

Digital Competence of Higher Education Professors in the European Context: A Scoping Review Study

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Abstract—The aim of this article is to map the current state of knowledge on the digital competences of higher education professors in the European context through a scoping review. The initial search resulted in 1,568 publications, which, after applying the selection criteria, resulted in the inclusion of 14 publications. The content analysis showed that the digital tools made available by the institutions are widely known by the professors, although they have little use. A broad use of the LMS was evidenced, but more specifically to administrative activities than to activities connected with the teaching and learning process. There was also a positive relationship between the level of digital competences and the pedagogical approach adopted by the professors (focus on the construction of knowledge by the students, development of open education resources) as well as the participation in research projects. Professors training was pointed out as a relevant topic and the literature analysed referred that this should be preceded by a rigorous analysis of the professors' digital competence levels so that training activities can be carried out in the most personalized way possible.

Keywords—digital competence, higher education, information and communication technologies, DigCompEdu

1 Introduction

The 2030 Agenda for Sustainable Development recognizes that the prevalence of Information and Communication Technologies (ICT) has significant potential to accelerate progress, bridge the digital divide and support the development of inclusive knowledge societies based on human rights, gender equality and empowerment [1].

The enormous proliferation of ICT has meant that individuals have to face situations that require the use of new technical, cognitive and social skills every day. It has also been responsible for one of the most important revolutions in education in the recent decades, providing a complete change in the way of conceiving, planning and carrying out the teaching and learning process [2], [3].

The digitalization of modern life has increased the complexity of the educational environment, requiring digital technologies to play a central role in everyday work. Thus, teachers are forced to rethink previous educational traditions through these

technologies, creating great pressure on institutions to strategically develop and promote the digital competences needed for teaching and learning in today's world [4], [5].

Higher education institutions, or at least a large part of it, have seen ICT as an opportunity to streamline and update instructional processes through the inclusion of electronic devices and digital environments into their teaching practices [6], although these practices must be followed by a respective investment in training to strengthen the digital competences among the faculty [7].

Digital competence is currently considered essential for professors, as they must be able to manage a range of knowledge, not only in the scientific area for which they are responsible, but also in the application of different pedagogical tools that can help them in the teaching and research processes. These competences assist them in acquiring and updating the skills needed for their work and are thus a key element in building pedagogical knowledge which is useful for practice and, consequently, for improving student learning and adequately preparing them for life and work in a digital society [8]–[10].

1.1 Conceptual background

Digital competence. The term digital competence originated from a social need to define the essential skills for a knowledge society and is an evolving concept; it is related to the development of digital technology and expectations of citizenship in an increasingly digital society [9], [11]. It has come under increasing discussion in recent decades, particularly in policy documents, and is considered as a core competence related to the “kinds of skills and knowing people should have in a knowledge society, what to teach young people and how to do so” [11].

As stated by Ilomäki et al. [12] “Digital competences are complex conceptual constructions that attempt to define the knowledge and skills to carry out actions in the academic, labour or vital field for social development. In this regard, they agree to consider these competencies as potentialities of the human being to adapt to the virtual demands that predominate in the coexistence of digital Communities”.

Several recommendations are issued by different international organizations for the digital inclusion of citizens. Following these recommendations and due to a fear of losing competitiveness for other countries, the European Union has launched several initiatives, action plans and programmes from the European policies for the development of the information society that included actions focused on the educational field [13].

The first publication in the European Union context related to the topic occurred in 1994, when the European Council asked a group of researchers, chaired by Martin Bangemann, to prepare a report on specific actions to be studied by the Community and the Member States for the creation of information infrastructures. It was published in the *Boletín de La Unión Europea* (supplement 2) under the title “*Informe sobre Europa y la sociedad global de la información*”, which formally assumed the need to train and digitally literate teachers [13], [14].

In 2006 [15], and then again in 2018 [16], the Council of the European Union states that digital competence involves the confident, critical and responsible uptake and use of digital technologies in learning, work and participation in society, listing it among the eight key competencies for lifelong learning.

Two recent European Union publications on digital competences are noteworthy, both produced by the Joint Research Centre (JRC), part of the EU Science Hub European

Commission's knowledge and science service: i. the DigComp 2.2, the Digital Competence Framework for Citizens [17], focused on the general digital competences of citizens, and ii. the European Framework for the Digital Competence of Educators, the DigCompEdu [18], directed all levels of education, from early childhood to higher and adult education, including general and vocational education and training, special needs education, and non-formal learning contexts.

