ICT Resources for Research: an ANOVA analysis on the digital research skills of Higher Education teachers comparing the areas of knowledge within each gender

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Abstract: Research skills are part of the academic activities of Higher Education teachers. Regardless of the knowledge area they teach, there is a need to observe, reflect, select, analyse and communicate scientific results using technological advances. The aim of this study is to analyse the use that teachers make of different ICT resources for research in terms of gender, comparing within each gender the different areas of knowledge to which the teachers belong (Science and Engineering-Architecture, Health Sciences, Art-Humanities and Social-Legal Sciences). To this end, an ex post facto design through surveys was used with a sample of 867 university teachers in the Spanish education system. For the comparative analysis, univariate ANOVA by multiple comparisons was used.

The findings revealed that teachers have, in general terms and in both genres, an average level of use, highlighting more use in digital databases, academic Google, high-impact journal websites, and very little use in data analysis software, mainly in qualitative software. The results highlighted that the Engineering-Architecture area is the one that makes the greatest use of ICT for research in comparison with the Art-Humanities area which uses ICT resources the least. The results demonstrate the need to develop procedural and cognitive skills in teaching staff in the most needed areas, not only to encourage them to continue researching and sharing the results acquired, but also to attend and prepare students in research skills so that they can continue learning and increasing their academic and professional training once the university stage is over.

Key words: teaching staff, higher education, use, digital research skills, ICT resources, areas of knowledge, gender

Introduction

The ways of improving the education provided by Higher Education teachers have been substantially evolving in accordance with the requirements not only of the Twenty-first Century society but also by the inclusion of ICT as a transversal resource to be used in any branch of knowledge (Varela-Ordorica & Valenzuela-González, 2020). Therefore, teacher training is itself an increased challenge, of arduous training, but absolutely necessary in order to prepare students for success in the labour market (Picatoste *et al*., 2018).

The study of digital competence in of Higher Education teachers has been highlighted by numerous authors in recent years (Cabero & Barroso, 2016; Blanchard *et al*., 2019; Peña *et al*., 2019; Chanunan & Brückner, 2019; Cuartero *et al*., 2019), and has challenged education authorities to develop educational policies focused on the digital training of their university teachers. Continuous training courses are essential, for example through MOOCS (Gordillo *et al*, 2019; Koukis & Jimoyiannis, 2019), in order to get closer to the predictions of the Horizon 2019 EDUCASE report which identified the following six most emerging technologies which will have a significant impact on higher education in the next five years (2019-2023): mobile learning, analytics technologies, mixed reality, artificial intelligence, blockchain and virtual assistants (Alexander *et al*., 2019).

However, in the context of Higher Education there are few studies specifically focused on an ICT profile model around the areas in which teaching staff usually perform: teaching, management and research (Durán *et al*., 2016; Padilla-Hernández *et al*., 2020). Torelló & Pérez (2012) state that a good university teacher cannot be separated from the three main dimensions they develop (teaching, research and management), or from the areas where they put them into practice (social context, institutional context and classroom context). In this regard, as Pozos (2015) states, teachers must not only integrate the use of ICT into the curriculum but also promote research and participation in research projects with the support of ICT (Twalib, 2012) in order to promote the results of their good teaching practices (Padilla-Hernández & Vanesa, 2018).

On this basis, there must be a high commitment on the part of universities to promote a generation of researchers who will not only transmit their knowledge to their students but also contribute to updating and increasing it. To achieve this, the route is to resort to research, since progress in technology aimed at improving the quality of education will depend on it (Valladares-Garrido *et al*., 2017). It is so important

that the Report to UNESCO of the International Commission on Education for the Twenty-first Century (Delors, 1996, p. 86) recognises that "given the importance of research for the qualitative improvement of teaching and pedagogy, teacher training should include a strengthened element of research training".

Achieving the integration of ICT into the educational process not only requires teachers to have digital skills in order to teach and evaluate students (Campos & Ramírez, 2018; Zia *et al*., 2018; Guillén-Gámez *et al*., 2020), but also that they have research skills (Rubio *et al*., 2018; Fuad & Hamid, 2019). Teachers must strengthen the incorporation of research as a fundamental part of their educational processes with their students (Crooks *et al*., 2010; Abykenova *et al*., 2016); and, consequently, in order to do this teachers must effectively teach students to search for scientific information, organise, analyse and communicate the information needed to structure the generation of knowledge (Machado, 2008; Reyes *et al*., 2019), in our case, with the help of ICT resources (Estrada, 2014; El Hassani, 2015).

If university teachers succeed in getting their students to acquire these skills, they will have a better chance of developing scientific work, disseminating the results of their research, participating in conferences and even publishing in scientific journals (Hampden-Thompson & Sundaram, 2013). In this regard, not only will the use of ICT in research provide teachers with better academic performance, but it will also generate and update knowledge in their area of study (Lim *et al*. 2011; Zia *et al*., 2018). But for students to acquire these skills, their reference, i.e., university teachers, must have these research skills.

In this line of thought, training in research skills by Higher Education teachers implies the appropriation and experimentation of technological resources that allow them to carry out tasks of selecting, organising and analysing information, as well as sharing and disseminating the findings of their research. Therefore, the main purpose of this study is to know the use of Higher Education teachers on ICT resources to investigate (digital research skills) according to each gender, as well as compare within each gender the area of knowledge to which they belong (Science and Engineering-Architecture, Health Sciences, Art-Humanities and Social- Legal Sciences).

Theoretical framework

Approach to the concept of digital competence in research

Several authors define research competence as the set of specific skills for research, according to the logic of the scientific method (Chu *et al*., 2008; Ain *et al*., 2019; Basilio & Bueno, 2019). In this sense, Rubio *et al*. (2018) developed an instrument on Self-perception of mastery in research skills composed of the following dimensions: (1) General research concepts: qualitative or quantitative process and methods; (2) Bibliographic searches through Google or other specialised databases; (3) Information collection techniques through questionnaires, interviews or observation; (4) Information analysis through quantitative or qualitative software; and (5) Ethical treatment of information and academic writing with respect to knowing how to reference the cited texts at the end according to APA. However, the instrument lacked psychometric properties with respect to reliability and validity; and furthermore, it was not focused on the use of ICT resources to support research. Along similar lines, Alvarado et al. (2016), Ricardo et al., (2019) or Estrada (2019) developed similar instruments to the previous one to measure the research skills of university students. However, these instruments were not focused on Higher Education teachers, nor on the support of ICT resources in research.

