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Digital Competence, Device Access, and Classroom Practices in Higher Education

Competencia digital, acceso a dispositivos y prácticas de aula en educación superior

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Abstract

This article explores the relationships between digital competence, access to digital devices, and digital practices among Portuguese higher education professors, emphasizing the need for digital proficiency in today's educational landscape. A quantitative approach was employed, with data from 846 professors collected through a questionnaire and analyzed using inferential statistics, including *t* tests, Cohen's d for effect size, and Pearson correlation coefficients. Results highlighted statistically significant differences in digital competence associated with the use of mobile devices, excluding mobile phones, with medium effect sizes. All digital practices showed statistically significant differences, with effect sizes ranging from medium to large. Notably, digital competence correlated more strongly with the number of digital practices in the classroom than with the number of digital devices, indicating that active engagement in digital practices may play a more important role in developing digital competence than mere access to digital devices. These findings suggest that educational policies should focus not only on providing access to digital tools, but also on integrating these tools effectively into pedagogical practices to enhance educational outcomes and prepare educators and students for a digital future.

Keywords: digital skills, digital devices, higher education, professors

Resumen

Este artículo investiga las relaciones entre la competencia digital, el acceso a dispositivos digitales y las prácticas digitales entre profesores portugueses de educación superior, destacando la importancia de la competencia digital en el panorama educativo actual. Mediante un enfoque cuantitativo, se recopilaron datos de 846 profesores a través de un cuestionario y se analizaron con técnicas de estadística inferencial, entre ellas pruebas *t*, la *d* de Cohen para medir el tamaño del efecto, y coeficientes de correlación de Pearson. Los resultados muestran diferencias estadísticamente significativas en la competencia digital en relación con el uso de dispositivos móviles, excepto los teléfonos móviles, con tamaños de efecto medianos. Todas las prácticas digitales mostraron diferencias estadísticamente significativas, con tamaños de efecto que van de medianos a grandes. En particular, la

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competencia digital presentó una correlación más fuerte con el número de prácticas digitales adoptadas en el aula que con el número de dispositivos digitales, lo que indica que la realización de prácticas digitales podría desempeñar un papel más importante en el desarrollo de la competencia digital que el simple acceso a dispositivos digitales. Estos hallazgos sugieren que las políticas educativas deben centrarse no sólo en proporcionar acceso a las herramientas digitales, sino también en integrar estas herramientas de manera efectiva en las prácticas pedagógicas para mejorar los resultados educativos y preparar a los educadores y estudiantes para un futuro digital.

Palabras clave: competencia digital, dispositivos digitales, educación superior, docente

I. Introduction

Digital technologies have profoundly changed almost every aspect of our lives, including the way we communicate (Redecker, 2017); how we play; how we work; how we organize our lives, our cities, and our mobility; how we participate in civic, social, and political life; how we acquire knowledge and information; how we think; and how we behave, in isolation or collectively (Boulianne, 2020; Redecker, 2017; Trencher & Karvonen, 2020; Zagorskas & Burinskienė, 2019). In the words of Benali et al. (2018), "the proliferation of mobile technologies such as smartphones and tablets has changed the way people live, communicate, interact, learn, and generate new knowledge" (p. 99).

Consequently, "children and young adults are growing up in a world where digital technologies are ubiquitous" (Redecker, 2017, p.12), and they must be able to use digital technologies effectively, consciously, productively, and civilly. However, not all new professors are comfortable interacting with technologies at the expected level (Pedro, 2016).

As society and education have become increasingly digitalized, innovative technologies and pedagogies have substantially impacted higher education. Teaching is increasingly centered on digital resources due to the abundance of information available on the internet and the promotion of a massive open education approach (Vega et al., 2021).

Information and communication technologies (ICT) are essential tools in academic practice, both in teaching and research. However, their use in the teaching-learning process has often been limited to digitizing educational content without taking full advantage of the benefits of collaborative environments, Web 2.0, and emerging technologies. Improving teachers' digital competence can facilitate the transition from an instrumental use of technologies to a more intentional, consistent, and effective incorporation of these technologies into pedagogical practices and the teaching-learning process. Thus, it is essential to explore the potential of technology to improve the learning experience of students and promote more efficient and innovative teaching (Zempoalteca Durán et al., 2017).

