Digital competence of higher education professors in the adequation of remote teaching

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Abstract

Introduction: Adoption of remote teaching for the continuation of face-to-face classes during COVID-19 pandemic, urgently required the development of digital competences by academic community. **Objective:** analyze the digital competence of Brazilian higher education professors during the period of adaptation to remote teaching. **Method:** it is a survey with 322 Brazilian higher education professors. A questionnaire was applied to raise the professors' perception about remote teaching, as well as to assess their digital competence. **Results:** digital competences that need to be better developed by professors are: adoption of information management strategies; development of tools for online assessments; and use of tools to promote gamification and collaborative learning. **Discussion:** the development of these digital competences helps in solving the problems with remote teaching. Professors who usually take courses and exchange experiences are the ones with a greater development of the analyzed digital skills.

Competência digital de docentes da educação superior na adequação ao ensino remoto

Resumo

Introdução: A adoção do ensino remoto para a continuidade das aulas presenciais durante a pandemia de COVID-19 exigiu, de forma urgente, o desenvolvimento de competências digitais da comunidade acadêmica. **Objetivo:** analisar a competência digital de docentes da educação superior brasileira durante o período de adequação ao ensino remoto. **Método:** pesquisa de levantamento com 322 professores do ensino superior brasileiro. Um questionário foi aplicado para levantar a percepção dos professores acerca do ensino remoto, bem como avaliar sua competência digital. **Resultados:** as competências digitais que precisam ser melhor desenvolvidas são: adoção de estratégias de gestão da informação; desenvolvimento de ferramentas para avaliações online; uso de ferramentas para gamificação e a aprendizagem colaborativa. **Discussão:** o desenvolvimento dessas competências digitais auxilia na solução dos problemas com o ensino remoto. Docentes que costumam fazer cursos e trocar experiências são os que possuem um maior desenvolvimento das competências digitais analisadas.

Palavras-chave: competência digital; educação superior; formação docente; ensino remoto.

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Introduction

In mid-March 2020, with the onset of the COVID19 pandemic and the suspension of face-to-face classes at all levels of education, countries promoted emergency remote learning initiatives as a short-term solution for the continuity of teaching and learning processes. Each initiative depended on the technical capacity of the institutions, their organizational skills, and the digital competence of their educational community, as pointed out by the International Institute for Higher Education in Latin America and the Caribbean (IESALC, 2020).

In Brazil, the authorization for Higher Education Institutions (HEIs) to replace face-to-face classes with classes mediated by Information and Communication Technologies (ICT) came with the publication of Portaria (ministerial directive) 343, of March 17, 2020, by the Ministry of Education (MEC, 2020). After the publication of Portaria, the private education network took days or weeks to adjust its activities and adapt to remote teaching, while most public HEIs took practically the entire first semester to make this reorganization (Kohls-Santos, 2021). Among the factors that justify this difference in time for adaptation are the lack of resources and the shortage of qualified professors.

The stoppage of face-to-face classes highlighted the necessary changes that were taking place in the educational context even before the pandemic, such as the establishment of teaching and learning strategies and pedagogical innovation with and through digital technologies (Kohls-Santos, 2021). In this way, HEIs that were already adapting to these changes found it easier to adapt to remote teaching compared to HEIs that were not adapting.

Continuing face-to-face classes remotely required the institutions to implement three stages: i. diagnosis of the situation; ii. design and training, to strengthen the institutional and digital competences of those involved; and iii. ongoing technical-pedagogical support and follow-up (Martín-Cuadrado et al., 2021).

In view of this, after the authorization of emergency remote teaching, HEIs mobilized to adjust their technological resources and promote adequate training for professors and students.

It is important to point out that, in addition to the difficulties mentioned above, there are others that have led to the late adoption of remote teaching in some HEIs. These include the difficulty of accessing technology, the lack of equity due to regional inequalities, and the lack of adequate infrastructure. However, the focus of this research is on professors' digital competence, since the pandemic has further highlighted its importance in implementing technology-enhanced learning practices at all levels of education (Sillat et al., 2021).

Among the basic skills that every citizen should have for lifelong learning is digital competence (European Commission, 2006). It is considered a human right and its concept goes beyond technical competence related to technology, assuming that it includes areas such as: information management; collaboration; the ability to communicate and share information; content creation and co-knowledge; ethics and responsibility; evaluation and problem-solving; and, finally, technical competence (Ferrari, 2012). Thus, to be considered digitally competent requires a certain set of knowledge, skills, and attitudes towards ICT (Lopes Pereira et al., 2019) and not just their use (Durán Cuartero et al., 2019).

In the educational context, digital competence is defined as the set of skills and abilities that incorporate and make appropriate use of ICT as a methodological resource, integrated into the teaching-learning process, becoming Learning and Knowledge Technologies with a clear didactic application (Tourón et al., 2018).

Therefore, the concept of digital competence in teaching includes (Durán Cuartero et al., 2019): i. the appropriate dimensions of the concept of digital competence (technological/technical component, communicative/informational component, and multimedia literacy); ii. the ability to effectively use technologies in educational contexts with pedagogical criteria is added to these dimensions. Also, in the educational context, different actors make up digital competence. Students, teachers, and other education professionals, as well as the institution itself, form an integrated phenomenon. Digital competence is an organizational task, influenced and driven by various contextual

factors embedded within and across the wider school organization (Pettersson, 2018).

