Scientific production on digital competencies in higher education: a bibliometric study

Produção científica sobre competências digitais no ensino superior: um estudo bibliométrico

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Abstract

Digital Technology has attracted the scientific community's interest in investigating the theme concerning professors' performance. This study investigates the scientific production of digital competencies in higher education. Bibliometric research was carried out of quantitative nature and of exploratory character in which the publications on the theme between 2012 and 2021 were analyzed. Thirty-one (31) scientific papers were selected for analysis. It is concluded that scientific research on professors' digital competencies contributes to the changes in Brazilian higher education.

Keywords: fish; digital skills; teaching work; higher education; ICTs.

Resumo

A utilização da Tecnologia Digital (TD) tem atraído o interesse da comunidade científica em investigar o tema no que se refere à atuação dos professores. Este estudo tem como objetivo investigar a produção científica a respeito das competências digitais no ensino superior. Foi realizada uma pesquisa bibliométrica, de natureza quantitativa e de caráter exploratório em que foram analisadas as publicações sobre o tema entre 2012 e 2021. Foram selecionados para análise 31 (trinta e um) trabalhos científicos. Conclui-se que a investigação científica sobre as competências digitais dos docentes contribui para as mudanças ocorridas no ensino superior brasileiro.

Palavras-chave: competências digitais; trabalho docente; ensino superior; TDICs.

1. INTRODUCTION

Digital Technologies (DTs) in teaching have transformed the professors' performance, in which new learning environments change the form of communication between the teacher and the students (SCHUCK; NEUENFELDT; GOULART, 2019). This scenario has triggered the need to investigate the training, knowledge, and institutional conditions that involve these subjects, especially in higher education. In addition, with teaching mediated by digital technologies, teachers have begun to devote more time to developing new competencies concerning work demands (SIMÕES; SOUZA; REIS, 2021), as is the case with distance activities.

Given this, Branco, Conte, and Habowski (2020) pointed out that it is not enough to include new devices and technological innovations in teaching; it is necessary to align these resources to the needs and social and cultural issues of the actors in the teaching-learning process. Digital Information and Communication Technologies (DICTs) must be adopted strategically to achieve educational goals and the training of these citizens for the labor market (TRINDADE; MOREIRA; NUNES, 2019).

Therefore, the expansion and accessibility of educational resources such as digital media, interactive whiteboards, apps, and social networks, among others (CECÍLIO; SOUSA, 2012; SILVA, 2013), strengthens the need to develop Digital Competencies (DCs) of professors to make the educational environment qualified (CASTAÑEDA; ESTEVE; ADELL, 2018), decreasing digital exclusion (UNESCO, 2019).

Digital competencies can be understood as "holistic, situated, role-oriented in performance, function, and relationship, systemic, trainable and constantly developing"

(CASTAÑEDA; ESTEVE; ADELL, 2018, p. 14); that is, the professor must make conscious, safe, and critical use of ICTs in teaching-learning activities (PERIN, FREITAS, COELHO, 2021).

Thus, having the DCs was essential to provide quality and effective teaching during the restrictions imposed by the COVID-19 pandemic, in which several educational institutions were directed to adopt emergency remote teaching, as provided in the Ministry of Education ordinance no. 345 of 2020. This ordinance allowed courses provided by the presential modality to migrate temporarily to online activities (Hodges et al., 2020).

Costa Carvalho (2020) highlighted that this scenario had influenced a new posture in teaching, such as openness, dialogue, and greater student involvement. These changes need to be investigated to understand their impact and which are the possible paths for a quick adaptation to the new challenges. Therefore, showing the scenario of scientific research on digital competencies can characterize the research published on the subject and thus subsidize new studies.

Therefore, this study seeks to answer the following question: What is scientific production progress on digital competencies in higher education? To this end, the objective is to show the evolution of scientific production on digital competencies in higher education. Therefore, a literature review and a bibliometry of the theme were carried out between 2012 and 2021 in the following databases: Google Scholar, Periodicals of the Coordination for the Improvement of Higher Education Personnel (CAPES), Brazilian Digital Library of Theses and Dissertations (BDTD), and CAPES' Catalog of Theses and Dissertations.