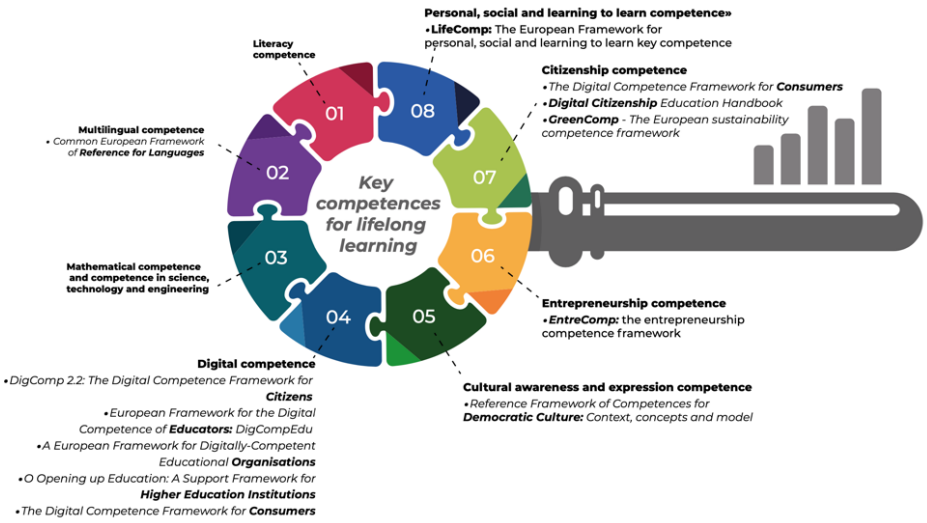
Use of technology in education is a central focus of discussion in institutions such as the United Nations Educational, Scientific and Cultural Organization (UNESCO), through the UNESCO ICT Competency Framework for Teachers (UNESCO, 2018); and the United Nations (UN), through the 2030 Agenda for Sustainable Development, which includes several ICT-related goals (4, 5, 9, 10, and 17).

Digital competence is considered a key competence, foundational for the development of other essential competences needed for lifelong learning, including the ability to adopt and use digital technologies confidently, critically, and responsibly in different contexts. The Council of the European Union has listed it as one of eight critical lifelong learning competences (Council of Europe, 2018a).

The European Union has a long history in the development of frameworks., including for key competences for lifelong learning (Council of Europe, 2018a), as shown in Figure 1. Some of these frameworks specifically focus on digital skills, whether for citizens (Vuorikari et al., 2022), educators (Redecker, 2017), educational organizations (Kampylis et al., 2015), open education for higher education institutions (Dos Santos et al., 2017; Santos, 2019), or consumers (Brečko & Ferrari, 2016). This is in addition to an ongoing digital skills certification process, the European Digital Skills Certificate (EDSC), as envisaged by Action 9 of the Digital Education Action Plan 2021-2027 (European Commission, 2020).[1]

[1] https://joint-research-centre.ec.europa.eu/digcomp/european-digital-competence-certificate-edsc_en

Figure 1. Key frameworks and competences for lifelong learning



Source: Translated from Santos (2023).

At the national level in Portugal, digital competences are strongly aligned with several policies, namely the National Digital Competence Initiative e.2030 (INCoDe.2030) (Conselho de Ministros, 2021), the Certificate of Digital Competence program (Government of Portugal, 2021), the Portugal 2030 Strategy (Conselho de Ministros, 2020a), and finally, the Action Plan for the Digital Transition (PATD) (Conselho de Ministros, 2020b). This is in addition to national reference frameworks such as the Digital Competence Reference Framework: Study for Non-ICT Employability in the Future (INCoDE.2030, 2023).

The European Digital Competence Framework for Educators, DigCompEdu (Redecker, 2017), describes competences that focus on supporting and encouraging the adoption of digital tools to improve and innovate in education. Aimed at educators from preschool to higher education, it is organized into six areas with 22 competences and six proficiency levels. Levels progress from Newcomer (A1) to Pioneer (C2), following those of the Common European Framework of Reference for Languages, CEFR (Council of Europe, 2018b).

