Digital Teaching Competence of University Teachers: Levels and Teaching Typologies

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Abstract—Today, university teachers need to have not only basic digital skills, but to be able to use technologies in teaching-learning processes, in their professional development and that of their students. This article focuses on analysing digital teaching competence (DTC), and exploring its dimensions based on the self-perception of a sample of 558 teachers from a Spanish university, following the European DigCompEdu framework. According to the results, university teachers perceive themselves to have an intermediate level of DTC. Technical and professional aspects were higher than the pedagogical ones and those that refer to the effect on student's digital competence. The ANOVA test did not show significant differences in DTC according to the academic position, but it did according to the scientific area. One of the most significant findings is that the DTC would not be a unitary construct; after the factorial analysis of the items, three categories were obtained that can constitute different teaching typologies: the inspiring teacher, the creator and the tutor. This study provides a new instrument to explore university teachers' level of DTC. Although this study is an exploratory one, it contributes to the debate on this competence by exploring the categories that underlie it, providing data that can be useful both at a scientific level and in the development of practices and policies for teaching improvement.

Keywords—digital competence, higher education, self-assessment, teacher training, didactic competence, professional development

1 Introduction

The use of information and communication technologies (ICT) in education has been a common practice on university campuses and classrooms for decades. In recent years, universities have stepped up their efforts, through institutional initiatives fostering digital transformation [1], to incorporate these technologies as means to modernise the management of their training processes and introduce innovation [2]. At the same time hybrid and flexible learning environments are becoming increasingly common [3]. The period of lockdown established in 2020 due to the COVID-19 pandemic and the subsequent gradual return to teaching activity has highlighted, more than ever, the need

for higher education institutions to have sufficient technological resources and, above all, the need for digital training for all members of the educational community [4]. Many authors and international institutions have stressed the importance of adequate digital competence among teachers [5]. However, despite the importance of this issue, the volume of literature dealing with this subject in higher education is significantly lower than that covering the pre-university level [6]. As highlighted in previous research [7], it is very relevant to have more investigations that analyse in-depth the level of digital competence of university teachers. University teaching staff is a highly heterogeneous group, both in terms of areas of specialisation and professional categories, in contrast to previous levels of education. Furthermore, and especially in universities with a Napoleonic tradition [8] such as the one in which this study is placed; there is an even wider variety in terms of teaching staff. In this specific type of university, the teaching staff also has a dual role of teacher and researcher, between which there is not always an appropriate balance [6]. The above situation impacts on selection processes as well as on teachers' career development. This further highlights the need to explore in-depth digital teaching competence (DTC), as well as possible differences between teachers, which is often considered in most studies as a unitary construct. This information is not only of interest in scientific terms, but also allows educational institutions to design and implement teacher training strategies for an increasingly digital world [9]. The purpose of this study is to provide a new instrument to explore university teachers' perception of their level of DTC that can be useful for teachers themselves and their professional development. Based on the described research gap above, this study seeks to contribute to the debate on this competence by exploring the teaching categories that underlie it and providing data about the level held by higher education teaching staff.

1.1 Digital competence and digital teaching competence

[10] defined digital competence as the set of skills, knowledge and attitudes required when using digital technologies in an effective, efficient, critical or creative way, whether for work, learning, leisure or participating in society. It is a competence identified as key [11], which everyone should develop throughout their training [12]. In addition to this generic digital competence for any citizen, different authors have highlighted the importance of digital competence in the field of teaching [13], [14], [15]. In this regard, digital teaching competence (DTC) comprises the set of skills, knowledge and attitudes required by teachers to promote student learning, in a digitally rich world, by designing and transforming classroom practices and enriching their own professional development [16].