Digital teaching competence. Digital teaching competence (DTC) can be defined as a set of values, beliefs, knowledge, skills, and attitudes of teachers linked to the technological, informational, and communicative aspects used in a professional context. To this can be added good pedagogical and didactic criteria for the effective and conscious integration of these elements in the teaching and learning processes regarding the implications in the digital training of students [19], [20].

Teachers' digital competence has become an indispensable professional competence in the face of the educational potential of ICT as well as the social changes related to the digital field; teachers are also responsible, in part, for promoting the digital competence of their students for them to become collaborative, problem-solvers, and creative learners through the use of ICT so they will be effective citizens and active workforce members [21].

The integration of ICT and the consequent digitalization of society, which includes all actors in the educational field (students, teachers, and educational institutions of all levels), has introduced a new dimension into the pedagogical skills and competences required of these teachers and in the responsibilities of educational institutions on this matter. This has resulted in new challenges for high-quality teaching practice and for adapting to the changing needs of students [22], as well as increasing the pressure on educational institutions regarding the improvement of the technological infrastructures made available to their different actors.

The emergence of technical and digital innovation tools in the classroom has led to an increase pressure for the adoption of new teaching models in which teaching and assessment strategies are no longer based exclusively on face-to-face and one-to-one interactions between teachers and students [23]. This makes teachers' digital teaching competency fundamental in the teachers' initial and continuous education processes as well as effective integration of ICT use in the educational institutions daily practices [8], [21], [24], [25].

The certification of these competencies has been highlighted in the European Union. The Digital Education Action Plan (2021–2027) [26] proposes the development of a European Digital Skills Certificate (EDSC) "... that may be recognised and accepted by governments, employers and other stakeholders across Europe. This would allow Europeans to indicate their level of digital competences, corresponding to the Digital Competence Framework proficiency levels" (p.15). Generating more recently a publication by JRC the European Digital Skills Certificate Feasibility Study [27].

Digital teaching competence in higher education. More recently, in this pandemic scenario, digital teaching competence has become a key domain of competency that higher education institutions are facing and will face as a challenge in the coming years, whether they assume a face-to-face, distance or hybrid format. This puts pressure on higher education institutions to internalize this new reality; teaching and learning are increasingly mobile, constant, ubiquitous, and technologically mediated, happening not only between the architectural boundaries of universities, but taking place anytime and anywhere [28].

The COVID-19 pandemic has resulted in temporary physical closures of schools and higher education institutions worldwide, affecting the lives of almost 1.6 billion children, youth, and their families of these 220 million higher education students, inducing the adoption of Emergency Remote Teaching (ERT) [29]–[32].

As for the recent European report on the impact of COVID-19 on higher education showed that this impact had three levels: (a) immediate impact: how the pandemic affected institutions and learners in the last two academic years; (b) short-term impact: how the pandemic is affecting or is likely to affect the following academic years; and (c) medium-term impact: how the effects of the pandemic are likely to affect higher education systems, institutions and students by 2025 [29].

In these last two years, ICT has been integrated into all areas of life and professional domains, from the personal to the academic field and has become a teaching tool. However, its process of adoption is closely linked to the intrinsic characteristics of university professors, their beliefs, attitudes and knowledge. Considering the important changes that are presently emerging, adequate levels of digital competence are now required from these professors [33], [34].

Digital technologies in the field of higher education offer the possibility of creating creative spaces for training, innovation, research and collaboration, new paths for the social construction of knowledge and for the professional development of any student [13].

Educational institutions are one of the sectors that the COVID-19 pandemic has affected heavily worldwide. Some challenges are common, others vary by country or institution, depending on factors such as cultural and social life, technological infrastructure, and financial and economic conditions, but it is possible to highlight that the higher education system lived a rapid digitalization process [32], [35].

The use of ICT is often considered as an indicator of innovation in higher education, but its mere inclusion in the classroom does not guarantee improvements in teaching and learning processes. Also, it will not necessarily lead to the reflection and transformation on learning that has been desired in the last decades and more intensively in the last years. However, when used properly, it can contribute to the transition from passive to more active instructional models [36], [37].