2. COMPETENCIES

The studies on competence in Brazil in the 21st century seek a comprehensive way to investigate this theme from the perspective of several lenses. The essential and non-essential competencies for the organization, individual and group competencies, ideas, and real and professional competencies are investigated. Nonetheless, the concept of the term competence is still a broad discussion, in which there is not a complete and unique definition that is accepted by the various areas of science (PAIVA; MELO, 2008). This means that, depending on the area in which the scientific research seeks to investigate a given phenomenon, the researcher must understand the principles that guide the discussion and interpret the context in question to define which concept to adopt for the study.

Hence, in this study, the concept adopted competencies for action, as pointed out by Cassundé (2015, p. 47), who interprets this concept, aligned with authors of the French aspect, as "related to the ability to act within a given context responsibly and appropriately, integrating complex knowledge, skills, and attitudes." The French aspect proposes that the organization can teach workers and thus develop the competencies required to achieve superior performance (ZARIFIAN, 2008). Regarding professional competencies, Paiva (2007, p.45) defines this theme as:

> [...] the mobilization in a particular way by the professional in his productive action of a set of knowledge of different natures (which form the intellectual, technical-functional, behavioral, ethical, and political competencies) in order to generate results recognized individually (personal), collectively (professional), and socially (community).

For a professional to be considered competent in the teaching career, professionals must have the ability to constantly reinvent themselves from the changes that have occurred (GROHMANN; RAMOS, 2012). One of the studies whose research is oriented to understanding and mapping the new professor competencies is the book "The ten skills for teaching" by author and sociologist Philippe Perrenoud. In this work, Perrenoud (2000) highlights the emerging competencies that guide the basic and continuing education of students, in which they highlight reflective practices and training as a citizen. Including one of these competencies is the use of new technologies.

2.1 Digital competencies

New technologies can be represented through tablets, computers, interactive whiteboards, and the Virtual Learning Environment (VLE). When properly used for learning, these digital resources are transformative in the educational context. However, the actors involved in this process (Professors, Students, Administrative Technicians, and Managers) must develop digital competencies. In this way, the DCs can be understood as

> [...] the mobilization of the individual's training and experiences, with the purpose of the creative and conscious use of ICTs available in the work environment and context to meet the teaching-learning objectives, either online or offline (SOARES; MENDONÇA; PAIVA, 2021, p. 10).

This concept assigned by the authors is based on the review of national and international literature, as listed in Table 1. In this table, some concepts of the theme are addressed, organized as follows: the first column shows the authors, and the second column the attribution of the literal concept about digital competencies.

Table 1 - Concepts of digital competencies.

AUTHORS	CONCEPT
Perin, Freitas, and Coelho (2021)	"A set of knowledge, skills, attitudes, and values that promote the ability to use personal, social, and methodological skills in work or study situations and personal and professional development, and that are developed by teachers for the conscious, safe, and critical use of Digital Information and Communication Technologies in teaching and learning activities" (p. 14).
Castañeda, Esteve, and Adell (2018).	"Teaching competence for the digital world understood as holistic, situated, role-oriented in performance, function, and relationship, systemic, trainable, and constantly developing" (p. 14).
Lucas, Moreira, and Costa (2017)	"[...] is underpinned by ICT skills, specifically the use of computers to retrieve, evaluate, store, produce, present, and exchange information, and to communicate and participate in collaborative networks via the Internet" (p. 186)
Gutiérrez (2011)	"Values, beliefs, knowledge, skills, and attitudes in the appropriate use of technologies, including computers and different programs and the Internet, that enable the search, access, organization, and use of information in order to build knowledge" (p. 201)

Source: From the authors (2022)