[17] distinguished several different areas or dimensions that make up DTC, namely, (1) basic digital skills, i.e. information, communication or technological aspects; (2) competence in using ICT in teaching; and (3) lifelong learning strategies. In addition to these three major areas, other authors have also added, as part of the teachers' digital teaching competence, the capacity to empower their students and exercising their social commitment as educators [14], [18], as well as the ability to develop their students' own digital competence. There are also other frameworks that, at the institutional level and

in different contexts, have attempted to define this digital teaching competence [19], [20], such as the ISTE's teacher standards [21] or UNESCO's ICT competence standards for teachers [22]. Different countries have also promoted their own frameworks, such as the Chilean model [23], the British model known as DigiLit [24] or, in Spain, the Common Framework for Digital Competence for Teachers (Marco Común de Competencia Digital Docente) of the National Institute of Educational Technologies and Teacher Training (Instituto Nacional de Tecnologías Educativas y de Formación del Profesorado) [25]. More recently, for Europe, we find the European Framework for the Digital Competence of Educators (DigCompEdu), designed by the European Commission's Joint Research Centre (JRC) [26], which defines this competence in six areas: (1) professional engagement, which includes both collaborative work, communication, and professional and reflective development; (2) digital resources, i.e. their selection, creation, modification or management; (3) teaching and learning, which includes aspects of teaching, support, and collaborative and self-directed learning; (4) assessment, which includes strategies for evaluation, evidence analysis and feedback; (5) empowering learners, which incorporates aspects of accessibility and inclusion, personalised learning and active participation; and (6) facilitating learners' digital competence. This will be the framework that we will take as a reference in this study. According to [27], it was designed to fit the contexts of the different European countries and is sufficiently generic to allow it to be adapted to the different levels of education.

1.2 The digital teaching competence of university teachers

In a previous related work [7] a systematic review of the literature was conducted, providing a detailed account of the current status of DTC in university teaching staff. In relation to the level of DTC among university teachers, according to various studies, the vast majority of them rate themselves as having a medium or medium-high level in terms of their basic or technical digital skills [28], [29], [30]. This dimension includes skills related to the use of office automation tools, browsers and tools for sending files or communication by email. However, the educational use of social tools to communicate, or the capacity for multimedia audiovisual editing tends to reflect lower values [31], and even arouses certain reservations among teaching staff [32]. Similarly, lower scores are also observed in aspects related to security, data protection or the management of intellectual property [29]. Furthermore, some research has shown that, although teachers may have adequate technical skills, they are often inferior to those of their students [33]. With regard to pedagogical competence in the use of ICT, the levels achieved tend to be more varied. While some studies show that teaching staff have adequate competence in the design of online activities [34] or in the educational use of digital resources in teaching-learning processes [35], other research presents evidence running in the opposite direction. [36] or [37] showed that university teachers have low capacities for designing learning experiences enriched by digital tools, or for monitoring and assessing students through ICT. Likewise, [29] pointed out that teaching staff have low levels of use of ICTs for their own professional development, highlighting, for example, the lack of knowledge of online professional forums and

networks, and the scant use of repositories or spaces for exchanging teaching innovation experiences. In a similar vein, [35] pointed to the low level of knowledge and maintenance of their personal learning environments (PLE) by teaching staff. As regards the ability of teaching staff to develop the digital competence of their students, although a large number of university teachers believe that they encourage the use of ICTs among their students through collaborative work, online environments or by making use of bibliographic databases [38], there is a shared belief that students enter university with sufficiently developed digital competence and do not see the need to work on it in class [32]. In addition to the analysis of DTC according to the areas or dimensions it is made up of, several studies also analyse the differences that exist according to the type of university teacher. [39] showed that teachers in lower professional categories –assistant lecturers, assistants and associate lecturers –and with ages between 35 and 45, rate their level of competence higher than members of teaching staff with higher categories –senior lecturers and full professors –and are older (55-65). They also found significant differences in terms of the area of knowledge. According to these same results, university teachers in the Technical or Engineering field and Humanities have a higher level of self-perceived digital competence than those in the Social Sciences [39]. [38] analysed possible differences according to gender, age or teaching category, the only differences in the level of DTC being found exclusively according to age.

1.3 Research questions

This is an exploratory study and we have no prior hypothesis. This article attempts to answer the following research questions:

- What is the self-perceived level of DTC among university teachers?
- Are there any differences in teachers' DTC according to their professional category?
- Are there any differences in teachers' DTC according to the field of knowledge?
- What are the categories that underlie university teachers' DTC?