The future of higher education depends on the ability of its professionals to face the challenges arising from social and economic progress and continuous technological changes. The greater potential of ICT is relevant for the development of technological, digital and informational competences, without underestimating the importance of other essential factors in any educational process; its use in classrooms contributes strongly to the promotion of the digital competence of graduate and postgraduate students [36]–[39].

2 Methodology

As stated in [40], the literature review is probably the most widely used research methodology, since virtually all researchers need to prepare one for their publications. Specifically, in this paper, a systematic literature review (SLR) was conducted. It refers to a methodological approach that is explicit in all its procedures, it presents a

comprehensive description of its scope (by including all relevant material), and it can be reproducible, as it clearly describes all the steps taken in order to let others follow the exact same approach.

A literature review can be classified according to different types. As stated in [41], they propose nine types: narrative review, descriptive review, scoping review, meta-analysis, qualitative systematic review, umbrella review, theoretical review, realist review and critical review. The first three, in general, aim to summarize the existing literature on a given topic of interest, to provide readers with a broad basis for understanding the current state of knowledge in an area.

The scoping review adopted in this article presents itself as an SLR technique that aims to quickly map the key concepts that underpin a given research area, and the main sources and types of evidence available in that area at any given time, summarizing the literature and providing a basis for understanding the current state of knowledge, while at the same time allowing indicators to be raised, providing pathways or theoretical references for new research [41], [42].

This article adopts the framework developed by Arksey and O’Malley [42], which proposes five stages for a scoping review of literature: 1. identifying the research question; 2. identifying relevant studies; 3. studies selection; 4. charting the data; and 5. collating, summarizing and reporting the results.

This article aims to identify the current state of knowledge of digital competences of higher education professors in the European context (Stage 1); to this end, the authors sought to identify relevant studies (Stage 2). The search was performed on January 12, 2021 in the EBSCO database, in the Discovery Service catalogue. The following string was used: AB “Digital Competence” OR AB “digital skill” AND AB (“higher education” or college or university or “post secondary” or postsecondary) AND AB (professors or faculty or teachers or instructors). As an initial result of this search, 1,568 publications were obtained.

The study selection (Stage 3) was performed in three steps: refinement, selection, and deep reading.

The refinement step was performed after the initial search in the EBSCO database; the inclusion criteria were applied according to Table 1, using the filters available in the database.

Table 1. Inclusion criteria

Publication Number	Criterion	Parameter (Included)
1	Period	2013 to 2020
2	Idiom	English, Portuguese or Spanish
3	Full text	Availability of full text
4	Publication type	Peer-reviewed scientific journals
5	Duplication	One entry for each identified publication

Note: Year of the first framework published by the European Commission about digital competence [43].

In the next step, selection, the inclusion criteria in Table 1 were reapplied by reading the titles and abstracts of the articles.

Finally, in the reading step, a global reading of the resulting publications was performed and the exclusion criteria in Table 2 were applied in order to provide a more specific response to the objectives of this article.

Table 2. Exclusion criteria

Publication Number	Criterion	Parameter (Excluded)
1	Objective	Publications whose study objectives were different from studying the digital competencies of higher education professors
2	Nature	Publications where data were not of primary nature
3	Context	Publications focusing on non-European contexts

3 Results

At the end of the study selection (stage 3), 14 publications were obtained and included in this review. Its selective process can be seen in the flow diagram of Figure 1. These 14 publications are also described in Table 3, where they are sorted alphabetically by the first author last name.