The authors cited in the table above collaborate in the investigation of the theme, aligned with the contributions of international governmental and non-governmental institutions, such as the International Society for Technology in Education (ISTE), the United Nations Educational, Scientific and Cultural Organization (UNESCO), the Education and Technology Center of the Ministry of Education of Chile (ENLACES) and the National Institute of Educational Technologies and Teacher Training (INTEF), as well as the Department of Education of the Gov-

ernment of Catalonia, which have developed digital skills agendas (CASTAÑEDA; WAS; ADELL, 2018). "These institutions aim to map the competencies of citizens, to know the potentialities to interface with the world of work and the teaching process" (MINUZI, 2019, p. 31). In the case of Brazil, the country has the Innovation Center for Brazilian Education (CIEB), a civil, non-profit organization that has also contributed to and investigated the digital competencies focused on the professor's work. The CIEB points out the DCs in three pedagogical areas digital citizenship, and professional development (CIEB, 2019).

2.2 Digital competencies for higher education professors

For Mendonça et al. (2012), the professor's work in higher education demands specific knowledge, which includes teaching, research, extension, management, evaluation, interpersonal and technological knowledge. The digital competencies are arranged in the lives of these professionals, involving the ability to make an effective and didactic use of digital technologies in innovation processes (CANTABRANA; GISBERT-CERVERA; SILVA-QUIROZ, 2020). This has transformed the way of exercising the teaching profession in Brazil.

> Such changes require fluent digital skills from professors, which naturally include a technical dimension in the use of the computer and the Internet, to produce, present, exchange information, communicate and participate in cooperative networks, which cannot be separated from the pedagogical dimension associated with the use of strategies that promote the efficiency and quality of educational processes (JOLY; SILVA; ALMEIDA, 2012, p. 93).
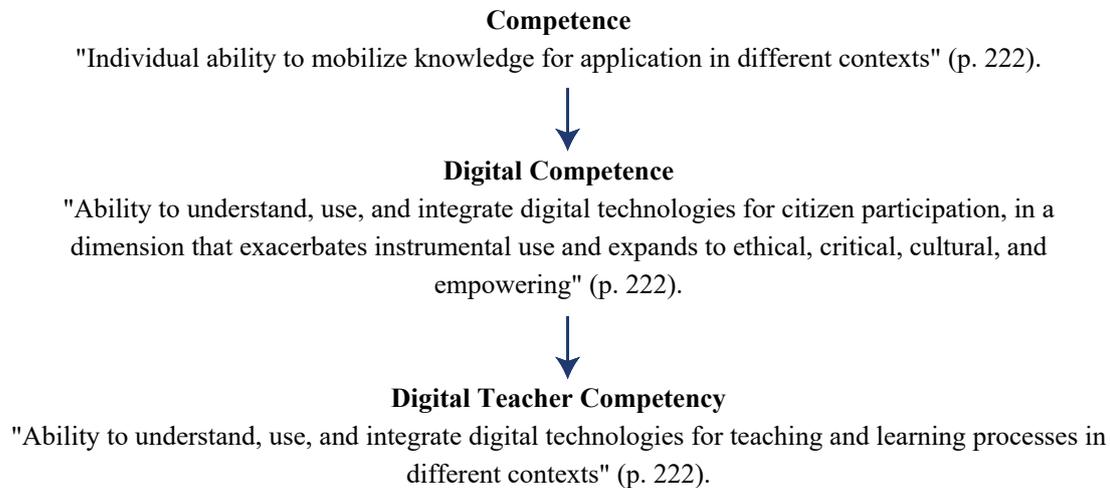
In relation to the Digital Teacher Competencies, according to the model developed by Perin, Freitas, and Coelho (2021), it includes the use of ICTs aligned to the curriculum in teaching activities; data management and interpersonal skills when transmitting information, besides being in constant learning and knowing how to interact with the immersed context.