Digital competence in the educational context requires a more complex set of competences compared to other areas (From, 2017). For this reason, specific digital competence models have emerged for education. One of these models is DigCompEdu, an initiative of the European Union, which aims to provide a common basis for developing, comparing, and discussing different instruments for developing the digital competence of teachers at national, regional, or local level (Lucas & Moreira, 2018; Redecker, 2017). This model proposes 22 competences organized into six areas: professional involvement, digital resources, teaching and learning, assessment, student empowerment, and promoting students' digital competence. It should be noted that the DigCompEdu areas and competences are interdependent and complementary, i.e. some competences could be classified or relate to more than one area.

Another globally accepted model that has been studied and applied at all levels of education is Technological Pedagogical Content Knowledge (TPACK). Its structure derives from the notion that technological integration in a specific educational context needs careful alignment between content, pedagogy, and technology. Therefore, teachers who wish to integrate technology into their teaching practice need to be competent in these three domains (Mishra & Koehler, 2006; Voogt et al., 2013).

One of the evolutions of TPACK deals with higher education and is called "Commitments and competencies of the quality teacher." In this proposal for TPACK, the elements of research and innovation have been added to the TPACK proposal. Research combined with innovation involves reflection on the subject area and on teaching practice; pedagogical research and openness to methodological innovations; creation and application of new knowledge, perspectives, methodologies, and resources in the different dimensions of teaching activity, with the aim of improving the quality of the teaching-learning process (García Aretio, 2014, 2020).

In the model, it is also possible to highlight the commitments that a good teacher needs to make, which are: professional (fulfilling the contractual obligations assumed—to turn teaching into a profession); social (education is a fundamental right); ethical; training and ongoing updating; collaboration with teachers and learning networks; management (which each teacher voluntarily acquires with the institution where they work) (García Aretio, 2014, 2020).

Durán Cuartero et al., (2016) carried out another relevant study on models dealing with the digital competence of higher education professors. The research compared digital competence models: for citizenship, for teachers in general and specifically for professors. Digital competence for citizens covers a more technological component, where competence concerns knowledge and use of ICT for any area of personal life. From this, the digital competence of teachers includes the elements of competence for citizens and adds all the elements of the pedagogical component related to the use of technologies as resources for teaching. Finally, as a differentiating factor, the digital competence models for university lecturers, in addition to the elements mentioned above, add those related to research (use of information resources, dissemination, data analysis, or other research procedures) and management or administration. Thus, there are three areas of activity for university lecturers: teaching, research, and management (Durán Cuartero et al., (2016).

The models discussed here show that for higher education there are specific elements that must be considered, such as the research and university management.

In the Brazilian context, there is one more element that is part of teaching activities and the tripod of higher education: extension activities. These activities should promote transformative interaction between HEIs and other sectors of society, through the production and application of knowledge, in permanent articulation with teaching and research (MEC, 2018). Teaching, research, and extension activities must be integrated and articulated together. This articulation is provided

for in a single, interdisciplinary pedagogical process (MEC, 2018). In this way, the development of digital competences in higher education professors must include, in addition to teaching, research, extension, and university management activities.

In view of the above, the general aim of this research is to analyze the digital competence of Brazilian higher education professors during the period of adaptation to remote teaching imposed by the COVID-19 pandemic. It is hoped that the results can contribute to future actions by HEIs in the post-pandemic period, in drawing up teacher training plans, or in public initiatives in relation to higher education.

Method

Design

This study is classified as descriptive, with a mixed qualitative and quantitative approach. It is a survey, with data collected using an online questionnaire applied to professors in Brazilian higher education in June and July 2020, i.e. at the beginning of the adoption of remote teaching by most universities.

Participants

According to the 2019 Higher Education Census, published by the Instituto Nacional de Estudos e Pesquisas Educacionais Anísio Teixeira (INEP, 2020), Brazil has 399,428 professors working in higher education, of which 186,217 (46.62%) work in public HEIs and 213,211 (53.38%) in private HEIs. We obtained 322 valid responses to the questionnaire and the sample is considered to be non-probabilistic from a finite population.

This figure corresponds to a confidence level of 99% with an inferential error of 7% (Bruni, 2013).

Instruments

The questionnaire consists of two parts: i) characterization of the respondents and their perception of remote teaching, and ii) selfassessment of digital teaching competence. It is classified as a cross-sectional study, as the data is collected over a given period, usually based on a random sample (cross-sectional data) (Richardson, 2017), obtaining a snapshot of the social situation at the time of data collection. The variables for characterizing the sample and collecting data on remote education are shown in Table 1.

To identify the digital competence of lecturers (second part of the questionnaire), a competence-based assessment based on rubrics was created. The competence units were defined and the rubrics developed based on DigCompEdu (Redecker, 2017), the digital competence model for higher education by Duran Cuartero et al., (2016) and and the TPACK premises for higher education (García Aretio, 2014, 2020). The models present an extensive and exhaustive list of competences. For the sake of simplicity, it was decided to work with 11 interdependent units that represent all the areas of the models and provide a summary of the competencies. These variables are described in Table 2.