> At the first two stages, Newcomer (A1) and Explorer (A2), educators assimilate new information and develop basic digital practices; at the following two stages, Integrator (B1) and Expert (B2), they apply, further expand and structure on their digital practices; at the highest stages, Leader (C1) and Pioneer (C2), they pass on their knowledge, critique existing practice and develop new practices. (Redecker, 2017, p. 9)

The progression in proficiency levels is cumulative, as higher levels incorporate the descriptors of lower levels with increasing complexity. This progression is inspired by Bloom's revised taxonomy. Moreover, DigCompEdu's alignment with the CEFR progression levels (Council of Europe, 2018b), which have become well established and widely disseminated across Europe, has facilitated educators' understanding and assessment of their level of digital competence, while providing greater coherence across European frameworks (Redecker, 2017).

Digital devices in the classroom should be treated as pedagogical tools, requiring the planning and implementation of teaching strategies. Professors should therefore integrate these digital technologies into their teaching to support the teaching-learning process (Santos, 2023).

The recognition and validation of higher education professors' digital competences are crucial in the digital age. Proof of the applicability of the DigCompEdu framework in higher education (Santos, 2023) underscores its relevance in fostering innovative pedagogical practices. Through the recent DigCompEdu-FyA project (Castañeda et al., 2023), DigCompEdu was adapted to create a Digital Competence Framework for University Educators, tailored to the specific context of higher education, with the aim of establishing a common standard for professors' digital competence and promoting the digital transformation of university teaching. Furthermore, the e-DigCompEdu, specifically designed for online higher education, adds a new dimension to the foundational framework, acknowledging the need for distinct competencies for online education. This framework expands DigCompEdu by introducing specific competences, such as digital curation and online assessment processes, and areas focused on scientific digital literacy and digital management of online teaching and learning, thereby adding 12 new competences (six distributed in existing areas and six grouped into two new areas).

1.1 Digital Competences of Higher Education Students

The digitization of society significantly impacts education, including higher education, where students are immersed in technologies and research-based teaching practices. Higher education institutions (HEIs) face a challenge: teaching and learning are increasingly mobile, ubiquitous, and technological. Professors are encouraged to access various digital devices and adopt new digital practices in the classroom. In this sense, an adequate use of ICT might promote advances in the teaching process in higher education, building enriched learning environments. This can lead to activities that generate autonomy and collaboration (Guillén-Gámez & Mayorga-Fernández, 2019; Santos, 2023).

Proper pedagogical use of ICT in classrooms, or online, might contribute to developing higher education students' information literacy and technological and digital competences. Educational institutions and professors must then adopt an appropriate approach to integrate ICT effectively into the teaching and learning process, with the aim of supporting students to face future challenges. Therefore, the ability of HEIs to meet the challenges posed by these technological changes involves quality professional development programs.

1.2 Objectives

The primary objective of this study is to investigate the relationships between digital competence, access to digital devices, and the adoption of digital practices in the classroom among higher education professors in Portugal. Specifically, this study seeks to explore four key research questions (RQs):

RQ1: Are there significant differences in digital competence based on access to specific types of digital devices?

RQ2: Is there a significant correlation between digital competence and the number of digital devices to which professors have access?

RQ3: Are there significant differences in digital competence based on the types of digital practices implemented in the classroom?

RQ4: Is there a significant correlation between digital competence and the number of digital practices adopted by professors in the classroom?

By addressing these questions, the study aims to provide a deeper understanding of how access to digital technologies and the integration of digital practices influence the development of digital competence among higher education faculty.

II. Methodology

Data on digital competences were collected using the digital tool www.digcomptest.eu, in which the Portuguese version of the DigCompEdu Check-In questionnaire was incorporated (Lucas, 2019; Redecker, 2019). The instrument also included sociodemographic questions related to personal, teaching, and institutional profiles and questions regarding access to digital devices and digital practices in the classroom.

Data collection occurred between the second semester of 2019/2020 and the first semester of 2020/2021.

Professors indicated which digital devices they had access to by selecting from seven options, with multiple responses permitted. Data were collected on mobile (mobile phone, tablet, e-book reader, and notebook) and non-mobile devices (desktop, printer, and iTV). They also indicated which digital practices they had adopted in the classroom, selecting from seven options, with multiple responses permitted. Data were collected on data sharing practices (files, collaborative document production, virtual learning environment, and calendar) and communication practices (instant messaging, personal social networks, and classes with synchronous videos).