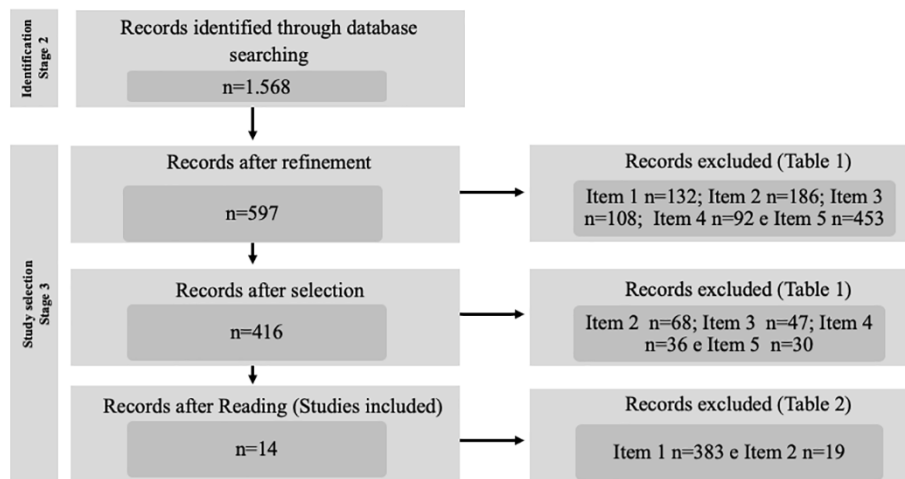


Fig. 1. Details the phases of the study selection process

Note: Adapted from [44].

Table 3. List of selected publications

N°	Year	Reference	Journal
1	2020	[45]	British Journal of Educational Technology
2	2019	[46]	Journal of Digital Learning in Teacher Education
3	2019	[47]	Caracteres – Estudios culturales y críticos de la esfera digital
4	2017	[48]	EAI – European Alliance for Innovation
5	2018	[49]	International Journal of Educational Technology in Higher Education
6	2015	[50]	EAI – European Alliance for Innovation
7	2020	[51]	Education Sciences
8	2019	[33]	The International Journal of Learning in Higher Education
9	2017	[52]	Teaching and Teacher Education
10	2016	[53]	International Journal of Educational Technology in Higher Education
11	2016	[36]	ENSAYOS
12	2020	[34]	Sustainability
13	2016	[2]	Pixel-Bit – Revista de Medios y Educación
14	2016	[54]	Revista Colombiana de Ciencias Sociales

In charting the data (stage 4), publications were categorized according to the journal of publication, the digital competence framework adopted as reference, the methodological approaches used, as well as the instruments applied for data collection.

3.1 Distribution by journals and authors

The 14 publications selected were published in 12 different journals, with two published in each of the following journals: International Journal of Educational Technology in Higher Education and EAI – Endorsed Transactions on e-Learning. The authors Guillén-Gámez [33], [51], Holley [48], [50], Mayorga-Fernández [33], [51] and Mirete [34], [36], each had two publications among those selected, as shown in Table 3.

3.2 Scope of the articles

The publications selected were categorized into two categories: i. digital competence measurement studies, when their main objective was to measure the level of digital competence; and ii. development and/or validation of digital competence evaluation tools. Subcategories were also added according to the focus on general digital competencies or on professors' digital competencies, according to Table 4 and Figure 2.

Table 4. Number of publications by categories and subcategories

Category	Subcategory		Publication Number
Measurement studies		Subtotal: 11	
	Digital Competence – General		5, 6, 8, 11 and 12
	Digital Competence – Educators		2, 3, 4, 7, 8 and 14
Instrument development studies		Subtotal: 3	
	Digital Competence – General		–
	Digital Competence – Educators		1, 10 and 13

Note: The publication numbers as indicated in the 1st column of Table 3.

Regarding the period, the first publications were observed in 2015, although the initial filter of the search was 2013, which coincides with the publication of DigComp 1.0 [43], developed with a focus on citizens’ general competences. The peak of publications occurred in 2016, coinciding with the publication of important European documents focused on the topic of digital competences [55]–[57]. It was also found that research did not grow over the years, even considering that in 2020 the COVID-19 pandemic led educators, at all educational levels and worldwide, to make use of technologies to support their teaching, due to the mass adoption of emergency remote teaching [31] which provoked diverse discussions about teaching staff’s digital readiness and competences.