For each unit of competence presented, there are 5 levels (rubrics) for assessing professors' digital competence:

1. No knowledge: This is the most basic level, where the professor has no knowledge of the subject, very little knowledge, or no interest.
2. Motivation: Recognizes the importance of competence and is beginning to learn about it.
3. Attitude: In addition to recognizing the importance, the professor researches the subject and begins to adopt it in some teaching activities.
4. Attitude and skill: The professor is motivated, knows some tools, and has the skills to use them in his teaching activities.
5. Knowledge, skill, attitude: This is the highest level of digital competence development. The professor has the motivation, knowledge, attitudes, and skills to use ICT in the teaching activities that are appropriate to their use.

The complete headings with the respective frequencies of occurrence can be found in Appendix 1.

Procedures

Prior to application, the questionnaire was pretested by 9 higher education professors involved in higher education issues. After making the necessary adjustments, the data was collected online using the Google Forms platform. At the start of the questionnaire, the Informed Consent Form (ICF) was presented, outlining the objectives of the research, and ensuring the anonymity of the participant.

The questionnaire was distributed by e-mail and social media to professors belonging to the researchers' network of contacts.

Table 1

Variables to Characterize the Sample

Variable	Description
age	*Identifies the age range.*
gender	*Identifies gender: male, female, not informed.*
uf	*Federation unit (or state).*
area	*Area of knowledge that the professor teaches.*
institution	*Whether you're public, private, or work in both.*
hiring	*Form of employment (civil service, CLT, temporary, or other)*
workload	*Weekly working hours.*
workQuarantine	*He worked more, less, or the same as before the pandemic.*
modeRemote	*Whether or not the HEI adopted the remote modality at the beginning of the pandemic.*
continuity	*Feasibility of remote teaching.*
resources	*Technological resources that the professor has.*
internet	*Internet access.*
activities	*Teaching activities during quarantine.*
challenges	*Teaching challenges encountered in quarantine.*

Table 2

Variables for Assessing Digital Teaching Competence

Variable (Competence Unit)	Description
evaluationInformationWeb	*Critical evaluation of web information.*
storage	*Tools for storing and managing shared files and content.*
strategiesGI	*Information Management Strategies.*
socialnetworksCommunities	*Social networks and learning communities.*
toolsCollaborativeLearning	*Tools for collaborative learning.*
toolsEvaluations	*Tools for designing evaluations.*
toolsContextCreation	*Tools for creating digital content.*
toolsGamification	*Tools that help gamify learning.*
security	*Security of equipment and information.*
solutionsProblems	*Solutions to technical problems arising from the use of digital devices in the classroom.*
update	*Ways to update and incorporate new devices, applications, or tools.*

Data Analysis

The data was analyzed descriptively, using electronic spreadsheets to compile the results.

For the quantitative analysis, the variables were considered categorical. All the variables in Table 2 were related to all the variables in Table 1 to see if there was a significant relationship between professors' digital competences and perceptions of remote teaching and other particular characteristics of the sample.

To relate the variables, Pearson's chi-square test was used, calculating the degree of freedom and the p-value. The chi-square test identified whether there was a significant association between two categorical variables, and significance was measured by the p-value and, if less than 0.05, the hypothesis that the variables are independent was rejected and the hypothesis that they are related was accepted (Field et al., 2012). For the variables where a significant relationship was identified, contingency tables were generated with the frequencies of responses. In addition, the variable/competence unit updating was related to the other competence units to identify whether there is a relationship between the ways in which professors update themselves and the development of digital competencies.

Results

The results are presented in two stages: i. descriptive analysis characterizing the sample and 'professors' perceptions of remote teaching; and ii. an analysis of the relationships between the variables studied.

Descriptive Analysis

Regarding the characterization of the sample, Table 3 shows data on the age group, area of knowledge to which the professor belongs, gender, whether the professor works at a public or private university, form of employment, and teaching workload.

Table 3
Characterization of the Sample

Age group	Quantity	%
From 25 to 29 years old	*9*	*3%*
From 30 to 34 years old	*35*	*11%*
From 35 to 39 years old	*44*	*14%*
From 40 to 44 years old	*56*	*17%*
From 45 to 49 years old	*50*	*16%*
From 50 to 54 years old	*47*	*15%*
From 55 to 59 years old	*43*	*13%*
From 60 to 64 years old	*21*	*7%*
Over 65	*17*	*5%*
Total	**322**	**100%**

Area of knowledge	Quantity	%
Applied Social Sciences	*115*	*36%*
Exact Sciences	*86*	*27%*
Humanities	*43*	*13%*
Health Sciences	*35*	*11%*
Not informed	*16*	*5%*
Agricultural Sciences	*9*	*3%*
Biological Sciences	*9*	*3%*
Linguistics, Literature, and Arts	*9*	*3%*
Total	**322**	**100%**

Gender	Quantity	%
Female	*163*	*51%*
Male	*157*	*49%*
Not informed	*2*	*1%*
Total	**322**	**100%**

Hiring	Quantity	%
Civil servant / permanent	*246*	*76%*
CLT Contractor	*56*	*17%*
Temporary contract	*11*	*3%*
Other	*9*	*3%*
Total	**322**	**100%**

Institution	Quantity	%
Public	*244*	*76%*
Private	*66*	*20%*
I work in both	*12*	*4%*
Total	**322**	**100%**

Workload	Quantity	%
Up to 16 hours	*50*	*16%*
From 16 to 32 hours	*72*	*22%*
From 32 to 60 hours	*185*	*57%*
Over 60 hours	*15*	*5%*
Total	**322**	**100%**

There is a predominance of professors from public HEIs compared to private HEIs and, consequently, the way professors are hired is by competitive examination. The predominant areas of knowledge are Applied Social Sciences and Exact Sciences. It should also be noted that the distribution between the different regions of Brazil is also not proportional, with 70% of the teachers being from the south of Brazil, 17% from the northeast, 8% from the southeast, 2% from the north and 1% did not identify their location. For the other variables, there were no significant differences in frequency distribution between the groups.