Parametric *t*-tests were conducted to identify statistically significant differences. Access to digital devices and adoption of digital practices in the classroom were treated as independent variables, while digital competence, measured through a self-perception instrument, was treated as a continuous dependent variable (Field, 2024).

The effect size of the observed differences between groups was assessed using Cohen's d, following widely accepted guidelines for interpreting effect sizes. A Cohen's d equal to or lower than 0.20 indicates a small effect size; a value ranging from 0.20 to 0.80, a medium effect size; and a value equal to or greater than 0.80, a large effect size (Field, 2024; Toksoz & Acikgoz, 2024). These criteria were used to classify the magnitude of the differences found in our sample data.

Pearson's correlation coefficients were used to investigate the relationship between digital competence and access to devices (mobile and non-mobile), and also between digital competence and digital practices (sharing and communication). According to Field (2024), the Pearson correlation coefficient measures the strength of a relationship between two continuous variables or between one continuous variable and a categorical variable containing two categories. It can vary from -1 (a perfect negative relationship) through 0 (no relationship) to +1 (a perfect positive relationship). It is also an effect size measure, where values of ±0.1 represent a small effect, ±0.3 a medium effect, and ±0.5 a large effect.

The data were exported from the data collection tool and then coded, processed, and analyzed anonymously with IBM® SPSS® Statistics version 29.0.2.0 (20).

III. Results

The results of the self-perception instrument were used to calculate professors' digital competence proficiency levels (Ghomi & Redecker, 2019) and examine their access to digital devices and digital practices in the classroom.

3.1 Characterization of Respondents

The study included 846 respondents, 53.8% (n = 455) male and 46.2% (n = 391) female; 74.8% (n = 633) held a PhD, 15.7% (n = 133) a master's, and 9.5% (n = 80) held an undergraduate degree. Participants primarily came from institutions in the university system

(61.5%, n = 529), while 38.5% (n = 326) were from polytechnic education. Most (91.7%, n = 776) were from a public institution, while 8.3% (n = 70) worked in the private sector; 52.7% (n = 446) worked at undergraduate level, 32.4% (n = 274) at master's level, and 14.9% (n = 126) at PhD level, as shown in Table 1.

Table 1. Characterization of Respondents

Gender	Male	Female	
% (*n* =)	53.8 (455)	46.2 (391)	
Degree level	Undergraduate	Masters	PhD
% (*n* =)	9.5 (80)	15.7 (133)	74.8 (633)
Institutional category	Universities	Polytechnic	
% (*n* =)	61.5 (529)	38.5 (326)	
Institutional funding sector	Public	Private	Military and political public
% (*n* =)	91.7 (776)	8.3 (70)	0 (0)
Level of the teaching cycle	Undergraduate	Masters	PhD
% (*n* =)	52.7 (446)	32.4 (274)	14.9 (126)

The sample comprised professors affiliated with 37 universities and 76 polytechnic institutes.

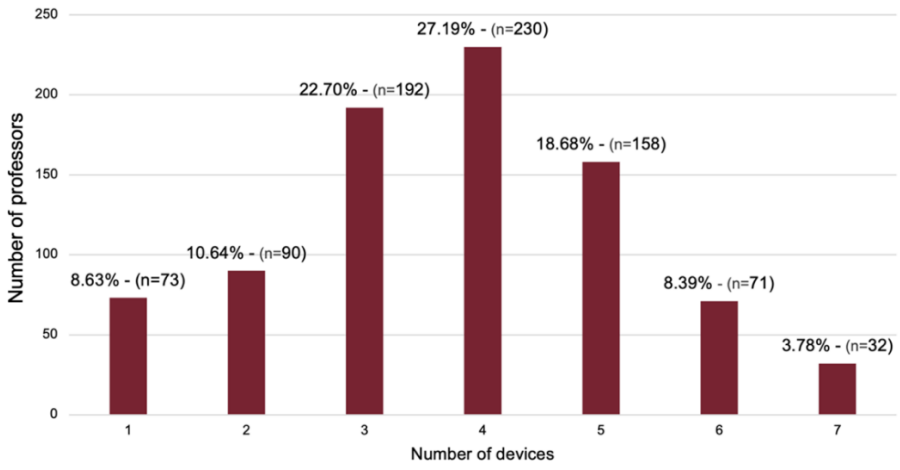
3.2 Digital Competence Proficiency Level

The digital competence proficiency results indicate an overall average of 47.88 points (on a scale from 0 to 88 points), corresponding to B1 – Integrator. Respondents were distributed across proficiency levels as follows: 3.07% at proficiency level A1 – Beginner, 16.67% at A2 – Explorer, 36.29% at B1 – Integrator, 28.37% at B2 – Specialist, 13.12% at C1 – Leader, and 2.48% at C2 – Pioneer (Santos, 2023).