Buendía-Arias *et al*. (2018) determine that among the dimensions that make up solid research competence, one of the least encouraged dimensions, and which is of essential importance for teachers, is technological competence. ICT resources in the field of research provide a wide range of possibilities in order to achieve sound research competence. Cacheiro (2011) states that online databases (i.e., WoS, Dialnet, Teseo, Eric) represent an essential information resource for researching the state of the art in a topic. Harker (2013) states that a person with sound research competence does not only include searching, but also searching in places that guarantee valid and scientific information such as google scholar, and at the same time includes the ability to select and evaluate information relevant to the proposed objective. Hampden-Thompson & Sundaram (2013) state that there is a growing need to be equipped with software to use quantitative (i.e., SPSS, Minitab,) or qualitative (i.e., Altas.ti, NVivo,) methods in order to be able to handle large-scale representative data sets. A number of researchers have pointed out the importance of developing a good command of this type of software, given that those researchers who have little or no understanding in this area are forced to accept the findings as true (since they are not equipped to question them) or completely ignore them, leading to erroneous or inaccurate knowledge of science (Vandiver, D. M., & Walsh, 2010;

Henson *et al*., 2010). Idri (2015) adds a further connotation to improve skills in this competency, the use of critically managing the literature with ICT resources (i.e., Zotero, Refworks, Mendeley, and EndNote).

Related works

The studies found regarding the analysis on research skills with the use of ICT resources have mainly focused on using easily accessible samples for researchers, mainly university students (Seraji *et al*., 2017; Akuegwu & Nwi-ue, 2018; Robelo & Bucheli, 2018) or masters or doctoral students (Bolgzda & Olehnovica, 2012; Bourke & Holbrook, 2013; Sim & Stein, 2016).

For example, Strutynska & Umryk (2017) analysed the use of ICT resources for research by 127 PhD students, university and school teachers from Ukraine. The results determined that most of them used Google Scholar to search for information, although they made little use of social networks to share their articles and results (ResearchGate) or for the creation of profiles in ORCID as researchers; regarding the use of ICT resources to select references and adapt them to the style of each journal, they were hardly used. However, Huamani-Navarro *et al*. (2011) and Wu and Lee (2012) found opposite results when they stated that university students were not confident in doing literature searches and preferred to search on Google instead of academic Google or using a specialised and reliable database.

In a similar context, Reyes *et al*. (2019) analysed research skills with the use of ICT in 39 PhD students. The results determined that half of the students use scientific repositories to search for information. Regarding the use of bibliographic managers, a quarter of the students did not use any, compared to a third who did (Mendley, EndNote or Zotero). In relation to the use of software to analyse data, only a quarter of the students used SPSS, while for qualitative analysis (atlas.ti) the students did use it quite frequently. With respect to the publication of manuscripts in journals, a quarter of the students stated that they did not know how to publish in digital media. Contrasting results were found by Sánchez and Bucheli (2020) or Buarki (2016) regarding the low use of bibliographic managers.

Rubio *et al.* (2018) analysed the self-perception of 109 students in research skills. The results found that students perceived themselves to be more competent in Google searches, but less so in academic Google searches and less competent in specialised databases. It is in the quantitative approach that students perceive themselves as less competent (scale and questionnaire type information collection instruments, and quantitative data analysis using SPSS). In addition, students perceive they have low proficiency in the use of bibliographic managers. In the same context, Guillén-Gámez, & Peña (2020) determined with a sample of 217 university students that the use of software for data analysis was very low, as well as a medium-low use of digital libraries.

Abykenova *et al*. (2016) analysed the use of 147 Master's students on research competence, finding that students' perceptions of quantitative software (SPSS, STATA, R) were very low. Furthermore, only a quarter of them were familiar with bibliographic managers such as Zotero or EndNote. Similar results on these and other ICT resources were found by Robelo & Bucheli (2018), who analysed the use of two groups of students in two time frames (between 2016-2018 and 2018-2020). Focusing on the most current results, the authors found that the student body almost always used web search engines such as Google, but less frequently Google Scholar or digital databases (Eric, Dialnet, Latindex, Redalyc). Bibliographic managers were hardly ever used. As for quantitative software (SPSS, SAS, BMPD, STADISTICA), it was rarely used, the use of qualitative software being slightly higher (Atlas.ti, Aqua). In addition, research profiling (Google Academic, ResearchGate, ORCID) was rarely used.

Regarding the study by subject areas, the only research found was by Seraji *et al*. (2017). The authors analysed the technological research skills of 343 masters and doctoral students classified into 8 types of university degrees (literature and humanities, veterinary, physical education and sports science, chemistry, social science and economics, fundamental sciences, engineering, agriculture, art and architecture). The results determined that there were no significant differences either in gender, or between the two types of students or different educational levels.

Taking into consideration the different research carried out on research skills and ICT resources, we can draw the following conclusions: the studies have been mainly focused on students and not on Higher Education teachers. Furthermore, no studies have been found that focus on digital research skills of teachers

according to the area of knowledge they belong to. Therefore, the main contribution and objective with this study, and as a result we take a step further in science, is the following: the study on the use that Higher Education teachers make of ICT resources for research, according to each gender, as well as comparing within each gender the branch of knowledge to which they belong. By emphasising all these aspects the present investigation has a more solid base.

Method

Design. In order to respond to the proposed objectives, a survey methodology was used (non-experimental design), since the aim was to find out the use made by Higher Education teachers in Spain of ICT resources for research in each area.

Participants. For the collection of the data, intentional non-probabilistic sampling was used. The universe of the Spanish population consisted of 120,383 Higher Education teachers from the Spanish Education System (MECD, 2018-2019). The response rate was 1206 teachers. A previous exploratory analysis was carried out in order to define the database, so the final sample was composed of 867 teachers who filled out the survey completely. The sample belonged to four branches of knowledge, Social-Legal Sciences (N= 400), Sciences and Engineering-Architecture (N= 183 teachers), Health Sciences N= (173 teachers), and Arts-Humanities (N=111).