Regarding remote teaching, Table 4 summarizes the variables relating to professors ' perceptions.

Although remote teaching has not been adopted by some HEIs, most of them have continued with the classes, and most professors find it a viable alternative, even if only partially. This is probably due to the fact that most of the respondents have internet access and their own technological resources for conducting remote classes (96% have a notebook, 36% a computer, and 91% a smartphone), which has facilitated the adoption of remote teaching and the continuation of most of the respondents' teaching activities, as shown in Table 5.

The "Other activities" in Table 5 refer to the continuation of research projects, management/ administration activities, and the development of professor training courses. All these activities are inherent to the higher education professors and make up the teaching, research, and extension tripod.

The challenges encountered in conducting remote lessons during quarantine are presented in Table 6, in descending order of frequency.

The main challenges faced by professors (lesson preparation time, information overload, difficulty interacting with students, assessment difficulties) are related to the low development of some digital competences. This relationship can be seen by analyzing the frequency distribution of the digital competence units shown in Figure 1.

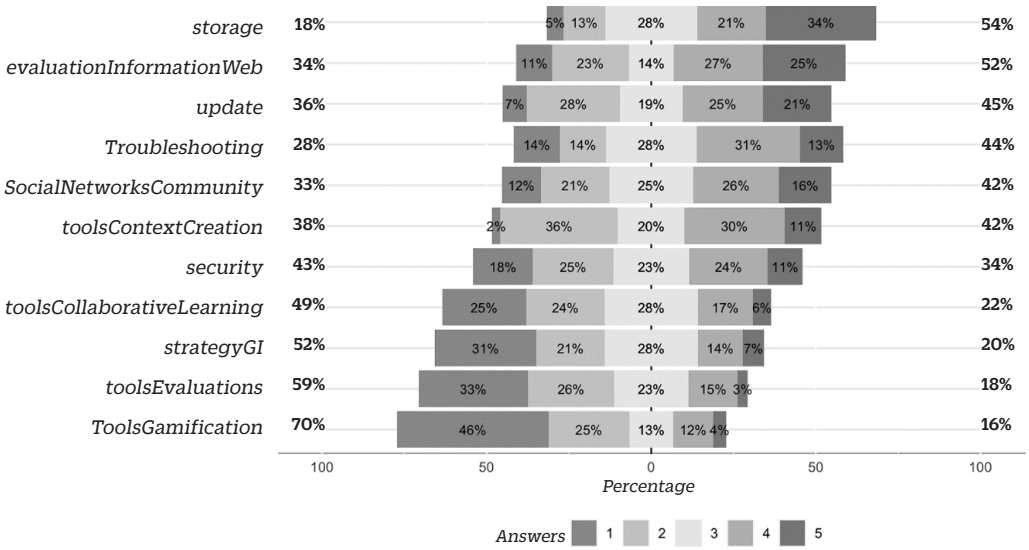
Table 4
About Remote Learning

HEI's adoption of remote modality	**Quantity**	**%**
Left free for each course / professor to evaluate	*135*	*42%*
Yes, in all courses	*108*	*34%*
Yes, in some courses	*21*	*7%*
No	*40*	*12%*
Under review	*18*	*6%*
Total	**322**	**100%**
Opinion on the viability of remote learning	**Quantity**	**%**
A viable alternative for some subjects and/or courses	*213*	*66%*
A viable alternative	*86*	*27%*
Feasible, with restrictions	*9*	*3%*
An unviable alternative	*14*	*4%*
Total	**322**	**100%**
Workload in remote teaching	Quantity	%
Working harder than before	*234*	*73%*
Working less than before	*48*	*15%*
Working just like before	*40*	*12%*
Grand Total	322	100%

Table 5
Teaching Activities during Quarantine

Activity	Quantity	%
Meetings with other professors	*275*	*85%*
Lesson planning	*266*	*83%*
Meetings with managers	*259*	*80%*
Writing articles, projects, books, etc.	*258*	*80%*
Guidance for students on virtual platforms	*256*	*80%*
Preparing and sending texts, articles, and other materials to students	*235*	*73%*
Conducting research	*235*	*73%*
Preparing / correcting exercises for students	*207*	*64%*
Virtual chats and forums	*200*	*62%*
Participation on boards	*192*	*60%*
Synchronous classes, at class time	*174*	*54%*
Recording lessons for the Internet	*141*	*44%*
Managing to do little or no activity	*6*	*2%*
Other activities	*33*	*10%*

Figure 1
Digital Competence of Higher Education Professors



The competences that received the highest frequency under headings 1 and 2, i.e. those that still need to be better developed by professors, are: adoption of Information Management strategies, which can help to manage information overload; development of tools for online assessments, which help to solve this difficulty, pointed out by the professors; use of tools to promote gamification and the use of tools for collaborative learning, which improve the problem of integration with students. In general, more developed digital competences make the whole process of planning and executing online classes easier, as well as developing other activities inherent to teaching in higher education, such as research, extension, and university management.