A relevant point when investigating the theme is to understand the theoretical construction that underlies the discussion because it is common to find in the literature the use of terms misaligned with the theme, which influences barriers to the construction of new models. Some of these terms are usually adopted as synonyms for the theme; they are computer literacy, media literacy, digital literacy, digital fluency, ICT competence, technological competence, digital literacy, and professional digital competence (SILVA et al., 2020; PERIN; FREITAS; COELHO, 2021). Nevertheless, Soares, Mendonça, and Paiva (2021) clarify that terms such as digital literacy, digital literacy, and digital fluency integrate the process of DC formation (i.e., they are related but have different moments in the learning process).

Paz et al. (2021) also contributed by demonstrating the different concepts attributed to the themes of Competence, Digital Competence, and Teacher Digital Competence (Figure 1). In the figure, one can observe the differences that contribute to the evolution of the concepts attributed and synthesize the discussion of this section of the work.

Figure 1 - Definition of Competency, Digital Competency, and Teacher Digital Competency

Competence
"Individual ability to mobilize knowledge for application in different contexts" (p. 222).

Digital Competence
"Ability to understand, use, and integrate digital technologies for citizen participation, in a dimension that exacerbates instrumental use and expands to ethical, critical, cultural, and empowering" (p. 222).

Digital Teacher Competency
"Ability to understand, use, and integrate digital technologies for teaching and learning processes in different contexts" (p. 222).

Source: Adapted from Paz et al. (2021)

Given this, Digital Technology represents a major educational milestone (KENSKI; MEDEIROS; ORDÉAS, 2019), including influencing positive student performance (BATISTA; SILVA; SOUZA, 2021).

3. METHODOLOGY

In this study, Bibliometric Research is adopted to answer the research question. This type of research is characterized by quantitative data analysis and can cover dimensions such as the number of authors, number of articles, number of journals, and number of themes or institutions (SOARES; PICOLLI; CASAGRANDE, 2018).

The quantitative approach aims to test assumptions previously formulated in the form of hypotheses, as well as to describe through the sophisticated use of statistics the characterization of the investigated phenomenon and thus generalize the results (CRESWELL, 2010; FLICK, 2013). In its research design, the research questions present the intentionality of investigating relationships between variables (CRESWELL, 2010). This study is characterized as exploratory since it aims to explore the phenomenon to facilitate its understanding (COOPER, 2003).

The following terms were used: "digital competence," "digital competencies," and "digital teacher competency." The databases chosen were: Google Scholar, CAPES Periodical, Brazilian Digital Library of Theses and Dissertations (BDTD), and CAPES1 Catalog of Theses and Dissertations.

The following methodological steps guided this study:

1. **Selection of the databases:** For the selection of the databases, we used as criteria those with documents available in a free and accessible way.

2. **Keyword publication selection:** the following criteria were adopted for the selection of the papers:

I. In the search space, the strategy of proximity operators was used in the keywords, with quotation marks in the terms.

II. The advanced search feature was also used for clipping the papers.

III. The publication period of the papers was between 2012 and 2021.

IV. Papers written in Portuguese (Brazil) include the Brazilian national context as research.

V. Repeated papers, reviews, books, and bibliographic and editorial notes were excluded.

VI. The publications could be from various fields of knowledge as long as they involve the higher education teacher as the subject.

3. **Bibliometric database registration and analysis:** Microsoft Excel® spreadsheets were used to build the database with the selected papers.

4. **Definition of analysis categories:** due to the need to have a filter for data extraction, four categories were considered to identify the evolution of publications: i) papers published per year, (ii) the institutions linked to the work, according to the data informed by the authors at the time of publication, III) the format of the work (article, dissertation, thesis), and lastly, iv) the research strategy adopted in the study.

After defining the search terms and the databases, the data collection process was carried out. After the exclusion based on the title and abstract of the papers that were not adherent to the study, as well as the duplicate papers, 23 papers were selected from Google Scholar, 2 papers from CAPES Periodicals, 1 paper from BDTD, and 5 papers from the CAPES Theses and Dissertations Catalog, totaling 31 selected papers. Google Scholar was the database that presented the greatest range of results.