2 Method

2.1 Participants

This study was carried out during the academic year 2019-2020 at a medium-sized Spanish university. A non-probabilistic sampling was carried out and participants were selected by convenience sampling [40]. A total of 558 university teachers participated in it (48% women), which represents a sampling error margin of 4.5 and a reliability index of 99%. The average age of the teaching staff participating in the study was 45.6 years (SD = 9.42), with ages ranging from 24 to 68 years. In terms of professional categories, the following distribution was presented: full professors, 9.6%; senior lecturers, 28.1%; contract lecturers (PhD), 13.2%; postdoctoral assistant lecturers and pre-postdoctoral researchers, 18.8%; and associate lecturers, 30.3%. As regards the area

of knowledge, the following distribution was observed: sciences, 12.9%; health and behavioural sciences, 10.8%; engineering and architecture, 21.1%; law and economics, 19%; social sciences, 19.5%; and arts and humanities, 16.7%. The study was approved by the University's Ethics Committee and participation was voluntary, after signing an informed consent document outlining its purpose and assuring confidentiality.

2.2 Instruments

To collect the data, a self-perception questionnaire was designed for the university teachers, developed online with the LimeSurvey tool and hosted on a university server (available at XXXXXX). The design of the questionnaire was based on the European DigCompEdu framework [26], as well as on the versions developed by the JRC in the DigCompEdu Check-In and the CRUE (Conference of Spanish University Rectors), all of which were adapted to the context of the university itself. In addition to a first section in which the biodata were collected, the questionnaire had 22 items evaluated with a Likert-type scale from 1 (never) to 5 (always).To ensure that the items were understood by the potential users, two focus groups were organised (6-8 members per group), one with specialised teaching support staff and the other with university teachers. After these sessions, the wording of some items in the questionnaire was modified and it was administered to a pilot group of 61 university teachers, from the different areas of knowledge, obtaining a high reliability index (α= .94), according to Cronbach's alpha.

2.3 Analysis of the data

First, the basic descriptors (frequencies, means and standard deviations) of the different items and areas of the questionnaire were calculated. To compare the means among the different professional categories and among the areas of knowledge, an analysis of variance test (ANOVA) was performed. In the case of the areas of knowledge, the Tukey post-hoc test was carried out to determine which groups had significant differences between them. Finally, a factorial analysis was carried out with all the items of the questionnaire in order to explore previously unknown grouping of variables to seek underlying clusters [41] and the resulting categories were rotated using the varimax method to facilitate their interpretation. In addition, the KMO measure of sampling adequacy and the Bartlett sphericity test were run to determine the adequacy of the factor analysis. The IBM SPSS v. 25 software package was used to perform all the analyses in this study.

3 Results

3.1 The digital teaching competence of university teachers

According to the results obtained (Table 1), the university teachers obtained an overall average of 3.7 out of 5 (SD = .75) on their DTC, considering themselves to be close to "quite" competent. If we analyse the mean values of the constituent areas, it

can be seen that the teaching staff perceived themselves to be more competent in everything related to their professional engagement (M = 4.19, SD = .68). The areas of digital resources (M = 3.87, SD = .87), teaching and learning (M =3.75, SD = .90) and assessment (M = 3.82, SD = .96) lay in an intermediate position. The areas with lower scores, and greater dispersion in the results, had to do with empowering learners (M = 3.30, SD = 1.0) and facilitating their digital competence (M = 3.23, SD = 1.0), areas in which the average university teacher only considered themselves competent "sometimes".