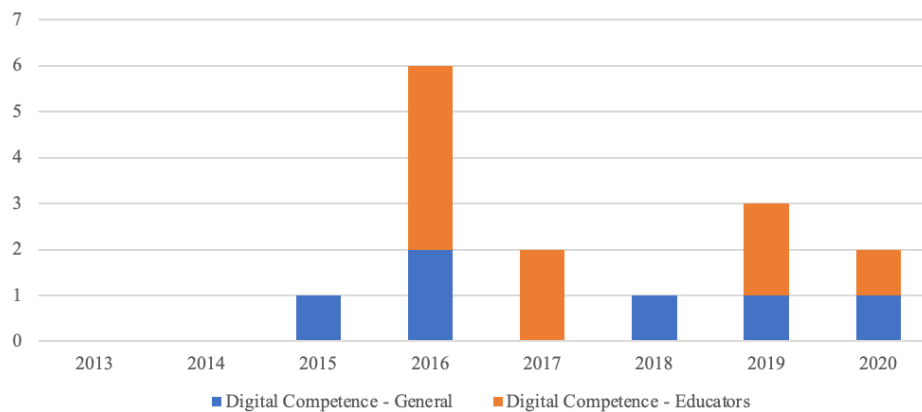


Fig. 2. Publications by subcategory according to the year of publication

3.3 Framework adopted as a reference

Of the 11 publications that aimed to measure digital competencies, only five explicitly refer to the adoption of a particular framework, listed in Table 5.

Table 5. Use of frameworks

Publication Number	Framework
2	TPACK [58]
3	INTEF 2017 [59]
4	DigComp 2.0 [57] and DigCap [60]
6	DigComp 1.0 [43]
7	DigCompEdu [18]

3.4 Methodological approaches and data collection tools

In the publications related to the measurement of digital competencies, several approaches and data collection instruments were used, either by adopting instruments previously developed by other researchers or by instruments specifically developed by the authors (*Ad Hoc*), as shown in Table 6.

Table 6. Methodological approaches and data collection instrument

Nº	Method	Instrument
2	Quantitative +qualitative	CSE – Computer Self-Efficacy [61]
3	Quantitative	Questionnaire to measure teachers’ digital competence (TDC) [62]
4	Quantitative	<i>Ad Hoc</i>
5	Quantitative	National research data analysis only.
6	Quantitative	Digital competence self-assessment toolkit [63]
7	Quantitative	<i>Ad Hoc</i>
8	Quantitative	ACUTIC – Cuestionario para el estudio de la actitud, el conocimiento y el uso de TIC [64]
9	Quantitative	National research data analysis only.
12	Quantitative	ACUTIC – Cuestionario para el estudio de la actitud, el conocimiento y el uso de TIC [64] and CEE – Cuestionario de Enfoques de Enseñanza [65]
11	Quantitative	ACUTIC – Cuestionario para el estudio de la actitud, el conocimiento y el uso de TIC [64]
14	Quantitative	<i>Ad Hoc</i>

With the aim of mapping the key concepts that support the objectives of this research, the stage 5 of the Arksey and O’Malley [42] literature review model was developed. This aims to understand the current state of knowledge around the topic, allowing us to establish indicators that provide paths or theoretical references for further research.

The study conducted by Sánchez, Sánchez, and Ramírez [54] identified that in the professors’ self-evaluation, of their own use of ICT, 57% of them refer that apply ICT “quite a lot” or “a lot” in their classes and 54% consider ICT “quite” or “very” important for the promotion of their students’ digital competence. The factor considered the most important was access to sources of information, and the least important was the expression of ideas through ICT. The virtual campus platform was still indicated as

the most used tool, but those considered Web 2.0 (Wikis, Social Networks, etc.) were declared as the least used.

With data collected by the institution's internal evaluation units [49], reported a massive use (80%) of the Learning Management System (LMS) and showed that it is considered useful by the majority of faculty (93%). Conversely, several tools, such as the real-time response systems (e.g., Cliqr), microblog (Bubbler), and video conferencing systems (Meetings), though integrated with the LMS, were reported as not used in the classroom by the majority of the respondents (80%).

In relation to the toolkits made available by the institutions, [48] demonstrated that 32% of faculty were unaware of them. Another 27%, despite stating that they know these, do not use them. In general, 26 of the 33 tools made available were reported as not used; the most used ones were the Virtual Learning Environment (VLE), anti-plagiarism software (e.g., Turnitin), presentation equipment, Facebook, Skype, and YouTube.

Three publications [33], [36] and [34] adopted the ACUTIC as the data collection instrument; this tool measures digital competence by considering the proficiency in three dimensions: attitude, knowledge, and use of ICT tools [64].