4. RESULTS AND DISCUSSION

The first category analyzed is the absolute frequency of published papers by year. In Figure 2, it is possible to notice that the triennium 2019–2021 obtained a growth in the publication of papers related to the investigated theme, corresponding to 27 (twenty-seven) published works, that is, approximately 87% of the papers present in the database. This period is marked by the COVID-19 pandemic, in which higher education institutions (HEIs) adopted the DICTs to continue their teaching activities. This scenario caused many professors to be influenced to develop digital competencies, and because of this, researchers began to investigate the theme more frequently.

Another factor that has contributed to drawing the attention of the scientific community in Brazil in the last three years was the trend of the semi-attendance teaching modality, which mixes face-to-face and distance curricular activities, predominate in the courses of the HEIs in Brazil (BLANCO; LACERDA, 2021). Digital Technologies influence new possibilities of teaching, and professors gain prominence in these processes of innovation in education (SCHUARTZ; SARMENTO, 2020, p. 430).

It is increasingly common for the availability of online content materials to complement face-to-face teaching. From the basic to graduate level, hybrid education has emerged as an alternative that will most likely continue to grow even after the end of the pandemic, not only in Brazil but worldwide (OLIVEIRA et al., 2021, p. 921).

Thus, the production of scientific knowledge on the subject should grow more and more to fill gaps in teacher training and in the structures of academic organizations that offer higher education courses (TORQUATO et al., 2021). Nogueira and Gouveia (2020) aimed to conduct a bibliometric study associated with digital competence between 2006 and 2019 and revealed that the theme has remained in growth since 2014 and that in 2018, it exponentially increased. It is worth noting that the authors investigated the theme beyond the Brazilian databases comprehensively, but that corroborates the findings of this study, in which the theme is emerging and has attracted the interest of researchers in recent years.

Figure 2 - Evolution of the scientific production on the theme Teachers' Digital Competencies in Brazil
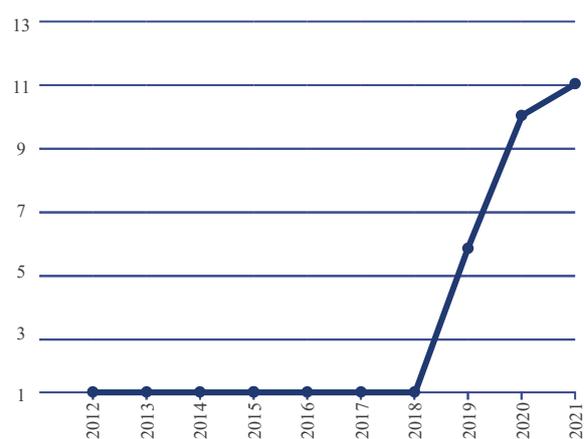
Source: From the authors (2022)

The second category analyzed the occurrence in which the HEIs, through the linked researchers, are listed in the database of the region of the HEI to which they belong in the Brazilian territory. To construct Figure 4, the list of 64 authors and the institutions to which they are linked was listed. In this process, the times that the name of the authors was repeated were not considered, that is, the names of the listed authors were not excluded with recurrence.

Thus, the five HEIs that have greater representativeness of the studies through the link of the researchers, in which they developed works on teachers' digital competencies are: Federal University of Santa Catarina (10 records), Federal University of Paraná (5 records), Federal Technological University of Paraná (4 records), Federal University of Rio Grande do Sul (3 records), University of Vale do São Francisco (3 records), and La Salle University (3 records). The records of the other Brazilian institutions are listed in Figure 4.

Public HEIs assume a fundamental role in scientific production in the country. Public policies have influenced this since the government of Fernando Henrique Cardoso (1995–2003), in which new organizational models in education influenced academic productivity and the insertion of new technologies. Among these policies is Law 9.394/96 of the Directives and Bases of Education, which assigns as a purpose of higher education

> To encourage research and scientific investigation aimed at developing science and technology and creating and disseminating culture, and thus develop an understanding of man and the environment in which he lives (Article 43, clause III).