In order to guarantee that such results were not influenced by the large size of the Social-Legal Sciences sample compared to the rest of the areas where the number of samples was lower, a random selection was made in SPSS of the samples of each of the branches of knowledge in order for them to be assimilated. The sample number for each branch was 100 subjects, a representative number for each of them. Table 1 shows that the female sex represents 48.25% compared to 51.75% for the male sex. Specifically, both types of sexes are assimilated in each branch of knowledge. With regard to the age of the teaching staff, it is observed that they are in the range of 45-50 years old approximately.

Table 1 Count of participants by branch of knowledge and gender

	Health Sciences		Sciences and Engineering-Architecture		Art-Humanities		Social-Legal Sciences	
	Age	% N	Age	% N	Age	% N	Age	% N
Female	45.3	49.0%	48.2	41.0%	48.4	57.0%	43.4	46.0%
Male	53.9	51.0%	47.1	59.0%	50.2	43.0%	47.0	54.0%

Instrument. To measure the use of ICT resources for research, the third dimension of the instrument developed by Guillén-Gámez & Mayorga-Fernández (2020) was used. This third dimension consisted of a total of 8 items. To measure use, a 5-point Likert scale was used, where value 1 referred to "no use" and value 5 corresponded to "high use".

The instrument had accurate psychometric properties. The reliability of the Cronbach alpha instrument was .89, while the dimension in ICT resources for research had a reliability of .81. The AFE explained 59.89% of the true variance of the instrument. Specifically, the research dimension explained 38.40% of the subjects' true scores. For AFE, the coefficients determined a good model fit: CMIN/DF = 2.51, p = <.05; IFC = .957; TLI = .947; IFI = .957; RMSEA = .059. In addition, the authors of the instrument carried out the analysis of invariance of the instrument by gender, proving that it was equally valid for both.

Teachers' use of ICT resources for research purposes, taking into account the five-point Likert scale, could be interpreted according to the Common Framework for Teacher e-Competence (INTEF, 2017). That is, value 1 of the Likert scale could be interpreted as level A1 and A2 (a person has a basic level and requires support to be able to use ICT resources for research). Value 2 of the Likert scale could be interpreted as level B1 (a person has an intermediate level, when he/she is able to solve simple problems by himself/herself using basic ICT resources for research such as web browsers or scientific databases). Value 3 would be associated with the level B2 (a person has an intermediate level when he/she can respond to his/her needs, solving research problems with specialised software). Value 4 would be associated with level C1 (a person has an advanced level in the use of resources and software for research, being able to guide other people to develop research competence). And, finally, value 5 would be associated with level C2 (has a very advanced level, so that, responding to his/her needs and those of other people, he/she can use these ICT resources in different complex contexts).

Procedure and analysis of results. The analysis of such data included two procedures: The first one, the descriptive graphical analysis of each item of the questionnaire in relation to the gender of the teachers, classifying each gender according to the branch of knowledge to which it belongs; the second procedure was focused on using two univariate ANOVA models for multiple comparisons. A model for each gender, in order to determine and compare if there were significant differences in the use made by teachers of each item between the four areas of knowledge. In each of the models used, Levene's assumption of homoscedasticity has been tested, in order to show the results of the multiple comparisons by Tukey or Games-Howell.

Results

Comparative analysis of each item according to gender

Figure 1 A. In general terms, teachers' use of databases is high in all areas of knowledge and in both sexes (level C1). In the model for female teachers, Levene's assumption of homoscedasticity is met, F (3, 189) = 1.978, p. > 0.05. ANOVA determined that the proposed model was not significant in the variable between groups, F (3, 189) = 1.131, p. > 0.05, that is, there were no significant differences in the use of this ICT resource in female teachers between the different areas of knowledge. For male teachers, Levene's assumption of homoscedasticity was not fulfilled, F (3, 203) = 3.266, p. > 0.05. ANOVA determined that the proposed model was not significant in the variable between groups, F (3, 203) = 0.396, p. > 0.05; that is, neither were there differences in the male teachers between the 4 areas of knowledge in the use of this resource.

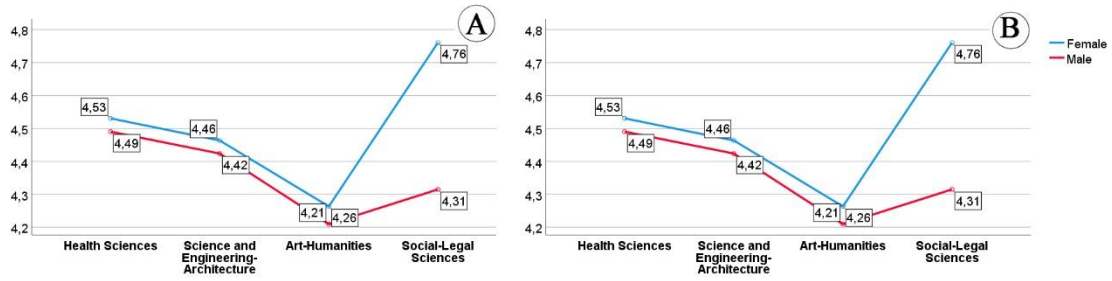

Figure 1 a) research databases such as Wos, Dialnet, Theseus; b) web search engines to consult bibliography such as Google scholar

Figure 1 B. In general, the use of Google Academic by teaching staff in both sexes and areas of knowledge is high (level C1). In the model for female teachers, Levene's assumption of homoscedasticity is met, F (3, 189) = 1.916 p. > 0.05. ANOVA determined that the proposed model was not significant in the variable between groups, F (3, 189) = 1.481, p. > 0.05, that is, there were no significant differences in the use of this ICT resource in female teachers between the different areas of knowledge. For the male teachers, Levene's assumption of homoscedasticity was fulfilled, F (3, 203) = 0.898, p. > 0.05. ANOVA determined that the proposed model was not significant in the intergroup variable, F (3, 203) = 1.481p. > 0.05, i.e., there were also no differences in male teachers between the 4 areas of knowledge in the use of this resource.