3.3 Digital Devices

The results showed that 93.74% of professors had a mobile phone, 58.98% a notebook, 51.89% a tablet, and 14.07% an e-book reader. As for non-mobile devices, 78.13% of the professors had a desktop computer, 66.55% a printer, and 13.59% an iTV. The mode was four devices, as shown in Figure 2.

Figure 2. Device Access (Mobile and Non-Mobile)



Overall, professors access an average of 3.77 devices (out of a possible total of 7), comprising 2.19 mobile devices (out of 4), and 1.58 non-mobile devices (out of 3).

To address RQ1, which investigates whether there are significant differences in digital competence levels based on access to specific types of digital devices, *t* tests (Field, 2024) were conducted. Additionally, Cohen's d (Field, 2024; Toksoz & Acikgoz, 2024) was calculated to assess the effect size of the observed differences between the groups. Groups of professors who had access to a specific device were compared to those who did not.

The results showed a statistically significant difference in digital competence scores between professors with and without access to tablet, e-book reader, and notebook mobile devices, and the non-mobile device iTV. Table 2 also shows that the effect size, as measured by Cohen's d, ranged from small to medium.

Table 2. Mean Differences and Effect Sizes for Digital Competence by Device Access

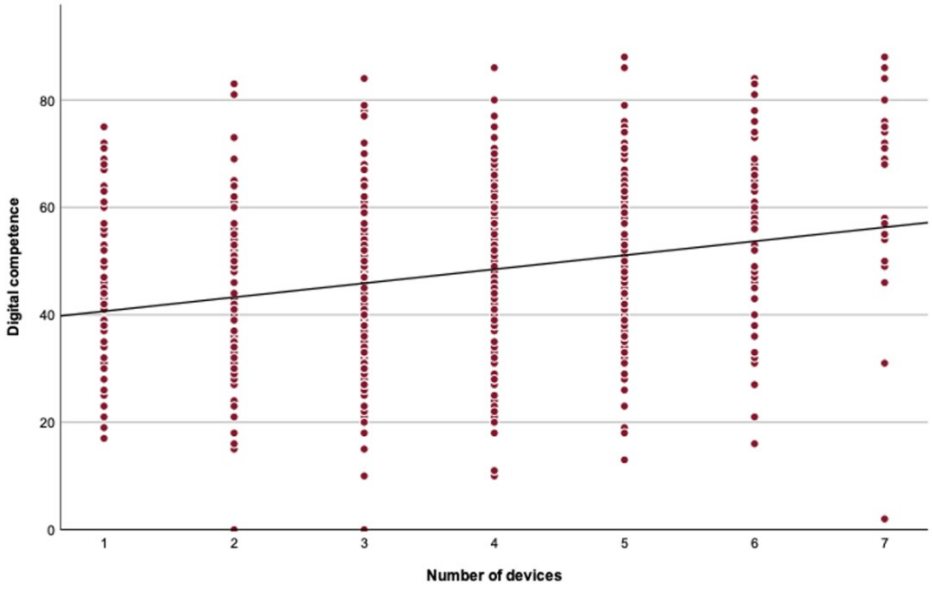
Digital device	*t* (844)[a]	*p*-value	Average DC[b] with access	Average DC[b] without access	Effect size (Cohen's *d*)
Mobile					
Mobile phone	1.436	0.151	48.08	44.81	Medium (.204)
Tablet	5.264	< 0.05 [c]	50.64	44.90	Medium (.362)
E-book reader	6.367	< 0.05 [c]	56.38	46.48	Medium (.630)
Notebook	4.471	< 0.05 [c]	49.91	44.94	Medium (.313)
Non-mobile					
Desktop	1.848	0.065	48.42	45.95	Small (.154)
Printer	0.635	0.526	48.13	47.48	Small (.004)
iTV	6.615	< 0.05 [c]	56.88	46.47	Medium (.664)

Note. [a] Degrees of Freedom; [b] Digital Competence; [c] Statistically significant difference

To address RQ2, which examines whether there is a significant correlation between the level of digital competence and the number of digital devices to which professors have access, a Pearson correlation analysis was performed (Field, 2024) to determine the strength and direction of the relationship between the two variables, providing insight into how the number of devices is associated with the level of digital competence.

