Digital teaching competence of university teachers: A comparative study at two European universities

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This study analysed the level of digital competence of 910 university teachers at one Spanish and one Polish university, using a self-perception questionnaire based on the DigCompEdu framework. For this purpose, a quantitative methodology was used with the aim of finding out the situation at both institutions through focusing on gender, professional category, and areas of knowledge of the participants. The results showed that the university teachers generally perceived themselves as having an intermediate level of digital competence. In this sense, it was observed that the elements selected for analysis (university, gender, and professional category) can have direct implications for the results and that there are significant differences depending on the group to which they belong.

Implications for practice or policy:

- Digital teaching competence need to be improved in the university context.
- Gender influences the self-perceived level of digital teaching competence and this needs to be considered in the university practices and policies.
- University teachers at the levels of junior lecturer and teaching assistant show better digital teaching competence and this needs to be considered in the university practices and policies.

Keywords: digital teaching competence, digital competence, DigCompEdu framework

Introduction

It is becoming increasingly important that, as higher education institutions transform from face to face lectures to predominantly online, universities migrate towards better digitisation processes (García-Aretio, 2019). As indicated by Crawford et al. (2020) with the pandemic resulting from COVID-19, this need has been even more visible and evident, and consequently, the digital transition of universities has been accelerated. However, as already indicated by the United Nations Educational, Scientific and Cultural Organization (UNESCO) (2011), a process of institutional digitisation is of little use if it is not accompanied by the appropriate digital skills on the part of education professionals. All staff involved in educational processes and institutions, including teachers, must have these skills in order to be able to make good use of the tools in the teaching and learning process. It is therefore of utmost importance that university teachers develop an appropriate level of digital teaching competence (DTC), which in turn, has a positive impact on students, who develop their digital skills as a result (Llopis et al., 2021).

Nevertheless, how can DTC be defined in today's context? There is no single, clear definition for the concept of DTC. There are several frameworks and models developed by institutions and scholars of the subject, that attempt to describe and qualify DTC (Falloon, 2020). Broadly speaking, DTCs are an umbrella of skills, abilities, and knowledge to make use of digital technologies in teaching and learning processes (Caena & Redecker, 2019). In this sense, it would be useful if DTC were a requirement to be able to work as a teacher (Cela-Ranilla et al., 2017). One of the most widely used reference frameworks in Europe is DigCompEdu, which although not designed exclusively for university teachers, is generic enough to be adapted to the specific needs of the context (Redecker & Punie, 2017). It should also be noted that there are more and more proposals promoted by both public and private organisations that seek to go beyond frameworks and models, and develop tests, tools, and training plans for teachers' DTC (Durán, et al., 2019). Therefore, in broad terms DTC can be defined as a set of skills, attitudes, and knowledge that teachers must develop in order to facilitate students' learning processes and also to support them in their corresponding learning development (Gisbert et al., 2016). It was defined in a similar way by Krumsvik as early as 2012,

who considered that being a digitally competent teacher implied having the ability to use digital technologies in a professional context based on appropriate pedagogical and didactic criteria, which in turn has direct implications on the learning strategies and digital training of students.

Literature review and theoretical framework

The teacher's digital competence

Digital technologies are increasingly present in daily life, a fact that has also translated to education. It is increasingly common to find digital technologies in teaching and learning processes, and this implies the need for teachers to develop DTC specific to their area of knowledge (UNESCO, 2013). Moreover, in the last 2 years, the COVID-19 pandemic has required the digitisation of teaching and learning processes. The consequent gradual return to face-to-face and hybrid scenarios, and the importance of teachers developing an adequate DTC has become even more apparent (Perifanou et al., 2021). It is clear that digitally competent teachers are needed to cope with the change in daily life and in education (Sjöberg & Lilja, 2019).