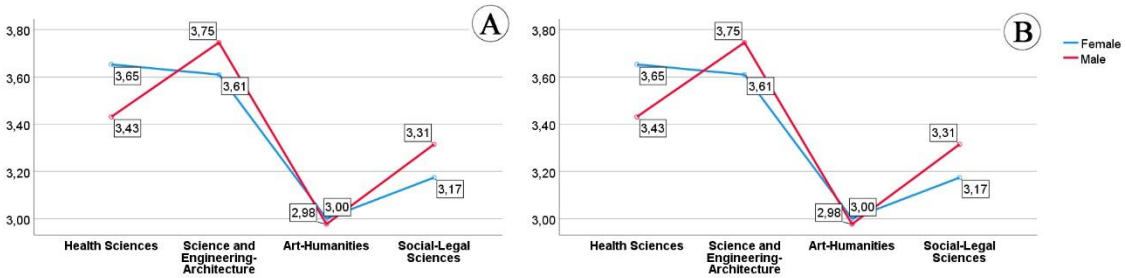

Figure 2 a) elaboration of quotations with Mendley, EndNote, Refworks; b) websites of JCR and SJR high-impact magazines according to their quartiles

Figure 2 A. In general, the level of use teachers make of citation software, in both sexes and areas of knowledge, is medium (level B2). In the model for female teachers, Levene's assumption of homoscedasticity is met, F (3, 189) = 1.809; p. > 0.05. ANOVA determined that the proposed model was

significant in the variable between groups, *F* (3, 189) = 2.772, p. < 0.05, that is, there were significant differences in the use of this ICT resource in the female teaching staff between the different areas of knowledge, between: Health Sciences - Art-Humanities (sig. 0.043). For the male teachers, the assumption of homoscedasticity of Levene, *F* (3, 203) = 2.746, p. < 0.05 was not fulfilled. ANOVA determined that the proposed model was significant in the intergroup variable, *F* (3, 203) = 2.675; p. < 0.05, that is, there were differences in the male teachers among the 4 areas of knowledge in the use of this resource, namely: Science and Engineering-Architecture- Art-Humanities (sig. = 0.035).

Figure 2 B. In general, the use of high-impact journals is observed, the level of use of teachers in both genders and in the area of Health Sciences and Engineering-Architecture is high (level C1), except in the area of Art-Humanities and Social-Legal Sciences (level B2). In the model for the female teaching staff, Levene's assumption of homoscedasticity was not fulfilled, *F* (3, 189) = 5.962; p. < 0.05. ANOVA determined that the proposed model was significant in the variable between groups, F (3, 189) = 8.354, p. < 0.05; that is, there were significant differences in the use of this ICT resource in female teachers between the different areas of knowledge, between: Health Sciences- Art-Humanities (sig. = ,001), Science and Engineering-Architecture- Art-Humanities (sig. = 0.001). For male teachers, Levene's assumption of homoscedasticity, *F* (3, 203) = 4.374, p. < 0.05, was not fulfilled. ANOVA determined that the proposed model was significant in the intergroup variable, F (3, 203) = 5.298; p. < 0.05, that is, there were differences in the male teachers among the 4 areas of knowledge in the use of this resource, namely: Science and Engineering-Architecture with Art-Humanities (sig. = 0.024), Science and Engineering with Architecture-Social-Legal Sciences (i.e., = 0.007).

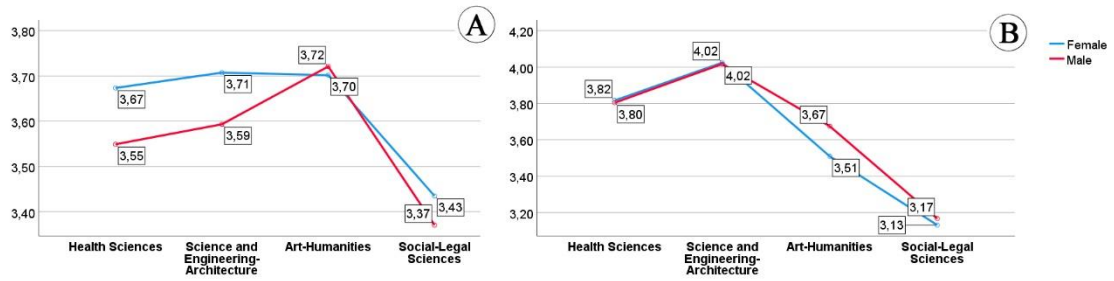

Figure 3 a) *Social networks for research such as Researchgate, Academia; b) Researcher profile such as Researcher ID, ORCID,*

Figure 3 A. In general, the teachers' level of use of social research networks is average in all branches and in both sexes, with a downward trend in the area of Social-Legal Sciences (level b2). In the model of female teachers, Levene's assumption of homoscedasticity, *F* (3, 189) = 0.176; p. > 0.05 was fulfilled. ANOVA determined that the proposed model was not significant in the intergroup variable, *F* (3, 189) = 0.438, p. > 0.05; that is, there were no significant differences in the use of this ICT resource in female teachers between the different areas of knowledge. In the male teaching staff, Levene's assumption of homoscedasticity was fulfilled, *F* (3, 203) = 0.479; p. > 0.05. ANOVA determined that the proposed model was not significant in the variable between groups, *F* (3, 203) = 0.584, p. > 0.05, that is, there were no significant differences in the use of this ICT resource in the male teaching staff between the different areas of knowledge.

Figure 3 B. In general terms, regarding the research profile, the level of use in both sexes and in both areas is medium (level B2). In the female teaching staff model, Levene's assumption of homoscedasticity, *F* (3, 189) = 1.067; p. > 0.05 was fulfilled. ANOVA determined that the proposed model was significant in the variable between groups, *F* (3, 189) = 4.668, p. < 0.05, that is, there were significant differences in the use of this ICT resource in female teachers between the different areas of knowledge, between: Health Sciences-Social-Legal Sciences (sig. = 0.031); Science and Engineering-Architecture-Social-Legal Sciences (sig. = 0.004). In the case of male teachers, Levene's assumption of homoscedasticity was fulfilled, *F* (3, 203) = 1.308; p. > 0.05. ANOVA determined that the proposed model was significant in the variable between groups, *F* (3, 203) = 5.029, p. < 0.05, that is, there were significant differences in the use of this ICT resource in male teachers between the different areas of knowledge, that is to say: Health Sciences with Social-Legal Sciences (sig. =0.035), Science and Engineering-Architecture with Social-Legal Sciences (sig. = 0.001).

