learning assessments and self-assessments tools, interaction, tutoring, monitoring, and evaluation of students, ethics and responsible use of ICT in the curriculum and in learning activities, equitable use of ICT with students, collaborative work, the use of didactic material while respecting cultural and linguistic diversity, evaluation of activities, ICT resources for pedagogical practice, development of cognitive skills, and knowledge society insertion.

With respect to the research function, the authors agree that ICT is mainly used to search and manage information, produce, and disseminate knowledge, access, and consult relevant information with scientific rigor, participate in research projects, identify and understand ethical and legal issues associated with digital information, participate in academic and research networks, and solve technical problems through installation manuals or guides.

For the substantive function of management, the use of ICT is highlighted in regard to professional academic administrative tasks, the management of learning content and collaborative work, use of digital channels to improve network communication, achievement of disciplinary, pedagogical–didactic or complementary knowledge that contributes to professional development, use of basic management tools in the fields of the profession, lifelong learning development, and management of stress and emotions while achieving a new knowledge.

The updating of techno-pedagogical strategies in higher education requires the commitment and dedication of university professors to assume a change and transformation in the teaching–learning process, for which universities must create digital organizational structures that allow the exchange of experiences, general knowledge, and techno-pedagogical knowledge through virtual learning ecologies, constituted as flexible environments enriched by technologies that respond to teacher training.

Finally, the line of research on digital competence contains an extensive list of programs, projects, and topics to investigate. The results should not be generalized or extrapolated without considering the characteristics of the educators and the context for which they work.

6. Limitations and Future Lines of Research

A wide coverage of studies that address university professors' training based on digital competence standards are presented here. Although, they do not focus on the development of the four substantive functions of higher education: teaching, research, management, and

community engagement; they only deal with the first three. A general overview of the problem is presented; therefore, the limitation lies in not providing specific data that must be addressed in each of these functions and thus have a comprehensive development of digital competence in the university context. Another limitation is related to the training proposals in which different educational models and experiences from other environments are considered: some of them are not applicable to all realities since they have different theoretical and practical characteristics and needs that in some cases are applicable and are not in others.

Lines of research can be developed using this systematic literature review, as an example, we point out: the application of the theory or training proposals of some of the authors of this study, a modification, or an expansion of the research questions to establish the relationships between the experiences and results obtained in different training scenarios or educational levels.

Other studies can focus on digital competence dimensions identification for the four substantive functions of higher education and establish the standards and university professors' training, and finally, describe the learning strategies of the didactic–pedagogical component of the teaching practice to make a critical and safe use of ICT in the classroom.

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