Although there is no single definition of the concept of DTC, several institutions and researchers who have developed their frameworks and models to try to describe it in depth (Caena & Redecker, 2019). Some examples are the International Society for Technology in Education (ISTE) teacher standards (2017), the UNESCO ICT competence standards for teachers (2018), the British DigiLit model (Fraser et al., 2013), and the Common Framework for Digital Teaching Competence in Spain (Instituto Nacional de Tecnologías Educativas y de Formación del Profesorado [INTEF], 2017). At the European level, one of the most recognised and widely used frameworks is the DigCompEdu, proposed by the Joint Research Centre, a body which is part of the European Commission (Redecker & Punie, 2017). This framework considers the DTC as the sum of six areas, which are described in Table 1.

Table 1
DTC elements/areas according to the DigCompEdu framework (Redecker & Punie, 2017)

Area	Definition
Professional commitment	Mastery of digital technologies for communication, collaboration, and professional development.
Digital resources	Creation, search, exchange, and management of digital content.
Teaching and learning	Management, organisation, and use of digital technologies in teaching and learning processes.
Evaluation and feedback	Use of digital technologies and strategies in order to improve evaluation and feedback processes.
Student empowerment	Use of digital technologies in order to improve inclusion, personalisation, and active engagement of students and their own learning.
Development of students' digital competence	Empowerment of students to creatively and responsibly use digital technologies for information, communication, content creation, well-being, and problem solving.

The DigCompEdu framework was used as reference in this study, since it was proposed with the intention of serving as a reference for all European countries, as well as being sufficiently generic to be adapted to specific contexts (Caena & Redecker, 2019). In addition, it is important to keep in mind that there are other frameworks and models that address DTC and this shows the interest that exists in this topic. One of the most popular models is TPACK, which considers that in order to integrate technologies in teaching and learning processes it is necessary to have knowledge about: (1) technology, (2) pedagogy, and (3) content (Mishra & Koehler, 2006). There are recent papers, such as Miguel-Revilla et al. (2020), which showed the usefulness of the TPACK model with trainee teachers. Saubern et al. (2020), noted that although much has been published on the subject, it is still essential to continue research in this area.

The digital teaching competence of university teachers

In recent years, universities have not escaped of the digitisation described above, which is why higher education institutions have increased their efforts towards digital transformation (Castro et al., 2020). However, the transition process towards this new digitised environment is uneven and the speed and actions to achieve it depend mainly on each institution (Llopis et al., 2021). For example, there are institutions that choose to carry out training in course format for their teachers (Basantes-Andrade et al., 2020; Guayara-Cuéllar et al., 2019), while other universities prefer to opt for more active training proposals and rely on reflective practice, as noted by Bastida-Bastida (2019) and Nascimbeni et al. (2019).

Some research that focuses on assessing the level of DTC of university teachers concludes that it requires improvement. For example, Domingo-Coscollola et al. (2020) concluded that the level of DTC of university teachers is deficient and should improve in what they call instrumental digital competence and methodological digital competence. Suárez-Rodríguez et al. (2013) considered that university teachers had an average level of DTC, and that they had more skills related to the tools themselves than to their integration in the teaching and learning processes.

Regardless of the strategy chosen, the DTC level of university teachers depends on the area or skills on which they focus their attention. When the focus is on basic and technical digital skills, such as the use of office programs, browsers, and tools for sending files, their DTC level tends to be medium or medium-high (García et al., 2013; Orozco et al., 2016). On the other hand, if the attention is directed towards areas of the DTC centered on the integration of these technical skills in the production of content for use in teaching and learning processes or the management of security and data protection, their level tends to be rather low (Flores & Del Arco, 2013; Orozco et al., 2016).