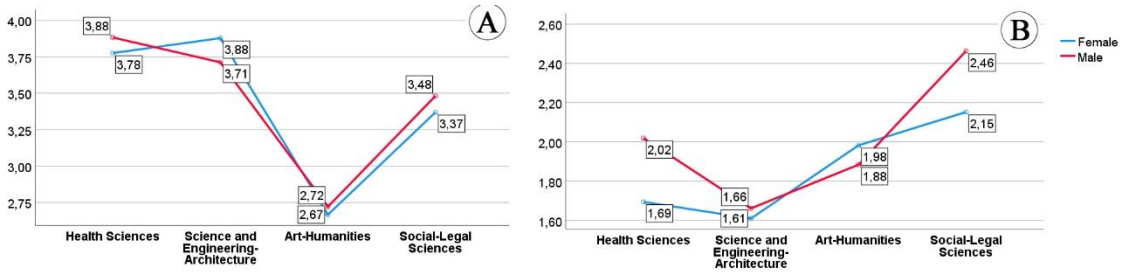

Figure 4 a) Quantitative software for data analysis such as *SPSS*, *Minitab*, *Mplus*, *R*, *PSPP* ,*Excel*; b) Qualitative software for data analysis such as *ATLAS.ti*, *NVivo*, *MAXQDA Aquad*, *ELAN*, *Cassandre*

Figure 4 A. In general, the level of use of quantitative software in both sexes and areas of knowledge is medium (b2) except for the area of Art-Humanities (level B1). In the female teacher model, Levene's assumption of homoscedasticity was fulfilled, F (3, 189) = 1.731; p. > 0.05. ANOVA determined that the proposed model was significant in the variable between groups, F (3, 189) = 9.633, p. < 0.05; that is, there were significant differences in the use of this ICT resource in female teachers between the different areas of knowledge, between: Health Sciences- Art-Humanities (sig. = 0.001), Science and Engineering-Architecture- Art-Humanities (sig. = 0.001), Social-Legal Sciences- Art-Humanities (sig. = 0.030). In male teachers, Levene's assumption of homoscedasticity was not fulfilled, F (3, 203) = 2.864; p. < 0.05. ANOVA determined that the proposed model was significant in the variable between groups, F (3, 203) = 7.343, p. < 0.05, that is, there were significant differences in the use of this ICT resource in male teachers between the different areas of knowledge, namely: Health Sciences with Art-Humanities (sig. = 0.001), Science and Engineering-Architecture with Art-Humanities (sig. = 0.003).

Figure 4 B. With respect to qualitative software, in general, the level of use in both sexes and areas of knowledge is low (A2). In the female teacher model, Levene's assumption of homoscedasticity was met, F (3, 189) = 0.670; p. > 0.05. ANOVA determined that the proposed model was significant in the variable between groups, F (3, 189) = 2.032, p. > 0.05; that is, there were no significant differences in the use of this ICT resource in female teachers between the different areas of knowledge. In male teachers, Levene's assumption of homoscedasticity was not fulfilled, F (3, 203) = 4.089; p. < 0.05. ANOVA determined that the proposed model was significant in the variable between groups, F (3, 203) = 3.684, p. < 0.05, that is, there were significant differences in the use of this ICT resource in male teachers between the different areas of knowledge, between: Science and Engineering-Architecture with Social-Legal Sciences (sig. = 0.007).

Comparative analysis as a global research competence

Figure 5 shows the overall use made by teachers by gender and area (total average of all ICT resources). In general, it can be seen that teachers have an average level of use (level b2). Regarding female teachers, significant differences were found in the model, F (3, 189) = 3.256; p. < 0.05. Specifically, there were differences between Health Sciences-Art-Humanities (sig. = 0.047), Science and Engineering-Architecture with Art-Humanities (sig. = 0.037). With respect to male teachers, significant differences were found in the same areas as in the female case.

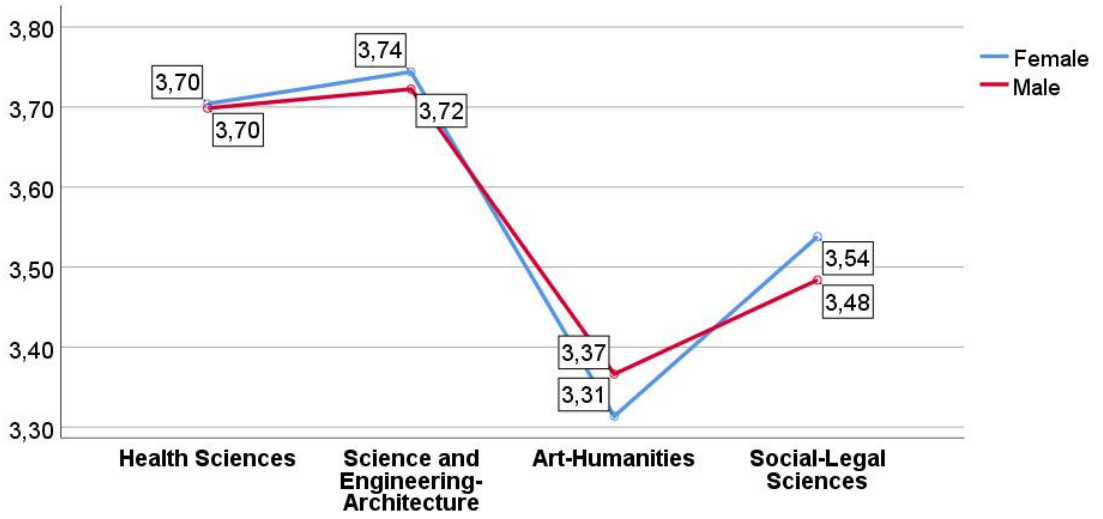

Figure 5. Total use of ICT resources by teachers for research according to gender and area

Discussions and conclusions

The competencies that have been researched with the use of technology must represent transversal knowledge which should be taken on and developed by university teachers in the first instance by acting as a guide to teach these competencies to university students. The aim of this study was to analyse and compare Higher Education teachers' use of ICT resources for research in terms of gender and the branch of knowledge to which they belong. Without a doubt, this study represents an advance over previous studies by considering samples of Higher Education teachers from different areas of knowledge, and thus, having the opportunity to apply the necessary improvements in the group and gender that requires it.