The data analysis revealed a moderate positive correlation (r = 0.243; $p < .001$) between the number of digital devices professors own and their digital proficiency, as shown in Figure 3. The same graph also shows a linear trend line indicating a gradual increase in average proficiency as the number of devices increases.

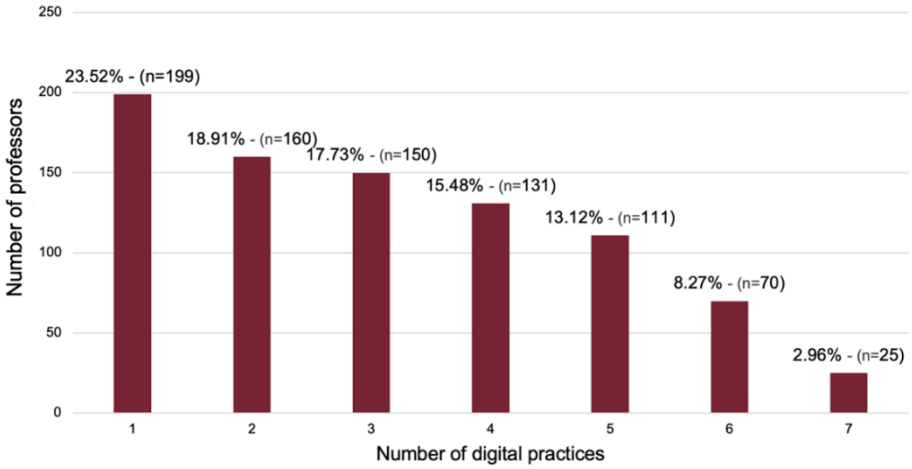
Figure 3. Correlation Between Digital Competence and Number of Devices



3.4 Digital Practices in the Classroom

The results showed that 88.53% of professors used shared files, 45.04% developed documents collaboratively, and 22.34% used calendars. As for communication practices, 47.04% of professors used synchronous classes with videos, 45.86% used instant messaging, 36.17% used virtual learning environments (VLE), and 27.42% used personal social networks. The mode was one digital practice in the classroom, as shown in Figure 4.

Figure 4. Adoption of Digital Practices in the Classroom



Professors adopt an average of 3.12 digital practices in the classroom (out of a possible total of 7), comprising 1.92 sharing practices (out of 3) and 1.2 communication practices (out of 4). To address RQ3, which explores whether there is a significant correlation between the level of digital competence and the number of digital practices adopted by professors in the classroom, *t* tests were conducted (Field, 2024). Additionally, Cohen's *d* (Field, 2024; Toksoz & Acikgoz, 2024) was calculated to assess the effect size of the observed differences between the groups. Groups of professors who adopted a specific digital practice in the classroom were compared to those who did not.

The results showed a statistically significant difference in digital competence scores between professors who did and did not adopt each of the classroom practices. Table 3 also shows that the effect size, as measured by Cohen's *d*, ranged from medium to large.

Table 3. Mean Differences and Effect Sizes for Digital Competence by Digital Practice