Table 1. Percentage distribution and descriptive results of DTC

Items	1	2	3	4	5	M(SD)
1. Professional engagement (PE)						4.19(.68)
1. Digital communication	.2	.2	5.0	24.4	70.2	4.64(.60)
2. Collaborative work with ICTs	2.2	5.0	10.8	26.3	55.7	4.28(.99)
3. Critical reflection on ICTs	2.0	5.9	26.0	35.1	31.0	3.87(1.9)
4. Digital professional development	1.6	7.0	21.3	33.0	37.1	3.97(1.0)
2. Digital resources (DR)						3.87(.87)
5. Location and selection	.4	3.1	10.3	31.8	54.4	4.37(.82)
6. Creation of resources	5.9	11.8	22.9	29.9	29.5	3.65(1.2)
7. Sharing open contents	7.5	14.2	20.0	28.8	29.5	3.59(1.3)
3. Teaching and learning (T&L)						3.75(.90)
8. Planning digital teaching	2.2	7.1	21.4	33.6	35.7	3.93(1.0)
9. Tutoring and interaction	1.3	6.3	17.3	33.3	41.8	4.08(.98)
10. Fostering collaborative learning	5.0	14.1	21.5	35.0	24.4	3.60(1.2)
11. Encouraging reflection	7.1	18.0	24.1	28.2	22.6	3.41(1.2)
4. Assessment (A)						3.82(.96)
12. Using ICTs in evaluation	3.5	10.3	15.6	32.4	38.2	3.92(1.1)
13. Collecting digital evidence	4.6	12.7	23.7	30.4	28.6	3.66(1.2)
14. Using ICTs for feedback	2.8	9.4	20.6	32.2	35.0	3.87(1.1)
5. Empowering learners (EL)						3.30(1.0)
15. Tools for accessibility	10.2	17.0	24.3	27.4	21.1	3.32(1.3)
16. Personalised learning	10.4	18.7	26.6	27.5	16.8	3.22(1.2)
17. Fostering digital participation	7.9	15.5	27.6	28.1	20.9	3.39(1.2)
6. Facilitating learners' DC (FLDC)						3.23(1.0)
18. Facilitating information	6.6	12.8	27.5	29.6	23.5	3.51(1.2)
19. Facilitating communication	10.4	18.9	23.9	28.2	18.6	3.26(1.3)
20. Facilitating the creation of contents	20.2	23.7	22.1	19.8	14.2	2.84(1.3)
21. Facilitating well-being & security	15.5	21.4	24.9	23.1	15.1	3.01(1.3)
22. Facilitating problem solving	7.8	13.2	24.8	29.4	24.8	3.50(1.2)
Digital teaching competence (DTC)						3.70(.75)

Table 1 also shows the frequency of each of the items that make up the different areas, as well as their mean score and standard deviation. More than 94% of university teachers always or very frequently (values 4 or 5) use different digital channels to

communicate with their students and, similarly, more than 82% do so to work with other colleagues. Similarly, more than 86% always or almost always use different internet sites to select digital resources. However, and in this same dimension of digital content, about 22% never or hardly ever (values 1 or 2) share them by considering the possibility of using open licenses. As regards teaching and evaluation, more than 75% of the teaching staff interact and conduct tutoring in collaborative environments and over 70% of them use different evaluation tools. In contrast, only 25% rarely or never encourage students to use ICTs to reflect on their own learning. As for the items in the two areas with the lowest scores, around 50% of the teaching staff always or nearly always encourage active and creative student participation through digital media or teach students how to search for information and critically evaluate it. However, about 30% of university teachers never or hardly ever use ICTs to provide students with personalised learning opportunities. Finally, around 40% never or hardly ever design activities for their students to encourage them to create contents, nor do they teach their students to use ICTs in a healthy, safe and responsible manner. These two items had the lowest mean scores in the whole questionnaire, with 2.84 and 3.01 respectively.

3.2 Comparison of means in digital teaching competence

Firstly, we analyse the differences in teachers' DTC depending on their professional category. As can be seen in Table 2, the teaching staff with the highest scores are those in the group of associate or part-time lecturers (3.77), and that of postdoctoral assistant lecturers and contract lecturers (PhD) (3.72, in both cases). In contrast, senior lecturers (3.66) and, especially, full professors (3.50) are the groups with the lowest overall scores. Among the areas with the highest scores, it is worth highlighting professional engagement, which exceeds an average of 4 in all the professional categories. In contrast, it is worth noting a particularly low score in the area of empowering learners in the case of full professors (2.97) and facilitating learners' digital competence in the case of full professors (3.07) and senior lecturers (3.10).

Table 2. Descriptive results of DTC according to professional categories

	Full professor	**Senior lecturer**	**Contract lecturer**	**Assistant lecturer**	**Part-time lecturer**
	M (SD)	***M (SD)***	***M (SD)***	***M (SD)***	***M (SD)***
1. Professional engagement	4.09 (.77)	4.22 (.65)	4.20 (.75)	4.25 (.61)	4.16 (.71)
2. Digital resources	3.71 (.93)	3.85 (.91)	3.85 (.90)	3.97 (.78)	3.88 (.88)
3. Teaching and learning	3.61 (1.0)	3.76 (.90)	3.77 (.98)	3.62 (.91)	3.86 (.83)
4. Assessment	3.53 (1.2)	3.75 (.99)	3.84 (1.02)	3.99 (.99)	3.87 (.88)
5. Empowering learners	2.97 (1.2)	3.26 (1.1)	3.34 (1.06)	3.24 (1.0)	3.44 (.98)
6. Facilitating learners' DC	3.07 (1.1)	3.10 (1.0)	3.29 (1.02)	3.19 (.95)	3.37 (1.0)
Digital teaching competence	3.50 (.89)	3.66 (.76)	3.72 (.78)	3.72 (.73)	3.77 (.73)

Yet, from the results of the analysis of variance test (ANOVA), it was found that differences according to professional categories were not significant in the overall result of DTC nor in the areas that it is made up of.