A first conclusion is that teachers generally have an average level of use (level B2). Specifically, it is notable in those ICT resources available on the Internet such as web search engines, databases, impact journals (level C1), however, the use of those ICT resources developed in data processing software is very limited (level A2-B1). Despite living in the information and communication society, constantly surrounded by ICT devices and resources, these are still not evident in the digital research skills that a Higher Education teacher must possess in order to be able to train their students efficiently (Rubio *et al*., 2018; Robelo & Bucheli, 2018).

With respect to bibliographic managers which allow the easy creation of bibliographic references or automatic citation elaboration in different styles, teaching staff in both genres have an average level (B2), with a greater use in the Engineering-Architecture area as opposed to Art-Humanities, data contradictory to those found by Buarki (2016) or Sánchez & Bucheli (2020) regarding the low use of bibliographic managers.

The least use made by teachers in both genders is of qualitative software for data analysis with a low level (A2), which are similar results to those of Robelo & Bucheli (2018) and contradictory to those found by Reyes *et al*. (2019) which showed that university students use this type of qualitative resource very frequently. Specifically, it is in the Social-Legal Sciences area where there is more use of this type of ICT resources in both genders as opposed to the Engineering-Architecture area.

Regarding the need and importance of using quantitative software, and thus being able to handle large data sets as stated by Hampden-Thompson & Sundaram (2013), the results found in our study were assimilated at a medium-low level in both genders (B1 level), despite the continuous training courses offered by universities for ongoing training of teachers, coinciding with the results of Abykenova *et al*. (2016), Rubio *et al*. (2018), Robelo & Bucheli (2018), Reyes *et al*. (2019), and Guillén-Gámez, & Peña (2020). These results could be due to the numerical aversion by teaching staff in attitudes towards statistics, especially the results found in the Art-Humanities area, quite the opposite of the Engineering-Architecture area, which usually has subjects related to mathematics and statistics in its curricula.

The use of ICT resources to search for information is considered a fundamental competence for any researcher (Harker; 2013). A use that not only includes performing searches, but searches in places that guarantee scientific information, and to achieve this, the ability to select and reflect on the information relevant to the objectives of the research is required. Such a fundamental competence that if teachers do not

efficiently use and understand the information they find, it can lead to erroneous or inaccurate knowledge of science (Vandiver, D. M., & Walsh, 2010; Henson et al., 2010). In the present study, teachers of both genders are perceived to be very competent with respect to the use of specialised databases and web search engines (level C1), with less use in the Art-Humanities area compared to the Social-Legal Sciences area, which is the one that uses it the most. Similar results were found in the research of Strutynska & Umryk (2017) but contradicted those of Rubio *et al*. (2018), Huamani-Navarro *et al*. (2011) or Wu & Lee (2012), perhaps because the type of sample was students rather than teachers.

Finally, the findings found in this study should contribute to improving those aspects that are currently less favoured in teachers' digital and research skills: the use of software for the elaboration of references, quantitative and qualitative software for data analysis. The way to achieve these improvements requires reflection on whether the training plans of university institutions are sufficiently committed to improving these skills in teachers, or, on the contrary, this development and acquisition depends in most cases on the willingness of the researcher to continue training.

With the completion of this study, the bases are set for the design, implementation and monitoring of a subsequent research project that will take as its starting point the study with samples of teacher-researchers from other countries representing other universities, both public and private ones, face-to-face teaching or by distance learning. And also collect complementary qualitative information, such as, for example, through discussion groups in each of the areas of knowledge, and thus better understand the processes of development and acquisition of procedural skills in ICT resources for research.

References

Abykenova, D. B., Assainova, A. Z., Burdina, E. I., Murphy, A., & Abibulayeva, A. B. (2016). Forming Master's Degree Students' ICT Competencies as Future Researchers and Educators: A Kazakhstan Case Study. *International Journal of Environmental and Science Education*, *11*(18), 11175-11193.

Ain, C. T., Sabir, F., & Willison, J. (2019). Research skills that men and women developed at university and then used in workplaces. *Studies in Higher Education*, *44*(12), 2346-2358. https://doi.org/10.1080/03075079.2018.1496412

Akuegwu, B. A., & Nwi-ue, F. D. (2018). Assessing Graduate Students'acquisition Of Research Skills In Universities In Cross River State Nigeria For Development Of The Total Person. *European Journal of Research and Reflection in Educational Sciences Vol*, *6*(5), 27-42.

Alexander, B., Ashford-Rowe, K., Barajas-Murph, N., Dobbin, G., Knott, J., McCormack, M., ... & Weber, N. (2019). *EDUCAUSE Horizon Report 2019 Higher Education Edition* (pp. 3-41). EDU19.

Alvarado, F. C., León, M. P., & Colon, A. M. O. (2016). Design and validation of a questionnaire to measure research skills: experience with engineering students. *Journal of Technology and Science Education*, *6*(3), 219-233. http://dx.doi.org/10.3926/jotse.227

Basilio, M. B., & Bueno, D. C. (2019). Research Skills and Attitudes of Master Teachers in a Division towards Capability Training. 19th CEBU – Philippines Int'l Conference on Economics, Education, Humanities & Social Sciences (CEEHSS-19) Jan. 29-30, 2019 Cebu (Philippines). https://doi.org/10.17758/ERPUB3.UH0119421

Blanchard, A. G., Blanchard, G., Gowreea, Y., & DePryck, K. (2019). ICT competences of teachers in Higher Education in developing countries. Challenges for quality education for professional development based on the DigCompEdu framework. In *EdMedia+ Innovate Learning* (pp. 547-552). Association for the Advancement of Computing in Education (AACE).

Bolgzda, I. y Olehnovica, E. (2012) Structure of Doctoral Students' Research Competences in Sustainability Context. *International Journal of Social, Behavioral, Educational, Economic, Business and Industrial Engineering*. 6(6), 1181-1184. https://doi.org/10.5281/zenodo.1331677

Bourke, S., & Holbrook, A. P. (2013). Examining PhD and research masters theses. *Assessment & Evaluation in Higher Education*, *38*(4), 407-416. https://doi.org/10.1080/02602938.2011.638738

Buarki, H. (2016). ICT skills evaluation of faculty members in Kuwait; Preliminary findings. *Information Development*, *32*(4), 777-798. Doi: https://doi.org/10.1177/0266666914568796

Buendía-Arias, X. P., Zambrano-Castillo, L. C., & Insuasty, E. A. (2018). Development of Research Skills in Pre-Service Teachers in the Context of the Teaching Practice. *Folios*, (47), 179-195.