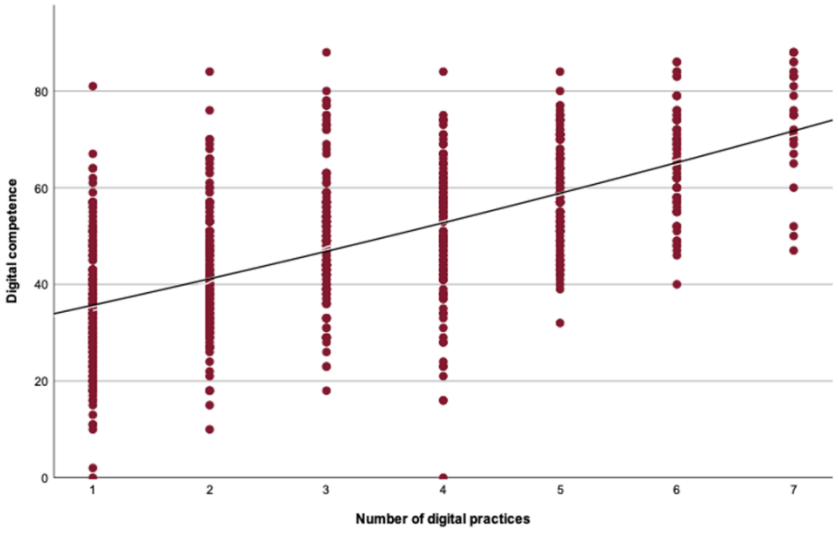
Digital classroom practices	*t* (844)[a]	*p*-value	Average DC[b] with practice	Average DC[b] without practice	Cohen's *d* (Effect size)
Sharing					
Cloud files	5.024	< 0.05 [c]	48.87	40.26	Medium (.542)
Production of collaborative documents	16.168	< 0.05 [c]	56.51	40.80	Large (1.120)
Virtual learning environment (VLE)	14.378	< 0.05 [c]	57.35	42.51	Large (1.030)
Calendar	9.902	< 0.05 [c]	57.55	45.10	Large (.817)
Communication					
Instant messaging	8.507	< 0.05 [c]	50.39	43.44	Medium (.587)
Personal social networks	8.294	< 0.05 [c]	55.06	45.17	Medium (.639)
Synchronous videos	12.550	< 0.05 [c]	54.64	41.89	Large (.865)

Note. [a] Degrees of Freedom; [b] Digital Competence; [c] Statistically significant difference.

To address RQ4, which examines whether there is a significant correlation between the level of digital competence and the number of digital practices adopted in the classroom, a Pearson correlation analysis was performed (Field, 2024) to determine the strength and direction of the relationship between the two variables, providing insight into how the number of digital practices is associated with the level of digital competence.

The data analysis revealed a strong positive correlation ($r = 0.636$; $p < 0.001$) between the number of digital practices adopted by professors and their digital proficiency, as shown in Figure 5. The same graph also shows a linear trend line indicating a gradual increase in average proficiency as the number of digital practices increases.

Figure 5. Correlation Between Digital Competence and Number of Digital Practices



IV. Discussion

Overall, Portuguese higher education professors were found to exhibit a digital competence proficiency level of B1 – Integrator (Santos, 2023). These results will now be discussed in relation to access to digital devices and digital practices in the classroom.

The growing use of ICT in education, particularly in higher education, demands that educators possess high levels of digital competence. This is due to the emergence of new digital tools for pedagogical and administrative purposes, a challenge that becomes even greater when professors start working with e-learning activities.

Competences derive from knowledge, skills, and abilities (KSAs) and are demonstrated through specific actions in the classroom, from planning to execution, evaluation, and overall management of educational work (Paz-Saavedra et al., 2022; Vuorikari et al., 2022), and through the adoption of digital practices.

The European Union considers digital competence key for lifelong learning (Council of Europe, 2018a). Frameworks and instruments have been produced to assess and develop the digital competences of citizens, educational organizations, and educators. The literature presented to support this article discusses the influences of technology in our everyday lives, and specifically in education, and points to a need for professional development to better prepare professors to contribute to the improvement of their students' digital competences.

Professors reported having greatest access to mobile phones (93.74%) and desktop computers (78.13%), while e-book readers (14.07%) and iTV (13.59%) were least common.

Official figures published by Portugal's National Communications Authority (ANACOM) show that mobile service penetration in Portugal stood at 114.3 per 100 inhabitants in the first quarter of 2020, further increasing to 121.8 by the first quarter of 2023, excluding machine-to-machine (M2M) connections and data-only access associated with PCs, tablets, USB modems, and routers (ANACOM, 2020, 2023). This suggests that access to mobile service is virtually universal in Portugal. However, universal access was not identified in our sample, despite high prevalence (93.74%).