With regard to pedagogical skills for the use of digital technologies, levels tend to vary. With regard to pedagogical skills for the use of digital technologies, levels tend to vary. There is a wide spectrum of research, for example in their study, Montor et al. (2015) considered that the participating teachers had good skills for the use of digital resources in teaching and learning processes. However, there is also research that provides contradictory evidence. For example Pozos and Tejada (2018) found that the participating university teachers in their study had low capacity for designing teaching and learning processes enhanced with digital technologies and evaluation processes using digital tools. In some cases, the differences not only depended on the skill that is the focus of attention, but also on: (1) the area of knowledge, with those belonging to the sciences and humanities coming out better and those in the social sciences areas lowere; and (2) age and professional category, with the youngest and with lower categories reporting higher levels of DTC (Tolic & Pejakovic, 2016). In part, this heterogeneity in the level of development or in the areas that make up the DTC may be due to the fact that, although the importance of developing the DTC at the university level is evident, most of the frameworks and models previously presented focus exclusively on pre-university level (Durán et al., 2016). For this reason and, as previously mentioned, this paper took the DigCompEdu (Redecker & Punie, 2017) as a reference.

This study therefore aimed to analyse the self-perceived DTC level of university teachers in two European universities, with similar characteristics, in order to be able to understand the current situation in these contexts. The following research questions will be answered:

RQ1. What is the DTC level of university faculty according to their self-perception?
RQ2. Are there significant differences in the perception of DTC according to university?
RQ3. Are there significant differences in the perception of DTC according to gender?
RQ4. Are there significant differences in the perception of DTC according to professional category?
RQ5. Are there significant differences in the perception of DTC according to area of knowledge?

Methodology

Context

This research was carried out in 2020 and 2021, in two European universities, one Spanish and the other Polish, both being of medium size, with approximately 15,000 students and 1,300 to 1,400 teachers each.

At the contextual level, there were certain differences. In Spain, as in France, Greece, and Turkey, the main teaching position is that of civil servant, which is obtained after passing a public competition. This civil servant status is not the usual one in Poland and other countries such as Croatia, Switzerland, Albania, and Norway, where permanent or temporary contracts are more common. Also, in Poland the teaching profession is regulated by its own legislative framework that establishes admission systems, functions, and remuneration (European Commission, 2018).

In addition, full-time or part-time work at university also differs across Europe. While in some countries, such as Germany, Austria, Slovenia, and Switzerland, 60% to 80% of academic staff work part-time, in other countries, such as Greece, France, Italy, and Poland, part-time employment is non-existent or very rare. In the case of countries such as Spain the percentage is between 30% and 60%. Specifically, in Poland, the percentage of part-time is 4%, in Spain it is close to 34% (European Commission, 2017). According to the same sources, full-time teaching staff in Spain usually teach between 180 and 240 hours per year, with slight variations depending on professional category and research activity. In Poland, teaching staff teach between 120 and 540 hours per year, depending on the professional category.

Regarding the distribution of teaching staff by gender, the figures in the two universities were quite similar. Overall in Spain the proportion of female academic staff was 42.5%, while in Poland it was 44.4%. However, the proportions of professor vary, with Poland having a ratio is one female professor in five, and Spain, one in three as at 2016 (European Commission, 2017).

Participants

The sample was accessible and incidental, comprised of participants who volunteered to answer the questionnaire, administered uniquely and by online channel. A total of 910 university teachers participated: 491 (54%) were from the Spanish university and 419 (46%) from the Polish university. The sample represented approximately 30% to 35% of the population each university. In the Spanish university, taking into account the size of the population and with a margin of error of 4.8%, a confidence level of 99% was obtained. In the Polish university, with a margin of error of 4.6%, the confidence level was 98%. The minimum age of the participants was 24 and the maximum was 80, with a mean age of 45.7 years. By gender, in both cases there were more men than women: 52.5% in the Spanish university and 68.7% in the Polish university.

Regarding the distribution by professional category, in the Spanish university there were 8.7% full professors, 25.7% associate professors, 21.6% senior lecturers, 10.4% junior lecturers, and 33.6% other participants, made up of mostly part-time professors and with an exclusively teaching role. In the Polish university there were 14.3% full professors, 22% associate professors, 49.9% senior lecturers, 10% junior lecturers, and also 3.8% other. In relation to the area of knowledge, in the Spanish university there were 12.4% sciences, 10.6% health, 21.2% engineering, 38.3% social sciences, and 17.5% arts and humanities teachers. In the Polish university there were 35.1% science, 49.9% engineering, 12.2% social sciences, and 3.8% arts and humanities teachers. The sample distribution is shown in Table 2.