Cabero, J. y Barroso, J. (2016). ICT teacher training: a view of the TPACK model. Cultura y Educación, 28(3), 633-663. Doi: 10.1080/11356405.2016.1203526

Cacheiro Gonzalez, M. L. (2011). ICT educational resources for information, collaboration and learning. *Pixel-Bit-Revista De Medios Y Educacion*, (39), 69-81.

Campos Cruz, H., & Ramírez Sánchez, M. Y. (2018). Las TIC en los procesos educativos de un centro público de investigación. *Apertura (Guadalajara, Jal.)*, *10*(1), 56-70. http://dx.doi.org/10.18381/ap.v10n1.1160

Castillo, S. (2011). *Evaluación de competencias investigativas*. XIII Conferencia Interamericana de Educación Matemática. Recife.

Chanunan, S., & Brückner, M. (2019). Digital Literacy Of Higher Education Instructors In Thailand. *Journal Of Education Naresuan University*, *21*(3), 1-27.

Chu, S., Chow, K., Tse, S. K., & Kuhlthau, C. C. (2008). Grade 4 Students' Development of Research Skills Through Inquiry-Based Learning Projects. *School Libraries Worldwide*, *14*(1), 10-37.

Crooks, V. A., Castleden, H., & Meerveld, I. T. V. (2010). Teaching research methods courses in human geography: Critical reflections. *Journal of Geography in Higher Education*, *34*(2), 155-171. https://doi.org/10.1080/03098260903093646

Cuartero, M. D., Espinosa, M. P. P., & Porlán, I. G. (2019). Certificación de la Competencia Digital Docente: propuesta para el profesorado universitario. *RIED. Revista Iberoamericana de Educación a Distancia*, *22*(1), 1-19. https://doi.org/10.5944/ried.22.1.22069

Delors, J. (1996). La educación encierra un tesoro [The education holds a treasure]. *Madrid: Santillana*.

Durán Cuartero, M., Gutierrez Porlan, I., & Prendes Espinosa, M. P. (2016). Conceptual analysis of digital competence models of university teacher. *Revista Latinoamericana De Tecnologia Educativa-Relatec*, *15*(1), 97-114. http://dx.medra.org/10.17398/1695-288X.15.1.97

El Hassani, A. (2015). The Role of Information Literacy in Higher Education: An Initiative at Al Akhawayn University in Morocco. *Nordic Journal of Information Literacy in Higher Education*, *7*(1), 32-37. https://doi.org/10.15845/noril.v7i1.229

Estrada Molina, O. (2014). Sistematización teórica sobre la competencia investigativa. *Revista electrónica educare*, *18*(2), 177-194. http://dx.doi.org/10.15359/ree.18-2.9

Estrada, L. (2019). Evaluación del desarrollo de competencias investigativas: Un estudio en la formación inicial de docentes. *Paradigma: Revista de investigación educativa*, *26*(41), 69-92. http://orcid.org/0000-0003-4095-8224

Fuad, A., & Hamid, A. (2019). Digital Information Literacy Competency among Lecturers of Sultan Ageng Tirtayasa University in Supporting Research and Scientific Publication. In *International Conference on Democratisation in Southeast Asia (ICDeSA 2019)*. Atlantis Press.

Gordillo, A., López-Pernas, S., & Barra, E. (2019). Effectiveness of MOOCs for teachers in safe ICT use training. *Comunicar*, *27*, 98-107. https://doi.org/10.3916/C61-2019-09

Guillén-Gámez, F. D. G., & Peña, M. P. (2020). Análisis Univariante de la Competencia Digital en Educación Física: un estudio empírico. *Retos*, *37*(37), 326-332.

Guillén-Gámez, F. D., & Mayorga-Fernández, M. J. (2020). Design and validation of an instrument of self-perception regarding the use in ICT resources of lecturers to teach, evaluate and investigate. Sent. Pending publish

Guillén-Gámez, F. D., & Mayorga-Fernández, M. J. (2020). Identification of Variables that Predict Teachers' Attitudes toward ICT in Higher Education for Teaching and Research: A Study with Regression. *Sustainability*, *12*(4), 1312.

Hampden-Thompson, G., & Sundaram, V. (2013). Developing quantitative research skills and conceptualising an integrated approach to teaching research methods to education students. *AISHE-J: The All Ireland Journal of Teaching and Learning in Higher Education*, *5*(3), 901-924.

Harker, Y. S. (2013). Information is cheap, but meaning is expensive: Building analytical skill into legal research instruction. *Law Libr. J.*, *105*, 79-98.

Henson, R. K., Hull, D. M., & Williams, C. S. (2010). Methodology in our education research culture: Toward a stronger collective quantitative proficiency. *Educational Researcher*, *39*(3), 229-240. https://doi.org/10.3102%2F0013189X10365102

Huamani-Navarro, M., Alegría-Delgado, D., López-Sánchez, M., Tarqui-Mamani, C. B., & Ormeño-Caisafana, L. (2011). Know-how, practicals and skills concerning bibliographical searches and students' perception of university training in research, in the case of students of obstetrics. *Educacion Medica*, 235-240.

Idri, N. (2015). Zotero Software: A Means of Bibliographic Research and Data Organisation; Teaching Bibliographic Research. *Arab World English Journal (AWEJ) Special Issue on CALL*, (2), 124-133.

INTEF. (2017). Marco Común De Competencia Digital Docente. Instituto Nacional de Tecnologías Educativas y Formación del Profesorado (INTEF), Gobierno de España. https://aprende.intef.es/sites/default/files/2018-05/2017_1020_Marco-Com%C3%BAn-de-Competencia-Digital-Docente.pdf

Koukis, N., & Jimoyiannis, A. (2019). MOOCS for teacher professional development: exploring teachers' perceptions and achievements. *Interactive Technology and Smart Education*, 16(1), 74-91. http://dx.doi.org/10.1108/ITSE-10-2018-0081

Lim, C. P., Chai, C. S., & Churchill, D. (2011). A framework for developing pre-service teachers' competencies in using technologies to enhance teaching and learning. *Educational Media International*, *48*(2), 69-83. https://doi.org/10.1080/09523987.2011.576512

Machado, E.F., Montes de Oca, N. y Mena, A. (2008). El desarrollo de habilidades investigativas como objetivo educativo en las condiciones de la universalización de la educación superior. *Revista Pedagogía Universitaria*, 13 (1), 156-180.