In addition, another relevant fact is the number of researchers linked to international educational institutions present in the research. There are 11 records linked to HEIs

from Portugal, in which the investigation and application of the DigCompEdu model (European Framework of Digital Competence for Educators) with teachers from different levels of education (Infant to Superior) in the context of Brazilian education are recurrent in the selected works.

Figure 3 - Number of authors per higher education institution in Brazil
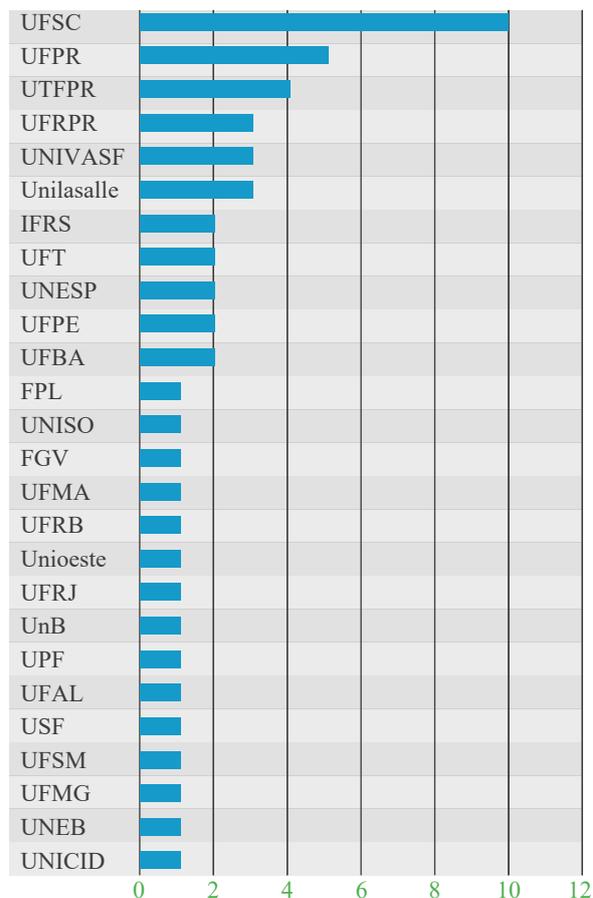
Source: From the authors (2022)

The third category analyzed was the percentage of the type of textual production in the database. As subcategories, the works were characterized as a) scientific articles (13 records) published in scientific journals, b) Master's dissertation (10 records) arising from the final defense of the students in academic or professional graduate programs, c) Articles published in scientific events (4 re-

cords) are usually works in development, d) Doctoral thesis (2 records) arising from the final defense of the students in academic or professional graduate programs. Only two works in different formats compose the database, denominated as others. One is an internal report on Technology, Network, and Society research group website, and the other is Preprint, which means that it has not yet been published in a peer-reviewed journal.

Figure 4 - Professors' textual production on digital skills
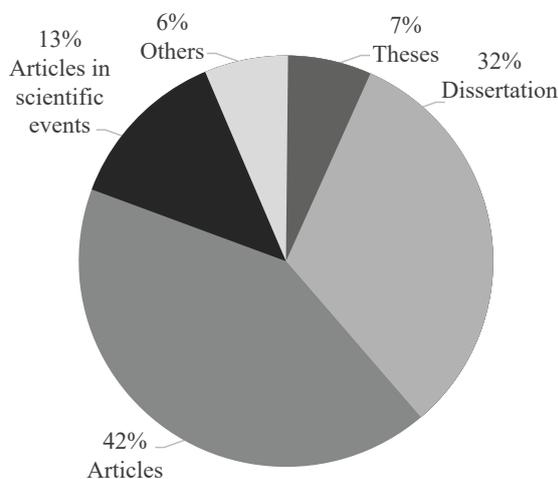
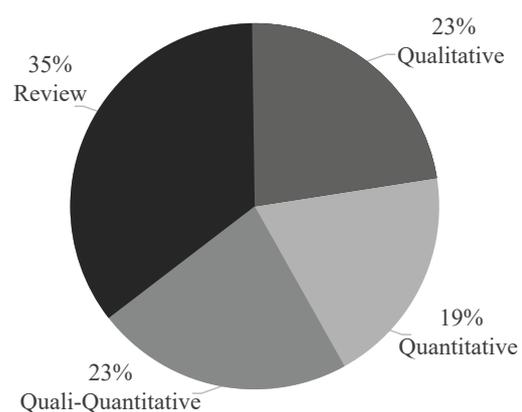Source: From the authors (2022)