Guillén-Gómez and Mayorga-Fernández [33] point out above-average results compared to the publications of [66] and [67], identifying differences in technological level promoted by factors such as age, gender, professional category and years of experience. The results showed that the female gender presented a higher level in the knowledge dimension and the male gender in ICT use. A positive correlation was also identified between professors' participation in research projects and digital competence.

Mirete [36] found evidence of a positive attitude of higher education professors towards the inclusion of technologies in the classroom for the development of educational processes. However, the knowledge and use of ICT were limited to tools and resources which were more related to the daily tasks of information managing and processing. These data corroborate the findings of [49], who found that professors' use of the tools as "learning management system" or "organizational tool" are seen as established, but big deficiencies were detected in the use of tools for creating course materials. As stated by Mirete [36] points out even greater deficiencies in the production of digital educational resources (DER), and statistical data analysis directly linked to research activities. Mirete et al. [34] showed that professors that adopted pedagogical approaches focused on students' knowledge construction present higher levels of digital competence, as opposed to those who adopted an information transmission approach. Thus, the pedagogical approach emerges as a conditioning factor in the mastery of digital competence as well as in the use of ICT in teaching.

The research conducted by Evangelinos and Holley [50] pointed out that professors tend to use a number of different digital tools, mostly to create and reuse teaching content, at the same time that they demonstrate proper levels of knowledge regarding the legal implications of using digital media. However, the authors reflect on the negative effects of a relentless use of technology by professors, which can induce a type of "techno-stress that arises from endless information overflow that often acts sub-consciously" (p. 5). They also point out that digital technologies offering enhanced access encourage the culture where professors tend to be seen as an 'always on' or 'always available' person, bringing concerns about the continuous work-related flow of information on their private time and through their private devices (e.g., smartphones or tablets).

Biel and Ramos [47], adopting the as a framework [59], evaluated professors digital skills in two dimensions: knowledge and use of ICT. The scale used by the framework, which is structured around five areas, is composed of six levels, ranging from A1 (foundation level) to A2, B1, B2, C1 and C2 (advanced level). The results indicate a B2 level in both dimensions in the following areas: i. information and data literacy; ii. safety; and iii. problem solving; as well as level B1 in the digital content creation area. Regarding the communication and collaboration area, the results were different between the dimensions, obtaining a C1 level in the knowledge dimension, and a B2 level in the use of ICT.

Amhag, Hellström, and Stigmar [46] demonstrated the existence of an association between a high level in digital competences and the ability of creating digital content for online learning environments. They also found a relationship between a low digital competence and the digitalization of teaching as well as with a high need for training. Even so, the respondents who rated their digital competence as high (75.9%) also continue to indicate the need for training, i.e., even professors with a high level in digital competences consider training important.

The publication presented by Instefjord and Munthe [52] shows that in general professors have an average perception of their own digital competence (3.54 on a scale from 1 to 6 points). They recognize themselves as good role models for their students regarding their use of digital tools for teaching (3.90 on a scale from 1 to 6 points) and reveal a good understanding of the use of digital tools to promote students' learning.

Guillén-Gámez and Mayorga-Fernández [51], using an ad hoc instrument (ICT Resources to Teach, to Evaluate and to Research – PDC-TER), found that professors reveal a medium level of digital competence. For each dimension, professors obtained a medium-high level in the dimension 'to teach' and in the dimension 'to investigate', while in the dimension 'to evaluate', professors presented a medium level. In the predictive variables of the level of 'total digital pedagogical competence', it could be observed that the number of postgraduate degrees, projects and international stays correlate positively, while teaching experience (in years) correlates negatively.

Three publications were identified that aimed to validate data collection instruments. The instrument 'Competencia digital del profesorado universitario de las Facultades de Ciencias de la Educación Españolas' was developed and validated by Montoro, Lucena, and Rechein [2]. It was designed as a result of the review of similar studies; it involved several indicators and standards (national and international), thus not having a reference framework. As stated by Mengual-Andrés [53] the Delphi method was used to validate the CDES instrument previously developed by Mengual-Andrés [68], also built from different frameworks. Finally, Alarcón et al. [45] developed and validated the DIGIGLO, which considers external factors not included within the DigCompEdu, such as digital resources and support services that are available to educators in their working environment.