Table 6
Challenges Encountered during the Quarantine period

Challenges	Quantity	%
It takes longer to prepare online lessons.	*213*	*66%*
I can't keep up with all the live sessions and trainings I'd like to.	*207*	*64%*
Information overload (too many lives, courses, training).	*204*	*63%*
Interaction with students is more complicated remotely.	*195*	*61%*
Reconciling lessons with homework.	*158*	*49%*
Difficulty in finding ways to assess students.	*130*	*40%*
Difficulty using some tools for online classes.	*125*	*39%*
I need to share technological resources with other people.	*84*	*26%*
I need to help my children with their online lessons.	*65*	*20%*
I don't have the skills to conduct remote classes.	*27*	*8%*
I'm not finding it difficult to conduct remote classes.	*23*	*7%*
Other	*2*	*1%*

Table 7
Statistics of the Relationships between the Variables that Showed Dependence

Variable 1	Variable 2	chi2	p-value	dof
gender	*solutionsProblems*	*23*	*0,011*	*10*
institution	*toolsEvaluations*	*34*	*0,003*	*15*
hiring	*toolsCollaborativeLearning*	*45*	*0,009*	*25*
modeRemote	*toolsEvaluations*	*39*	*0,039*	*25*
modeRemote	*toolsContextCreation*	*39*	*0,041*	*25*
workQuarantine	*evaluationInformationWeb*	*27*	*0,026*	*15*
continuity	*update*	*34*	*0,026*	*20*

Analysis of Relationships Between Variables

To understand the development of digital competence in higher education professors, the variables dealing with their characteristics and their perception of remote teaching were compared with the variables dealing with digital competences. Of all the relationships, seven stood out, showing that there is dependence between the variables (p-value < 0.05); these relationships can be seen in Table 7.

When relating the gender variable to the problem-solving variable, males have the most developed digital competence for solving technical problems arising from the use of digital devices in the classroom, showing slightly more autonomy than females on this question. The contingency table for this relationship shows that 36% of the female gender marked items 4 and 5, while the male gender accounted for 54% of the respondents.

The other competencies did not show significant differences between genders.

The relationship between the variables institution and toolsAssessments shows that digital competence related to the use of tools to assess learning is more developed in professors who work in private institutions than those who work in public institutions.

A similar conclusion is reached when relating the variables hiring and CollaborativeLearningTools.

Professors who are employed under the "competitive or permanent" contract (predominantly in public HEIs) have a higher concentration of competence levels under headings 1 and 2 (54%). Those with "CLT - Consolidation of Labor Laws" and "Temporary" contracts (predominant in private HEIs) have a lower concentration of frequencies in headings 1 and 2.

The relationship between the variables modalityRemote and toolsEvaluations shows that lecturers working in HEIs that have adopted remote teaching in all courses in advance are the ones with the greatest skills in carrying out online evaluations. The survey found that private universities were the pioneers in adopting remote teaching.

The same occurs when relating the variables modalityRemote and toolsContextCreation. The relationship indicates that HEIs that adopted remote teaching in all courses at the beginning of the pandemic have professors with more developed digital competence for creating digital content than those working in HEIs that did not adopt remote teaching early on.

Another dependency relationship was found when relating the variables workQuarantine and evaluationWebInformation. It shows that professors who are working as much as they did before the pandemic have high digital competence in evaluating the information available on the web. Professors who are working less than before the pandemic, probably because their HEIs had not previously adopted remote teaching, are those who have lower competencies in evaluating information.

The last relationship found was between the variables continuity and updating. This indicates that the majority of professors who do not usually update themselves or take courses to incorporate technological resources into their classes find remote teaching an unfeasible alternative. On the other hand, those who usually take courses, whether compulsory or not, are the ones who think remote teaching is a viable alternative or viable with restrictions.

Competence unit 11 (updating) is related to professors' continuing education, i.e. ways of updating and incorporating new devices, applications, or tools into lessons. This variable was related to all the other digital competence units, in order to identify whether there is a relationship between the way professors approach their training and the development of other digital competences. All the relationships were dependent (p-value < 0.05) and the results of the statistics can be seen in Table 8.

These results indicate that professors who usually take courses, both compulsory and non-compulsory, on the incorporation of technological resources in education and who exchange experiences with other professors in the search for innovation, are the ones with the greatest development of all the digital competences analyzed.

Table 8

Statistics of the Relationship between the Updating Variable and the Other Competence Variables

Variable 1	Variable 2	chi2	p-value	dof
update	*evaluationInformationWeb*	*45*	*0,008*	*25*
update	*storage*	*78*	*0,000*	*25*
update	*strategyGI*	*59*	*0,000*	*25*
update	*socialnetworksCommunity*	*51*	*0,001*	*25*
update	*toolsCollaborativeLearning*	*96*	*0,000*	*25*
update	*toolsEvaluations*	*89*	*0,000*	*25*
update	*toolsContextCreation*	*74*	*0,000*	*25*
update	*toolsGamification*	*86*	*0,000*	*25*
update	*security*	*81*	*0,000*	*25*
update	*solutionsProblems*	*116*	*0,000*	*25*

Discussion

The discussion is grouped according to some relevant aspects found in other research on digital competence carried out mainly during the COVID-19 pandemic. These are: differences between genders, differences between public and private higher education institutions, and the continuing training of professors.