Ministerio de Educación, C. y D. (MECD, 2019). Datos y cifras del sistema universitario español. http://www.educacionyfp.gob.es/dam/jcr:2af709c9-9532-414e-9bad-c390d32998d4/datos-y-cifras-sue-2018-19.pdf

Padilla-Hernández, A. L., & Vanesa, M. (2018). Selección de categorías para el estudio de la evolución de la competencia digital docente del profesorado en Educación Superior. *Revista Interuniversitaria de Investigación en Tecnología Educativa*, 4, 55-67. https://doi.org/10.6018/riite/2018/327881

Padilla-Hernández, A. L., Gámiz-Sánchez, V. M., & Romero-López, M. A. (2020). Evolución de la competencia digital docente del profesorado universitario: incidentes críticos a partir de relatos de vida. *Educar*, *56*(1), 0109-127. https://doi.org/10.5565/rev/educar.1088

Peña, H. H. Z., Méndez, M. E., & Álvarez, H. I. G. (2019). Evaluación de la Competencia Digital en Profesores de Educación Superior de la Costa Norte de Jalisco/Evaluation of digital competence in higher education teachers of the North Coast of Jalisco. *Revista Iberoamericana de Producción Académica y Gestión Educativa*, *6*(11).

Picatoste, J., Pérez, L., & Ruesga, S. (2018). A new educational pattern in response to new technologies and sustainable development. Enlightening ICT skills for youth employability in the European Union. *Telematics and Informatics*, 35(4), 1031–1038. doi: https://doi.org/10.1016/j.tele.2017.09.014

Pozos, K. V. (2015). Evaluación de necesidades de formación continua en competencia digital del profesorado universitario mexicano para la sociedad del conocimiento (Doctoral dissertation). Universidad Autónoma de Barcelona: España. http://hdl. handle.net/10803/382466

Reyes, G., Enrique, C., & Salado Rodríguez, L. I. (2019). Competencias investigativas con el uso de las TIC en estudiantes de doctorado [Research competences with ICT in PhD students]. *Apertura (Guadalajara, Jal.)*, *11*(1), 40-55. http://dx.doi.org/10.32870/ap.v11n1.1387

Ricardo Velázquez, M., Amat Abreu, M., Andrade Santamaría, D. R., Jiménez Martínez, R., & Cisneros Zúñiga, C. P. (2019). Desarrollo de competencias investigativas formativas: retos y perspectivas para la Universidad. *Dilemas Contemporáneos: Educación, Política y Valores*, *6*, 1-26.

Robelo, O. G., & Bucheli, M. G. V. (2018). Comparative Analysis of Research Skills and ICT: A Case Study in Higher Education. International Journal of Educational Excellence, *4*(1), 15-27.

Rubio, M. J., Torrado, M., Quiros, C., & Valls, R. (2018). Self-perception of investigative competences in final-year students of Pedagogy of the University of Barcelona to develop the Final Grade Work. *Revista Complutense De Educacion*, *29*(2), 335-354. http://dx.doi.org/10.5209/RCED.52443

Sánchez, A. G. A., & Bucheli, M. G. V. (2020). Desarrollo de competencias investigativas y uso de herramientas tecnológicas en la gestión de información. *Revista Conrado*, *16*(72), 96-102.

Seraji, F., Allah Tavakkoli, R., & Hoseini, M. (2017). The relationship between technological research skills and research self-efficacy of higher education students. *Interdisciplinary Journal of Virtual Learning in Medical Sciences*, *8*(3), 1-7. https://dx.doi.org/10.5812/ijvlms.11893

Sim, K. N., & Stein, S. (2016). Reaching the unreached: de-mystifying the role of ICT in the process of doctoral research. *Research in Learning Technology*, *24*, 1-15. http://dx.doi.org/10.3402/rlt.v24.30717

Strutynska, O., & Umryk, M. (2017). ICT Tools and Trends in Research, Education and Science: Local Survey. *Electronic Scientific Professional Journal "Open Educational E-Environment Of Modern University"*, (3), 150-160. https://doi.org/10.28925/2414-0325.2017.3.15016

Torelló, O. M., & Pérez, K. V. P. (2012). Las Competencias Pedagógicas Y Digitales Del Docente Universitario. Un elemento nuclear en la calidad docente e institucional. *Revista del Congrés Internacional de Docència Universitària i Innovació (CIDUI)*, *1*(1), 1-21.

Twalib, S., Lynton, A., Buttsworth, A., Boyes, C., Goessmann, F., Ricketts, M., & Lynton, S. (2012). *Survey report: ICT in the Research Workflow*. Curtin Univeristy, 1-20.

Valladares-Garrido, M. J., Flores-Pérez, I., Failoc-Rojas, V. E., Marinas-Miranda, W., Valladares-Garrido, D., & Mejia, C. R. (2017). Publicación de trabajos presentados a congresos científicos

internacionales de estudiantes de medicina de Latinoamérica, 2011-2014. *Educación Médica*, *18*(3), 167-173. https://doi.org/10.1016/j.edumed.2016.06.013

Vandiver, D. M., & Walsh, J. A. (2010). Assessing autonomous learning in research methods courses: Implementing the student-driven research project. *Active Learning in Higher Education*, *11*(1), 31-42. https://doi.org/10.1177%2F1469787409355877

Varela-Ordorica, S. A., & Valenzuela-González, J. R. (2020). Use of Information and Communication Technologies as a Transversal Competence in Teacher Training. *Revista Electrónica Educare*, *24*(1), 172-191. http://dx.doi.org/10.15359/ree.24-1.10

Wu, M. M., & Lee, L. A. (2012). An empirical study on the research and critical evaluation skills of law students. *Legal Reference Services Quarterly*, *31*(3-4), 205-238. https://doi.org/10.1080/0270319X.2012.723571

Zia, N., Ilahi, M., & Khan, N. A. (2018). The Role of ICT (Information & Communication Technology) in Higher Education. *Multidisciplinary Higher Education, Research, Dynamics & Concepts: Opportunities & Challenges For Sustainable Development (ISBN 978-93-87662-12-4)*, *1*(1), 204-212.