4 Discussion

From the literature review conducted, it was possible to conclude that research on digital competencies of higher education teaching staff is still at an early stage,

which corroborates the studies of [53] and [9]. It was also possible to indicate that the scientific community still needs to elaborate conceptual models that lead to more consensus around this topic.

These conclusions gain ground on various evidences from the studies under analysis: a wide distribution of publications in journals (n=11) and authors; the first publication in 2015, although the initial criterion was to find studies since 2013; 64.3% of publications are devoted to educators' digital competences, although a higher predominance was expected due to the fact that the population studied was composed of teachers/professors and also despite the wide range of frameworks available specifically for this purpose [18], [58], [59]; a low number of publications (n=5) that adopted a single framework as theoretical reference; and a considerable proportion of publications (21.4%) focused on the development and/or validation of new instruments.

The ubiquity of ICT has required education professionals to develop, preserve, and raise their level of teaching digital competence to thus improve the teaching-learning process and promote their students' digital competence. However, this ubiquity has proven to be relentless, inducing technological stress, which arises from the overflow of information and the inability to separate work-related and personal information, considering that both now reside on their private devices, thus creating conflicts in the work-life balance [13], [34], [50], [52], [69], a feeling that has grown in the last two years due to the pandemic scenario.

The predominance of the quantitative approach in the publications (n=11) can be explained by the use of questionnaires, which is favoured by the fact that the frameworks are organized in the format of proficiency levels [70].

The adoption of data collection instruments (quantitative) proved to be diverse, with the predominant use of four distinct instruments [61]–[64], with ACUTIC standing out, as it was used in three publications. Importantly, the ACUTIC instrument [71], aimed to study the attitudes of college students towards ICT, i.e. it assumes a population other than faculty.

Other publications chose to develop specific instruments [13], [48], [51] as shown in Table 6. In all these cases, they addressed professors' digital competences.

It is important to investigate the current state of the level of professors' proficiency in the digital domain with an adequate degree of precision and specificity in order to ascertain these levels in different areas. However, the multiplicity of descriptors and assessment instruments makes it more difficult to conduct more robust studies as well as meta-analyses which would allow a deeper statistical comparison between the results. This compromises the generalization and comparability of the results between investigations in the area [7], [47].

Currently, there are several frameworks focusing on teachers' digital competences that have instruments developed, such as TPACK and DigCompEdu, and these are used by the academic community worldwide, both for teachers in training [72], [73] and for in-service teachers [74] and in different school levels, even though not often on higher education.

Present in most classrooms, ICT has become an indispensable tool in academic practice. As stated by Durán et al. [75], however, its use in the teaching and learning processes has focused mainly on the digitization of educational content, preserving traditional methodologies, rather than taking advantage of collaborative environments

and other benefits that Web 2.0/3.0 enables. Multiple evidence in this sense were found in several of the selected publications [36], [48], [49], [54], such as the use of LMS as a mere resource for organization, administration and digitization of information, and the failure to effectively apply all the digital pedagogical tools that are made available by the higher education institutions.

The studies also showed differences when professors are evaluated on their knowledge and on their actual use of ICT, with the latter always being lower than the first. This leads to the conclusion that, in general, professors tend to know ICT tools, but do not use them in a way that really takes full advantage of them [47].

The studies by Amhag, Hellström, and Stigmar [46] found that even when teachers have a high level of digital competence (75.9%), they still indicate a need for training. In a complementary sense, as stated by Ramírez-Montoya, Mena, and Rodríguez-Arroyo [8], pointed out that training should be carried out considering different groups: those who already work with technological tools and digital materials, and those who use traditional forms of teaching and aspire to start introducing ICT into their classes.

The highest levels of digital competencies were associated with teaching approaches based on the promotion of students' construction of knowledge, that is, student-centred approaches. The higher levels of digital competencies also reveal a positive relationship with participation in research/innovation projects [33], [34], [52], [54], [76].

Higher education institutions have the incumbency of implementing digitization strategies for the promotion of the skills needed for the 21st century, whether technical, methodological or procedural. This consequently requires faculty members to be highly proficient in digital competences, so that they can promote equally high digital competences in their courses and on their students, which are essential to ensure students present and future employability. Today's business sector shows to be increasingly changing due to computerization and automation [49], [77].