Gender Differences

This study found a significant difference in favor of males in the skill related to solving technical problems arising from the use of digital devices in the classroom. No significant differences were found in the other skills. Similarly, Pozos Pérez & Tejada Fernández (2018) found similar competencies in male and female professors in general, except in the competence relating to the environment, health and safety at work with the use of ICT in the teaching profession, where female professors have greater competencies than male professors.

Portillo et al., (2020) and Zhao et al., (2021) found lower average values for digital competence development in female professors than in male professors in general. These results partially corroborate the research by Guillén-Gámez et al., (2021), who found slightly more developed digital competences in males compared to females, except for the question that addresses the intention to incorporate information technologies in the classroom and to continue the process of training and education to develop digital competencies, where the female gender has a greater intention than the male gender.

Therefore, it can be seen that, in general, male and female professors have similarly developed digital competence, except in a few specific cases that need further investigation and could be justified by some contextual reason.

Differences Between Public and Private HEIs

When relating the digital competences of lecturers from public and private HEIs, significant differences were found in favor of lecturers from private HEIs in three competences: use of tools for assessments, for collaborative learning, and for content creation. In the other competences, the levels were similar.

Pozos Pérez & Tejada Fernández (2018) also found similar levels in professors from public and private HEIs, except for the competence related to evaluating knowledgebuilding processes, where professors from private HEIs had significantly higher proficiency than those from public ones. Portillo et al., (2020) found, in general, lower levels of digital competence in professors from public HEIs compared to those working in private institutions.

Private HEIs had to deal with the urgency of continuing classes differently (Kohls-Santos, 2021), as their revenues would cease to exist if they were suspended and their activities would be compromised. The rapid resumption of classes remotely and the intensification of professor training justify, in recent research, a greater difference between the levels of digital competence of professors at public and private HEIs.

Professor Training

Professors who do not usually update or take courses to incorporate technological resources into their classes find remote teaching an unviable alternative.

Likewise, professors who usually invest in ongoing training have the highest levels of digital competence. Similar results were found by Pozos Pérez & Tejada Fernández (2018), where professors who undergo ongoing training have significantly higher levels of digital competence than those who do not undergo training. In addition to the importance of ongoing training, the research demonstrates the need for ongoing support and monitoring for the proper integration of ICT in university teaching.

HEIs have specificities that cannot be ignored and become even more important when we consider the variety of objectives and cultures that exist in the world of higher education. Therefore, the focus should not only be on investing in technological infrastructure, but it is also essential to invest in the training of professors and managers (Rodríguez-Abitia et al., 2020) to meet these specific needs.

Thus, HEIs should provide adequate training for their professors, motivate them to self-learning and professional development, encourage them to exchange experiences with other professors, increase investments in their training, as well as developing a training plan (Shurygin et al., 2021).

Various studies have pointed to weaknesses in the development of professors' digital competences, which indicates the need for HEIs to develop training models and plans, taking into account the different teaching modalities, for continuing training (Dias-Trindade & do Espírito Santo, 2021; Santos et al., 2021), in other words, it is necessary to systematize the integration of digital competences into the professor training process.

Final Considerations

The results contribute to the preparation of training plans by institutions and to decisionmaking regarding the continuity of classes in a post-pandemic period.

To draw up training plans to incorporate digital competence into them, HEIs first need to identify the level of digital competence of their teaching staff. To this end, the survey instrument based on the digital competence models and based on rubrics is effective for a general diagnosis of the digital competence of the institution's teaching staff and can be used by any HEI. It is necessary to identify whether professors have knowledge, motivation, attitude, and ability in relation to ICT, all of which starts with motivation. Even if there is no knowledge or ability, but there is motivation to learn and innovate, training plans can be drawn up to help professors develop and improve their digital competence.

The survey instrument is considerably smaller compared to other instruments for assessing professors' digital competence, but the units of selected competence and the developed rubrics integrate all the areas of the digital competence models used as a basis for this work and are interdependent. The general overview provided by the research results is in line with the majority of studies assessing professors' digital competence.

It is concluded that digital competence has been a fundamental item in the teaching-learning process during the pandemic and the recommendation is that professors improve this competence (Martín-Cuadrado et al., 2021). The creation of relevant learning strategies, the use of appropriate tools (Zhao et al., 2021) and training in digital competence for higher education lecturers are key elements for quality education (Cabero-Almenara et al., 2021). Furthermore, if ICT had not been integrated into the teaching-learning process during 2020, the continuity of classes would possibly not have been possible (Cabero-Almenara et al., 2021)

Universities that adopt better technological resources and have training plans for their teaching staff, geared towards the pedagogical application of technology, are the ones that have teaching staff with a more advanced level of digital competences (Jorge-Vázquez et al., 2021). This leads us to conclude that it is necessary for education policies to prioritize actions that promote the development of professors' digital competencies, i.e. alignment between policies and continuing education programs at universities is necessary (Sánchez-Antolín et al., 2014).

For future studies, we suggest diagnosing how Brazilian universities treat the training of their professors, especially training in digital competence, as well as identifying how digital competence can be integrated into universities' continuing education programs.