Table 2
Distribution of the sample

		Spain		Poland		Total	
		N	%	*N*	%	*N*	%
Gender	Male	258	52.5	288	68.7	546	60
	Female	233	47.5	131	31.3	364	40
Professional category	Full professor	43	8.7	60	14.3	103	11.3
	Associate professor	126	25.7	92	22	218	24
	Senior lecturer	106	21.6	209	49.9	315	34.6
	Junior lecturer	51	10.4	42	10	93	10.2
	Other	165	33.6	16	3.8	181	19.9
Knowledge area	Sciences	61	12.4	147	35.1	208	22.9
	Health	52	10.6	0	0	52	5.7
	Engineering	104	21.2	209	49.9	313	34.4
	Social sciences	188	38.3	47	11.2	235	25.8
	Arts and humanities	86	17.5	16	3.8	102	11.2

Instrument and data analysis

To carry out the data collection process, a self-perception questionnaire of university teachers' DTC developed by Llopis et al. (2021) was used. The questionnaire had 22 items that were evaluated using a Likert scale from 1 (*never*) to 5 (*always*), and the results were grouped into the 6 dimensions of the DigCompEdu framework. Prior to the 22 items, a demographics section was included. These six dimensions were grouped into three larger blocks: (1) professional engagement (PE, dimensions 1 and 2), (2) pedagogical competences (PC, dimensions 3 and 4), and (3) students' competences (SC, dimensions 5 and 6). The Cronbach's alphas in this study were for PE ($\alpha = .80$), PC ($\alpha = .89$), SC ($\alpha = .89$), and DTC total ($\alpha = .94$). Data collection was carried out virtually by means of an online form. For privacy and data management, the questionnaire included the informed consent of the participants.

Analysis of the data obtained was carried out using the SPSS statistical program, Mac version 25.0. The data collected at the two universities were combined in the same database, and the means, percentages, frequencies, and typical distributions (RQ1) were calculated. For the analysis of possible differences, the nonparametric Mann-Whitney U test (RQ2 and RQ3) and the Kruskall Wallis H test (RQ4 and RQ5) were performed, as well as the Bonferroni post hoc test. To deepen this analysis and to be able to compare between groups, the effect size was also calculated (Green & Salkind, 2008).

Results

Descriptive results of the university teaching staff's DTC

The following table (Table 3) shows the mean scores and standard deviations for digital teaching competence for the different dimensions, both for the participants as a whole and according to the corresponding university.

Table 3
Results by dimension

	Spain		Poland		Total	
	M	*SD*	*M*	*SD*	*M*	*SD*
Professional commitment	4.19	0.69	3.87	0.56	4.05	0.65
Digital resources	3.86	0.88	3.66	0.74	3.77	0.82
Teaching and learning	3.75	0.90	3.71	0.76	3.73	0.84
Evaluation and feedback	3.82	0.96	3.66	0.76	3.75	0.87
Student empowerment	3.31	1.04	3.49	0.86	3.39	0.96
Development of students' digital competence	3.23	1.01	3.23	0.87	3.23	0.95
Total DTC	3.70	0.75	3.61	0.60	3.66	0.70

Total combined DTC obtained an average value of 3.66 out of 5. The dimension with the highest score was professional commitment (4.05), while the lowest scores corresponded to the effect or action of the DTC on student empowerment (3.39) and the development of student digital competence (3.23). In the middle were the remaining dimensions that, according to the European framework, relate to pedagogical competencies, that is, digital resources (3.77), teaching and learning (3.73), and evaluation (3.75).