By analyzing the areas of production of the papers, the area of education shows the highest occurrence of publications on the theme. The last category analyzed deals with the relative frequency of the scientific research strategy. The following methods were found and are presented in Figure 5:

- **Literature review:** Consists of a critical evaluation of already published works. In this case, "the author needs to expose a critical perspective and a personal contribution in the discussion of the problematic addressed" (SOARES, PICOLLI; CASAGRANDE, 2018, p. 04).

- **Qualitative:** Subjectivity, degree of induction, and searching for meaning in human experiences characterize qualitative research (FLICK, 2013).

- **Quantitative:** It aims to generalize the results and analyze the data; it is necessary to know the use of statistics to understand them. This approach does not consider the subjective perceptions of the subject, only the existence of the fact as an observable and measurable phenomenon that can be tested (SACCOL, 2009).

- **Quali-Quantitative:** This method adopts qualitative and quantitative research data collection instruments to analyze the same phenomenon (CRESWELL, 2010).

Thus, the highest percentage were the studies that used a literature review to investigate the theme, which corresponded to 11 studies. This was followed by a qualitative approach with 7 and a quali-quantitative approach with 7 works. Lastly, quantitative research with 6 works.

Figure 5 - Percentage of research strategies

Source: From the authors (2022)

As discussed, the topic of DCs in higher education teaching is emerging in Brazil. The investigation of international literature, whether systematic or not, allows us to know the state of the art and develop an overview of the discussion and research strategies. Therefore, literature review research is a basis for new studies in Brazil (GALVÃO; RICARTE, 2019).

5. CONCLUSION

As mentioned, digital technologies are present in several activities in the daily lives of Brazilians. With this advance, especially in education, the ability of teachers to adapt to new scenarios is essential. Competency in using ICTs requires these professionals to be open to integrating and reflecting on experiences at work and in their interaction with society.

This study consisted of presenting the panorama of scientific research on the topic of digital competencies in higher education teaching in Brazil. A bibliometric analysis of 31 papers published between 2012 and 2021 on the subject was carried out for the investigation. For the analysis, we considered 5 categories divided into Microsoft Excel® spreadsheets.

The survey data show that the discussion about DCs in higher education intensified in 2020 and 2021 since emergency remote teaching covered Brazilian HEIs and the trend of adopting semi-attendance teaching in educational institutions. Especially those of federal scope, in which most of the 64 authors listed in the database are linked to the federal institution.

Nevertheless, the participation of authors linked to institutions in Portugal demonstrates the interest of these researchers in investigating the Brazilian educational context. From the list of selected papers, roughly 42% of the sample are scientific articles published in journals in

the area of education and teaching. Thus, when comparing the area of Public and Business Administration, Accounting Sciences, and Tourism with the two mentioned, the works in this area have not generated much impact when analyzing the highest Qualis found in the area was B2. This indicates that the theme lacks research in this area.

However, Brazil's scientific community has discussed Digital Competence more frequently in recent years, since 35% of the studies seek a literature review to understand the contours and particularities of the theme, meaning researchers have sought to delve into the literature to develop their own study.

Thus, for future research, scales should be developed that measure teachers' mastery level in relation to ICTs, as well as theoretical models on digital competencies directed to professors' performance in higher education. Another suggestion for research, which was a limitation of this study, is to deepen the discussion about which strategies are being implemented for developing DCs in Brazilian higher education.

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