A limitation of the research is the sampling strategy, as the questionnaire was sent to research groups and professors in the researchers' contact network. For this reason, most of the respondents are concentrated in the same region of Brazil and in similar areas of knowledge. Therefore, the sample is considered non-probabilistic, making it difficult to generalize the data to all professors in Brazilian higher education.

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Apendice 1

	Unidade de competência	1. Não tem conhecimento	2. Motivação	3. Atitude	4. Tem atitude e habilidade	5. Conhecimento, habilidade, atitude
1	Avaliação crítica da informação web	Não sei como verificar se uma informação web é atualizada e se possui fontes confiáveis.	Sei da importância e estou aprendendo a verificar se uma fonte é confiável e está atualizada.	Sei como verificar se uma informação web é atualizada e se possui fontes confiáveis, porém acho complicado fazer uma crítica.	Sei quais as ferramentas utilizar para verificação da confiabilidade da informação, como diferenciar *fake news* de notícias verídicas.	Sei quais as ferramentas utilizar para verificação da confiabilidade da informação, como diferenciar fake news de notícias verídicas e confiro qual é a fonte antes de utilizá-la. Quando a informação não é legítima, utilizo os canais de denúncia.
	%	10,87%	23,29%	13,66%	27,02%	25,16%
2	Ferramentas para armazenamento e gestão de arquivos e conteúdo compartilhados	Não costumo usar ferramentas para armazenamento de arquivos e gestão de conteúdos compartilhados como o Google Drive, One Drive, Dropbox.	Estou começando a aprender a usar ferramentas para armazenamento e gestão de arquivos e conteúdos compartilhados como o Google Drive, One Drive, Dropbox.	Utilizo ferramentas para armazenamento de documentos em nuvem, porém ainda tenho que melhorar a organização e gestão dos meus conteúdos.	Utilizo ferramentas como o Google Drive, One Drive, Dropbox, tanto para armazenamento de arquivos quanto para a gestão deles e dos seus conteúdos.	Utilizo com segurança e domínio ferramentas como o Google Drive, One Drive, Dropbox, tanto para armazenamento de arquivos quanto para a gestão deles e dos seus conteúdos. Utilizo essas ferramentas de forma colaborativa com meus alunos e outros docentes.
	%	4,97%	12,73%	27,95%	20,81%	33,54%
3	Estratégias de Gestão da Informação	Não conheço ou utilizo estratégias de gestão da informação (produção, classificação, avaliação, recuperação da informação, etc.)	Sei da importância e estou aprendendo sobre as premissas da gestão da informação (produção, classificação, avaliação, recuperação da informação, etc.)	Conheço algumas estratégias de Gestão da Informação, porém utilizo pouco.	Conheço a maioria das estratégias de Gestão da Informação e costumo aplicá-las em minhas atividades docentes.	Aplico seguramente as estratégias da Gestão da Informação e elas são relevantes para a minha rotina docente.
	%	30,75%	20,81%	28,26%	13,66%	6,52%
4	Redes sociais e comunidades de aprendizagem	Tenho dificuldades para usar redes sociais e comunidades de aprendizagem para acompanhar e compartilhar conteúdos educativos.	Percebo a importância de utilizar as redes sociais para comunicação e para compartilhar informações com os alunos, mas tenho receio em utilizar.	Sei utilizar redes sociais e comunidades de aprendizagem para fins educativos, porém fico inseguro (a) para compartilhar informações.	Utilizo redes sociais e comunidades de aprendizagem para fins educativos. Sigo perfis que me auxiliam nas atividades docentes e, eventualmente, compartilho minhas experiências e informações.	Utilizo seguramente redes sociais e/ou comunidades de aprendizagem para fins educativos, seja para acompanhar as novidades ou compartilhar conteúdo que produzo em minhas atividades docentes, com alunos e outros docentes.
	%	11,80%	20,81%	25,47%	26,09%	15,84%