Secondly, the differences in DTC were analysed according to areas of knowledge. As can be seen in Table 3, engineering and architecture (3.80) and social sciences (3.78) are the areas with the highest scores, while science (3.55) and law and economics (3.56) are the ones that obtain the lowest values. A one-way between subjects ANOVA was conducted to compare DTC level according to their areas of knowledge.

Table 3. Descriptive results of DTC and ANOVA results according to areas of knowledge

	Area of knowledge	**M**	**SD**	**F**	**p**
1. Professional engagement	Sciences	4.19	.74	1.555	.171
	Health	4.17	.70		
	Engineering	4.29	.62		
	Law	4.05	.74		
	Social sciences	4.22	.64		
	Arts	4.22	.65		
2. Digital resources	Sciences	3.87	.87	4.744	< .001*
	Health	3.84	.83		
	Engineering	4.13	.78		
	Law	3.57	.98		
	Social sciences	3.89	.80		
	Arts	3.88	.89		
3. Teaching and learning	Sciences	3.59	.95	.675	.642
	Health	3.79	.90		
	Engineering	3.78	.87		
	Law	3.73	.90		
	Social sciences	3.81	.88		
	Arts	3.79	.93		
4. Assessment	Sciences	3.54	1.0	2.441	.033*
	Health	3.89	.87		
	Engineering	3.95	.98		
	Law	3.71	.94		
	Social sciences	3.96	.93		
	Arts	3.81	.97		
5. Empowering learners	Sciences	3.11	1.0	1.037	.395
	Health	3.36	.96		
	Engineering	3.34	1.0		
	Law	3.18	1.1		
	Social sciences	3.36	.98		
	Arts	3.41	1.1		
6. Facilitating learners' DC	Sciences	2.95	1.0	2.948	.012*
	Health	3.09	1.0		

	Engineering	3.24	.99		
	Law	3.13	.96		
	Social sciences	3.46	1.0		
	Arts	3.35	1.0		
Digital teaching competence	Sciences	3.55	.80	2.131	.060
	Health	3.69	.70		
	Engineering	3.80	.73		
	Law	3.56	.78		
	Social sciences	3.78	.71		
	Arts	3.75	.78		

* Significant differences between groups.

According to the ANOVA test, although there are no significant differences in DTC at a general level according to the area of knowledge, some were detected in three of the areas it is made up of. The first was the area of digital resources [F (5, 552) = 4.744, P = < .001], in which, according to Tukey's post-hoc test, the engineering and architecture group scored significantly higher than the law and economics group. Differences were also detected in the area of assessment [F (5, 543) = 2.441, P = .033], with the social sciences group obtaining significantly higher values than the science group. Finally, significant differences were also detected in the area of facilitating students' DC [F (5, 537) = 2.948, P = .012], where the social sciences group obtained significantly higher values than the science group.

3.3 Analysis of the structure of digital teaching competence

A factorial analysis was then carried out on the 22 items in the questionnaire. The KMO measure of sampling adequacy was .96, while the Bartlett sphericity test was highly significant (p = < .001), indicating the adequacy of the factor analysis. By means of this latter, three categories were extracted and rotated with the varimax method. Table 4 shows the score of each of the items in the factor analysis, with factor loadings ranging from .59 to .77, as well as the values of the three categories, which account for more than 60% of the cumulative variance.