A comparative analysis of the results of both institutions showed a slightly higher average total score for the Spanish university (3.70) compared to the Polish university (3.61). However, this did not apply to all dimensions. In the dimensions of professional commitment (4.19 and 3.87, respectively), digital resources (3.86 and 3.66), teaching and learning (3.75 and 3.71), and evaluation (3.82 and 3.66), the Spanish university scored higher. In empowering students (3.31 and 3.49) and facilitating the development of their own DTC (3.23 and 3.23), the distribution was reversed, with the Polish university scoring higher.

Table 4 shows the results according to participant gender. The total DTC was higher for women (3.73), compared to the overall value for men (3.61). This distribution, with higher scores for women, was the same in all the dimensions that made up the DCT: higher in the dimensions of evaluation and professional commitment, and lower in digital resources.

Table 4
Results by gender

	Male		Female	
	M	*SD*	*M*	*SD*
Professional commitment	3.99	0.66	4.15	0.62
Digital resources	3.76	0.83	3.77	0.82
Teaching and learning	3.67	0.85	3.81	0.82
Evaluation and feedback	3.66	0.88	3.87	0.85
Student empowerment	3.35	0.94	3.46	0.99
Development of students' digital competence	3.19	0.95	3.28	0.94
Total DTC	3.61	0.69	3.73	0.68

Next the DCT was analysed according to the professional category of the teaching staff. As shown in Table 5, the highest values of DCT corresponded to junior lecturers (3.78) and other (3.73), while the lowest belonged to full professor (3.54) and associate professor (3.60). Junior lecturers scored the highest in all the areas that made up this dimension, with the exception of the teaching and learning dimension, which was surpassed by the other professional category, which was made up of teaching assistants and part-time teachers. The full professor category had the lowest score in all areas, except for digital resources and facilitating student digital competence, where the associate professor category had the lowest scores.

Table 5
Results by professional category

	Full professor		Associate professor		Senior lecturer		Junior lecturer		Other	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Professional commitment	3.96	0.61	4.05	0.64	4.01	0.62	4.18	0.63	4.11	0.72
Digital resources	3.73	0.77	3.71	0.85	3.75	0.76	3.89	0.88	3.83	0.89
Teaching and learning	3.59	0.79	3.69	0.85	3.73	0.84	3.78	0.87	3.82	0.84
Evaluation and feedback	3.51	0.88	3.67	0.89	3.75	0.82	3.98	0.92	3.83	0.89
Student empowerment	3.28	1.02	3.34	0.96	3.41	0.92	3.49	1.00	3.45	1.00
Development of students' digital competence	3.15	0.92	3.10	0.94	3.24	0.90	3.35	0.96	3.33	1.03
Total DTC	3.54	0.66	3.60	0.70	3.65	0.65	3.78	0.72	3.73	0.74

Finally, the DTC was analysed according to the area of knowledge of each of the participants. As shown in Table 6, the highest average DTC score corresponded to the teachers in arts and humanities (3.75), followed by those in health (3.68) and social sciences (3.68). The lowest scores were observed for teachers in the areas of sciences (3.61) and engineering (3.63). Professional commitment was the dimension with the highest average score for all areas of knowledge, also being also the highest in arts and humanities (4.19)

and health (4.17). On the contrary, the facilitating student digital competence dimension was the one with the lowest mean score in all knowledge areas, also being the lowest in sciences (3.18) and health (3.13).

Table 6
Results by area of knowledge

	Sciences		Health		Engineering		Social sciences		Arts and humanities	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Professional commitment	4.00	0.62	4.17	0.71	3.98	0.63	4.11	0.67	4.19	0.64
Digital resources	3.72	0.79	3.85	0.83	3.81	0.77	3.71	0.88	3.81	0.92
Teaching and learning	3.69	0.80	3.74	0.90	3.69	0.81	3.77	0.87	3.81	0.91
Evaluation and feedback	3.64	0.81	3.87	0.88	3.71	0.84	3.84	0.91	3.79	0.99
Student empowerment	3.44	0.87	3.33	0.96	3.37	0.95	3.36	1.02	3.49	1.09
Development of students' digital competence	3.18	0.90	3.13	1.00	3.19	0.93	3.27	0.96	3.38	1.02
Total DTC	3.61	0.64	3.68	0.71	3.63	0.67	3.68	0.72	3.75	0.78