As stated by Pereira, Ferenhof and Spanhol [69] the strategies for managing digital competencies developed by higher education institutions do not include all the relevant areas; some are lacking such as digital content creation and (online) security. The same idea was presented in some publications [36], [47], which identified greater deficiencies in areas related to the creation of learning materials and teaching resources. This deficiency is cause for great concern, given that nowadays, new course formats (e.g., Massive Open Online Course – MOOCs), content formats (e.g., Open Educational Resources – OER) and online teaching methodologies (e.g., interactive) are beginning to be increasingly present in undergraduate and postgraduate programmes, which requires digitally competent professors, not only in the use of online learning environments but also in the creation of digital learning resources [8], [69], [78]. Higher education institutions should strengthen faculty training in the digital domain if they aspire for their faculty to engage in OER production. A close relationship between the level of digital competences and the level of development of OER has been supported by the literature [8], [79].

Two publications on the development and/or validation of instruments for assessing digital competencies present limitations. The first one is related to the fact that the survey was developed specifically for professors of education science [2], and the second one related to the time in which they were developed [68] since it was developed a

decade ago. Several competencies considered essential today for teaching practice were not considered as so (e.g., the use of cloud computing solutions, learning analytics platform, web-based video conferencing systems).

The instrument developed and validated by Alarcón et al. [45], DIGIGLO, proved to be suitable for measuring teachers' digital competences with a focus on higher education. It is composed of eight areas, six based on DigCompEdu and two new ones referring to external factors (extrinsic digital environment and extrinsic digital engagement).

5 Concluding remarks

In order to map the current state of knowledge on the digital competencies of higher education professors in the European context, this study conducted a systemic literature review using a scoping review approach. The initial search resulted in 1,568 publications, and after applying all the recommended stages [40]–[42], duly described in the previous sections, 14 publications were selected.

Digital competence is now considered an indispensable skill for educators and is also partially responsible for the promotion of students' digital competence. Given its importance, it is at the centre of discussions of major global organizations such as UNESCO (ICT Competency Framework for Teachers), the United Nations (2030 Agenda for Sustainable Development) and the Council of the European Union (Key Competences and Digcomp framework).

Based on various evidence identified in this literature review, it can be stated that research on the digital competencies of higher education professors is still in an embryonic state. Half of the publications identified in this review focuses on general competencies. Even when it is applied to faculty, a large number of frameworks and different instruments are used to approach teachers' digital competencies creating diversity and incoherency in the research developed on this topic.

The use of several frameworks and surveys makes the statistical analysis of the global results and the determination of an overall proficiency level of European higher education professors an impossible task, which, consequently, impedes the development of more effective European public policies in the area of promoting initiatives that address the development of these competencies.

The digitalization of society, and consequently of education, has imposed the need to develop new skills and high levels of digital competencies on teachers, especially in higher education. This has brought a need for major reformulations in educational institutions, both in the digitalization of various academic and non-academic processes, as well as in ensuring proper physical and digital infrastructure and teacher training [80]. The process of teacher training must be preceded by a rigorous analysis of the levels of proficiency in digital competencies, so that this process can be carried out in the most personalised way possible. The offer should be made in different degrees of complexity, grouping teachers by different levels of competence, not only generally but also considering different areas of competence.

The results showed that, in general, professors are aware of the existence of digital tools provided by their institutions, and this demonstrates the institutions have invested in acquiring, adopting and promoting the use of ICT. However, a low effective use

of these tools has been found, which is understood to be related to the lack of digital competences for their use, or even the lack of knowledge of their functionalities and added value for the teaching and learning process. For example, the use of LMS has become widespread among higher education instructors, but these are mostly used as an organizational and administrative tool, serving, mostly, as a repository of digital learning resources with little or no interactivity.

At least three positive relationships can be established with digital competences: the adoption of a student-centred approach to teaching, the process of creating and using OER, and the involvement in research/innovation projects.

Through a scoping review process this study has outlined the current state of knowledge on the digital competencies of higher education teachers in the European context. However, some inner limitations can be pointed out to the study methodology: the use of a single database, EBSCO, and the search languages that leave out the research carried out in various European countries, namely in Northern Europe, where issues concerning the integration of ICT in teaching have become widespread in recent years. Therefore, new research should be carried out using other databases, as well as considering broadening the research contexts adopted in this article.

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