Table 4. Analysis of the categories according to the items of DTC

Item	Categories			Eigenvalue	Cumulative	Cronbach's alpha
	1	*2*	*3*			
C1. Inspiring teacher				10.560	60.25 %	.921
10. Fostering collaborative learning	.59					
11. Encouraging reflection	.66					
15. Tools for accessibility	.57					
16. Personalised learning	.67					
17. Fostering digital participation	.73					
18. Facilitating information	.66					
19. Facilitating communication	.65					
20. Facilitating creation of contents	.76					

21. Facilitating well-being	.77					
22. Facilitating problem solving	.69					
C2. Creator				1.628		.859
2. Collaborative work with ICTs		.60				
3. Critical reflection on ICTs		.60				
4. Digital professional development		.65				
5. Location and selection		.62				
6. Creation of resources		.69				
7. Sharing open contents		.66				
8. Planning digital teaching		.61				
C3. Tutor				1.068		.822
1. Digital communication			.61			
9. Tutoring and interaction			.68			
12. Using ICTs in evaluation			.63			
13. Collecting digital evidence			.63			
14. Using ICTs for feedback			.62			

As can also be seen in Table 4, these categories are not consistent with the areas of the DigCompEdu model itself, although they do have a high internal consistency, ranging from .822 to .921. After analyzing the approach of each of the items, three denominations were proposed (inspiring teacher, creator and tutor), which can give rise to different types of teachers and will be addressed in more detail in the discussion.

4 Discussion and conclusions

This study has focused on analysing university teachers' self-perception of their digital teaching competence based on the DigCompEdu framework. In relation to the first research question, university teachers perceived themselves as having an average general level, with special emphasis on technical and professional aspects, as opposed to pedagogical aspects and those related to transferring these outcomes to their students. As also occurred in the studies conducted by [28], [29] or [30], members of teaching staff often use technology to work with other colleagues, communicate with their students and locate resources. Nevertheless, aspects such as using ICTs to cater for student diversity, ensure accessibility or tailor learning opportunities all need to be improved. According to [42], empowering university students goes beyond teachers taking accessibility issues into account in the design of materials or in the use of certain platforms. This is undoubtedly fundamental, but following the approaches of these same authors, it is also necessary to consider the students' digital competence, that is, to ensure that they are familiar with the technologies and have suitable strategies and levels of confidence to be able to use them adequately. Yet, promoting learners' digital competence does not seem to be a dimension of competence that is generally carried out by university teachers [32], perhaps because it is assumed that they enter university sufficiently prepared in this area.

To answer the second question, possible differences in DTC according to the professional category were explored. According to the results, associate, assistant and contract lecturers obtained higher results than senior lecturers and full professors, which are similar to the findings presented by [39]. Nevertheless, after analysing the differences, they were not found to be statistically significant. These data seem to be in line with those presented by [43], who stated that factors such as professional category or age are not determining factors in the use of ICT.

The third research question focused on analysing possible differences according to the field of knowledge. As described in the results, teachers from engineering and social sciences had higher scores than those from science, law and economics. This result was statistically significant in certain areas related to their students' pedagogical use of such technology and their digital competence. Other studies, such as those by [39] or [44], also highlighted the more technical digital skills of engineering teachers. However, depending on the scientific field, they present different results in terms of the use of ICTs for educational purposes. These results show, beyond the actual value in the context of study, the wide range of levels of competence of teaching staff at a global level, as well as their need for pedagogical training, as suggested by [36]. Although it was not the main focus of the study, possible differences according to gender were also analysed. Similar to previous studies, no significant differences were found [45]. In relation to the fourth research question, the possible categories underlying university teachers' DTC were analysed. After conducting the factor analysis, three categories were obtained, which were highly consistent, but did not coincide with the areas of the DigCompEdu model [26]. This may be because, although the DigCompEdu model is a widely used framework in Europe, it is essentially constructed in a theoretical manner. These theoretical constructs, developed by the Joint Research Center of the European Commission, are based on the aggregate analysis of previous literature and expert review. However, we believe that it is necessary to deepen in a critical vision of the areas that make up the competencies, as well as in their analysis and validation in terms of research. These types of institutions generate frameworks that are instantly adopted by national and local administrations, which makes the analysis of these models even more relevant. From an analysis of the items, they are composed of, they could indicate three types of teachers according to our results. On the one hand, the inspiring teacher, who encourages his or her students to participate and carry out activities using ICTs. This approach may have some similarities with transformative teaching, in which the teacher, assuming the role of facilitator, not only fosters learning and knowledge acquisition, but also their students' personal development and attitudes towards learning [46]. As proposed by [47], it is a volitional type of learning, based on curiosity, which must be aided by the teacher who, through discovery, generates a certain feeling of 'discomfort' that drives knowledge. It is a theoretical approach that makes a lot of sense in practices that are based on collaboration and enriched by ICTs [48]. On the other hand, there is the creative teacher (creator), who generates digital artefacts and uses technologies to create and share resources. To a certain extent, this is a concept of the educator linked to the figure of craftsman proposed by [49], in an increasingly digital world [14]. In this sense, digitally competent university teachers must be capable of generating and managing emerging teaching practices and enriched digital content. And