Analysis of the differences in the DTC of university teachers

The results of the Mann-Whitney U test which was used to check for possible significant differences according to the type of university and gender are presented in Table 7. In relation to university type, the Spanish university faculty perceived themselves as having a significantly higher DTC in the dimensions of professional commitment, digital resources, evaluation, and total DTC. The Polish university faculty perceived themselves as having a significantly higher level in the dimension of empowering the student. However, the effect size (*r*) of all these significant differences turns was small (< 0.3). As for gender, women perceived themselves as having significantly higher levels of DTC than men in the dimensions of professional commitment, teaching and learning, evaluation, and empowering the student, as well as in total DTC. Similarly, the significant differences were very low according to the effect size values.

Table 7
Mann-Whitney U regarding type of university and gender

	University				Gender			
	Mann Whitney U	*Z*	*p*	*r*	Mann Whitney U	*Z*	*p*	*r*
Professional commitment	71669.50	-8.11	**0.00**	**0.27**	84479.00	-3.86	**0.00**	**0.13**
Digital resources	85557.00	-4.55	**0.00**	**0.15**	98764.50	-0.11	0.91	0.00
Teaching and learning	97507.50	-1.21	0.23	0.04	88291.00	-2.50	**0.01**	**0.08**
Evaluation and feedback	87729.50	-3.62	**0.00**	**0.12**	84024.00	-3.56	**0.00**	**0.12**
Student empowerment	90750.50	-2.34	**0.02**	**0.08**	86808.50	-2.27	**0.02**	**0.08**
Development of students' digital competence	100091.00	-0.12	0.90	0.00	90304.00	-1.58	0.11	0.05
Total DTC	93206.00	-2.64	**0.01**	**0.09**	88058.50	-2.91	**0.00**	**0.10**

The results of the Kruskal-Wallis *H*-test for possible significant differences according to professional category and area of knowledge are shown in Table 8. According to professional category, the differences found in the dimensions of professional commitment and evaluation, as well as in Total DTC, were significant. Similarly, regarding the area of knowledge, the differences obtained in the dimensions of professional commitment and evaluation were significant. As indicated by the epsilon coefficient (*E*), the effect size of all these significant differences was also small.

Table 8
Kruskal-Wallis H test for professional category and area of knowledge

	Professional category				Knowledge area			
	Kruskal-Wallis H test	*df*	*p*	*E*	Kruskal-Wallis H test	*df*	*p*	*E*
Professional commitment	10.39	4	**0.03**	**0.11**	18.11	4	**0.00**	**0.14**
Digital resources	7.28	4	0.12	0.09	3.94	4	0.41	0.07
Teaching and learning	6.69	4	0.15	0.09	4.59	4	0.33	0.07
Evaluation and feedback	17.44	4	**0.00**	**0.14**	11.86	4	**0.02**	**0.11**
Student empowerment	3.29	4	0.51	0.06	2.74	4	0.60	0.05
Development of students' digital competence	8.81	4	0.07	0.10	5.40	4	0.25	0.08
Total DTC	10.79	4	**0.03**	**0.11**	6.00	4	0.20	0.08

Discussion and conclusions

This study sought to explore the level of DTC of university teachers from two universities in different European countries, but with similar demographic and contextual characteristics. This analysis was conducted using a self-perception questionnaire, created in previous research (Llopis et al., 2021), and following the dimensions of the European framework DigCompEdu (Redecker & Punie, 2017).

For the first research question, concerning the level of DTC of university teachers, the faculty generally perceived themselves at an intermediate level. However, there was some variability in the score of the different dimensions, with the highest score corresponding to the professional use of digital technologies by teachers (communication, collaboration with other colleagues, professional development, and reflective use), with pedagogical competencies with digital technologies in second place (digital resources, and use for teaching, learning and assessment), and finally, those competencies related to the effect of the DTC on student (sudent empowerment and digital competence). Therefore, this study shows similar results to those obtained in other contexts, for example, in both Ecuador (Orozco et al., 2016), and the United Kingdom (Wheeler et al., 2012), which found that university teachers had an intermediate level of DTC, but particularly lower levels regarding the pedagogical and didactic use of digital technologies.