	Unidade de competência	1. Não tem conhecimento	2. Motivação	3. Atitude	4. Tem atitude e habilidade	5. Conhecimento, habilidade, atitude
5	Ferramentas para a aprendizagem colaborativa	Entendo pouco sobre ferramentas que facilitam a aprendizagem colaborativa.	Sei da importância de colaborar com meus colegas, porém tenho dificuldades de utilizar as ferramentas de colaboração.	Conheço ferramentas para a aprendizagem colaborativa, porém acho trabalhoso e complicado adota-las em minhas atividades docentes.	Conheço ferramentas para a aprendizagem colaborativa e, frequentemente, utilizo blogs, wikis, etc. em minhas atividades docentes.	Tenho domínio de ferramentas para aprendizagem colaborativa, como blogs e wikis, e elas estão sempre presentes em minhas atividades docentes, seja para divulgação de material ou para auxiliar os alunos na produção de conhecimento colaborativo.
	%	25,47%	23,91%	28,26%	16,77%	5,59%
6	Ferramentas para elaborar avaliações.	Desconheço ou conheço pouco sobre ferramentas para elaboração de avaliações online.	Tenho consciência da importância e estou começando a explorar ferramentas para realização de avaliações online.	Conheço como as ferramentas para avaliações online funcionam, porém tenho dificuldades para estruturar uma avaliação utilizando todos os recursos que gostaria.	Tenho domínio de ferramentas para avaliar a aprendizagem de forma online e uso com frequencia em aulas presenciais ou online.	Utilizo com segurança ferramentas para realização de avaliações online. Utilizo as rubricas para avaliar meus alunos por competências, explorando todos os seus recursos.
	%	33,23%	26,09%	22,67%	14,91%	3,11%
7	Ferramentas para criação de conteúdo digital	Não crio nenhum tipo de material de texto ou tabelas com informações numéricas ou alfabéticas, gráficos ou que utilizem elementos audiovisuais. Faço tudo na mão: caneta, lápis e papel.	Utilizo recursos simples para criar conteúdo para minhas aulas como, por exemplo, apresentações que incorporam texto, imagens estáticas, mas tenho dificuldade com áudio e vídeo.	Crio ou edito material didático, por exemplo, textos onde organizo as informações ou dados gráficos em planilhas eletrônicas, apresentações, e uso audio e vídeo de terceiros.	Crio ou edito material didático no formato de acordo com o tema que vou desenvolver. Ex. produzo textos, organizo informações ou dados gráficos em planilhas eletrônicas, apresentações, audio e vídeo. Preciso aprender mais sobre como melhorar minha diagramação.	Crio e produzo material para as aulas e edito materiais de acesso aberto. Escolho softwares adequados para editar elementos gráficos, textuais, imagens estáticas ou multimídia.
	%	2,48%	35,71%	20,19%	30,43%	11,18%
8	Ferramentas que auxiliam a gamificação da aprendizagem.	Desconheço ou conheço pouco sobre ferramentas para a gamificação da aprendizagem.	Considero importante utilizar gamificação no ensino, porém preciso aprender a desenvolver conteúdo nesse formato.	Conheço algumas ferramentas para a gamificação da aprendizagem, porém ainda tenho dificuldades para implantar em minhas aulas.	Conheço ferramentas para a gamificação da aprendizagem e já apliquei em minhas aulas, porém ainda não explorei todos os benefícios ou recursos que elas proporcionam.	Conheço ferramentas para a gamificação da aprendizagem e as utilizo com frequência e diversidade, o que torna minhas aulas mais dinâmicas e participativas.
	%	45,96%	24,53%	13,35%	12,11%	4,04%

	Unidade de competência	1. Não tem conhecimento	2. Motivação	3. Atitude	4. Tem atitude e habilidade	5. Conhecimento, habilidade, atitude
9	Segurança de equipamentos e informações	Nada sei sobre as questões relacionadas a segurança de equipamentos tecnológicos ou como identificar riscos associados ao uso. Se preciso instalar um equipamento ou programa, procuro ajuda de alguém com mais experiência.	Compreendo que os equipamentos de TI precisam ser instalados com segurança, especialmente se forem utilizados para armazenar dados importantes. Porém não sei identificar os riscos associados ao uso.	Compreendo as normas de segurança. Antes de manusear e instalar equipamentos recorro aos manuais de instalação. Uso softwares de detectação de vírus, malewere e spyware gratuitos.	Compreendo e executo ações básicas para proteger os meus dispositivos, por exemplo, ligar corretamente, verificar a compatibilidade dos aparelhos entre outras ações de proteção dos equipamentos. Protejo meus arquivos com softwares específicos que identificam os riscos associados ao seu uso.	Compreendo e sei verificar se todos os dispositivos instalados no computador estão funcionando corretamente e com segurança e posso resolver os problemas derivados do uso, sem recorrer a especialistas. Protejo meus arquivos com criptografia e uso softwares que fornecem total proteção para identificar os riscos associados ao uso do computador na web.
	%	18,01%	24,53%	22,98%	23,91%	10,56%
10	Soluções de problemas técnicos decorrentes da utilização de dispositivos digitais em sala de aula.	Não sei resolver problemas e procuro ajuda de técnicos ou de pessoas com mais experiência.	Percebo a necessidade de saber identificar os problemas relacionados ao uso dos dispositivos digitais porém não tenho conhecimento algum sobre o funcionamento dos dispositivos.	Sei identificar alguns problemas relacionados ao uso de dispositivos digitais (por exemplo, saber conectar e utilizar projetores).	Tenho estratégias para resolver problemas técnicos, por exemplo, recorrer a manuais ou tutoriais quando acontece algo que desconheço.	Tenho autonomia para resolver problemas decorrentes do uso dos dispositivos digitais e posso manter funcionando programas e equipamentos.
	%	13,98%	13,98%	27,64%	31,37%	13,04%
11	Maneiras para me atualizar e incorporar novos dispositivos, aplicativos ou ferramentas.	Não costumo fazer cursos, assistir ou ler conteúdos que façam eu explorar maneiras de incorporar recursos tecnológicos em minhas aulas.	Percebo o quanto é importante a incorporação de recursos tecnológicos em minha atividades docentes, porém não tenho muito tempo disponível para me atualizar.	Faço cursos obrigatórios de minha instituição, relacionados a utilização de recursos tecnológicos, porém sei que tenho muito ainda a explorar.	Faço cursos disponibilizados por minha instituição e troco experiências com meus colegas docentes. Costumo incorporar muitas tecnologias estudadas em minhas atividades docentes.	Faço cursos obrigatórios e não obrigatórios sobre as tecnologias na educação. Busco informações em vídeos, lives e troco experiências com meus colegas professores. Sempre estou inovando e incorporando algo novo em minhas atividades docentes.
	%	7,45%	28,26%	18,94%	24,53%	20,81%