the ICTs, which have promoted phenomena such as the maker culture, are an excellent arena for learning and professional development, reducing the learning curve through interaction with the community, with which materials, videos and advice are shared through networks and forums [50]. Finally, the tutor is one who interacts with, accompanies, evaluates and follows up the work of his or her students. As proposed by [51], digital technologies, such as social networks, allow for a great deal of interaction between teachers and students, which can have a clear impact on the learning process of the latter. There are also other technologies, such as digital portfolios, virtual environments or simulations, which can be useful to assess learners' competences [52]. Through these media, teachers can supervise student activity, facilitate reflective thinking and establish a greater relationship based on trust [53]. As mentioned in the introduction, Spanish universities bring together a wide variety of teaching profiles. Moreover, the teaching function is not always valued at the same level as research [6], generating an even broader profile of teaching staff. Digital technologies are a key factor in shaping alternative professional scenarios, transforming teachers' performance and leading to the updating of existing competences and new professional roles [36]. Notwithstanding this, frameworks defining DTC often have a restrictive conception of the definition of competence (analytical and decontextualised) as well as an instrumental view of technology [14], which impedes the visibility of this variety of profiles. However, as shown above, the teacher's digital profile is not a unitary construct. DTC frameworks and questionnaires can be useful if they are able to reflect these nuances; they must provide a contextualised and formative approach to help teachers, support teacher empowerment and accountability as well as promote teacher ownership [27]. This research has a number of limitations that could be addressed in future research, especially in relation to the sample of participants. Although the sample size allows for a representative image of the university under study, future lines of research could extend this instrument to other Spanish or international universities. On the other hand, the questionnaire used is a valid and reliable instrument for analysing this competence in this context, although, like many of the instruments currently employed, it is based on the teachers' own self-perception. While self-perception is undoubtedly an important element and one which needs to be taken into account, it also has its limitations and biases. In future lines of work, this information should be complemented with other evaluation instruments and strategies in order to have a more complete picture of the actual level of university teachers' DTC. Additional future considerations would be related to addressing whether the instrument used in this study would obtain similar results when applied in different contexts within higher education, such as public or private universities.

To sum up, this study is an exploratory one, but it shows a first validation of a new instrument to explore university teachers' level of the DTC assessment questionnaire, in which an exploratory factor analysis was carried out to detect structures and commonalities in the relationships between variables [41]. The present analysis allowed the extraction of three categories, which were interpreted as typologies of teaching. However, it could be complemented in future research by further analysis through structural equation modelling to analyse the relationships in depth, as well as to determine the multiple directions of causality.

Despite these limitations, the results of this research have important implications at several levels. On the one hand, they suggest that, although university teachers are generally digitally competent, aspects such as their use for teaching/learning purposes, student empowerment and the development of their digital competence are aspects to which the university should pay more attention through teacher training programmes [36], [54]. The differences that exist between the different groups, although they should be taken into account in the development of these training plans at university level, do not seem to be generalisable beyond this local context. On the other hand, this study also offers the scientific community and staff responsible for teachers' professional development a new instrument, based on self-perception, for exploring this competence in the university domain. As mentioned above, most of the literature and evaluation instruments continue to be clearly focused on pre-university settings [6], [55]. Although this trend is beginning to revert [38], this instrument can be useful in the analysis and debate on this digital teaching competence at universities. This research has intended to offer a source of information on aspects of digital competence in the university context that contribute with valuable knowledge to both researchers, teachers and decision-makers. From a practical viewpoint, the findings provide an understanding of the DTC in university teachers that can be useful both at a scientific level and in the development of practices and policies for teaching improvement. At the same time, it contributes to the debate on this competence by exploring and highlighting the importance of the categories that underlie it. While the research herein has been in Spain these findings are also relevant to other contexts.

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