For the second research question, concerning possible differences in results between educational institutions, the faculty at the Spanish university perceived themselves as significantly more digitally competent, on a general level, than the faculty at the Polish university. This was also the case in the dimensions of professional commitment, digital resources, and evaluation. In contrast, Polish university teachers perceived themselves to be significantly more competent in the dimension of student empowerment. This question may have been related to the findings for the fifth research question, concerning differences by subject area in which, although no significant differences were found in the overall level of DTC. Rather differences were found in the dimensions of professional commitment and evaluation. Although the two universities were of similar size and territorial influence, the Polish university had a greater number of STEM degrees. According to the results, teachers in arts and humanities, health, and social sciences obtained higher scores in these dimensions than those in sciences and engineering. With regard to this finding, it should be noted that from the DigCompEdu approach, DTC is not a purely technical competence, as in the study of Müller and Aleksa (2019), but rather contextualised in the educational field. This may explain the higher results of teachers in the areas of education, communication or similar, and therefore, in certain areas and universities. Nevertheless, this is a line of investigation that may be further explored in the future.

Regarding the third question, concerning any differences by participants' gender, the results showed that women's self-perceived level of DTC was significantly higher than men's, both in overall value and in most dimensions (professional commitment, teaching and learning, evaluation, and student empowerment). These results were of substantial importance. Often, at previous educational levels (Esteve-Mon et al., 2020), women tend to perceive themselves as less competent than men, especially in the more technical areas. In the results of this study, this tendency seems to have reversed, which may also be related to the social, educational, and applied aspects of this competence.

Finally, with respect to the fourth research question, related to differences according to professional category, there were significant differences in terms of the general level of self-perceived DTC by teachers. These differences were also significant in the dimensions of professional commitment and evaluation. In this sense, categories of younger faculty, such as junior lecturers, or with a more instructional profile, such as teaching assistants, obtained higher scores than more senior and consolidated faculty, such as full professors and associate professors. These results open the door to explore the possibilities of certain age-related digital divides (Tolic & Pejakovic, 2016).

Limitations and future research

It is important to note that, although this study used a previously validated questionnaire (Llopis et al., 2021), it was still a self-perception questionnaire administered to an accessible sample of two European universities. Therefore, it would be interesting in future related research to collect qualitative information in order to triangulate the data and consolidate the results. However, it is relevant to highlight that this instrument was chosen as it was directly based on the DigCompEdu, the TDC framework is intended to be the European benchmark (Redecker & Punie, 2017). Furthermore, although all the differences and limitations mentioned in the four research questions were statistically significant, the effect value was small. This has implications for the significance and relevance of such results at a practical level (Green & Salkind, 2008). Also, although this study was based on a robust quantitative analysis, there are always some actions that could lead to improvement. The results found were based on the completion of self-assessments by teachers and which may intrinsically imply biases in the answers (Yudes-Gómez et al., 2018). In this sense, it would be interesting to complement this study by obtaining more information for triangulation. Specifically, this could be done with qualitative information that would provide more in-depth knowledge of teachers' DTC-related practices (López-Meneses et al., 2020).

In short, we can conclude that DTC continues to be a relevant topic which necessitates continued research to improve on the studies that have been carried out so far. In fact, although it is true that there are several reference frameworks to draw on, this does not ensure comprehensive diagnoses of the situation. For example, at the European level, the use of the DigCompEdu framework has been standardised in recent years, which has made it possible to set concrete challenges shared by the member countries. Although it is true that there are differences between them, it is possible to make diagnoses and establish institutional policies to improve DTC. This last section has defined in some way the challenges that the academic and research community will have to face in the coming years in order to ensure the development of this competency by university teachers.

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