RQ1 investigates whether there are significant differences in digital competence levels based on access to specific types of digital devices. The *t* test showed statistically significant higher mean digital competence among professors with access to tablets, e-book readers, and notebook devices, compared to those without. Importantly, the effect size was medium across all these devices. The difference between professors who did and did not have access to a mobile phone was not statistically significant. This may be explained by the universal nature of mobile phone adoption, with mobile phones having become so widespread in society that their use has become largely intuitive, regardless of individual digital competence.

The opposite was observed with non-mobile devices. Only one of the three devices, the iTV, was found to be associated with a statistically significant higher digital competence among professors who had access to this device. The effect size for the iTV was medium. There was no statistically significant difference between professors who did and did not have access to a desktop or printer.

There is no apparent difference in means based on access to classic devices (whether mobile or non-mobile), such as mobile phones, printers, and desktop computers. This may reflect the fact they have become ubiquitous in everyday life and do not require an internet connection to operate.

RQ2 examines the relationship between digital competence and the number of digital devices to which professors have access. Our results showed a moderate positive Pearson correlation. This trend is illustrated in Figure 3, where a linear trend line shows a gradual increase in mean digital competence as the number of devices increases. This moderate positive correlation suggests that having access to multiple digital devices may be associated with higher levels of digital competence. However, it is important to consider that other factors besides the number of devices also significantly influence professors' digital competence.

The most common digital practices in the classroom are cloud file sharing (88.5%) and the use of synchronous video (47.04%), and the least common are shared calendars (22.34%) and personal social networks (27.42%). The Foundation for Science and Technology (FCT) provides the Colibri service to the entire academic community, including professors and students (Fundação para a Ciência e a Tecnologia, 2023). Colibri is a collaboration service that allows synchronous remote meetings via the Zoom videoconferencing platform, while a considerable number of higher education institutions also offer packages of productivity tools such as Microsoft 365 and/or Google Workspace. This may explain the high percentage (47.04%) of professors who use synchronous video classes. By contrast, a smaller proportion of educators reported using a VLE (36.17%), possibly because responsibility for adopting a VLE lies with each institution, and even each academic unit, with a range of suppliers, versions, and levels of quality and teacher support.

RQ3 examines the correlation between digital competence and the number of digital practices adopted by professors in the classroom. For all digital practices, the *t* test showed a statistically significant higher mean digital competence among professors who had adopted the practice compared to those who had not. Adoption of digital practices exhibits significant variation in effect sizes, indicating different degrees of impact on professors'

digital competence. In sharing practices, only cloud files showed a medium effect size, while the production of collaborative documents, the use of a VLE, and calendar practices exhibited large effect sizes, reflecting a more substantial impact on professors' digital competence. On the other hand, among communication practices, only the use of synchronous videos showed a large effect size, with instant messaging and personal social networks showing medium effect sizes. These results underscore the varying importance of certain digital practices in enhancing professors' digital competence, suggesting that activities related to sharing and collaboration in classes exhibit greater potential to support digital competence, compared to activities focused solely on communication.

RQ4 examines the correlation between digital competence and the number of digital practices adopted in the classroom. A strong positive Pearson correlation was found. This resembled, but was stronger than, the relationship observed between the number of digital devices accessed and professors' digital competence. This trend is illustrated in Figure 5, where a linear trend line shows a gradual increase in average digital competence as the number of digital practices adopted increases. This strong correlation suggests that engaging in more digital practices may be associated with improved digital competence among educators. However, again, it is important to consider that other factors also significantly influence professors' digital proficiency.

In a study conducted with higher education professors, Paz et al. (2022) found a positive attitude toward the use of digital technologies (DT) in education, as rated on a 5-point Likert scale. In their study, teachers reported that DTs helped improve teaching activities (M = 4.22), were helpful for the dissemination of educational projects (M = 4.12), and facilitated the generation of innovative educational strategies (M = 4.06). They also observed a positive relationship between attitudes and digital competence: "Our results indicate a positive correlation between TDC and the lecturers' attitudes" (p. 125). This finding corroborates the relationship observed in this article between the adoption of digital practices in the classroom and professors' digital competence.

V. Conclusion

This article examined the relationships between digital competence, access to digital devices, and digital practices in the classroom among higher education professors in Portugal.

In response to RQ1, which investigates whether there are significant differences in digital competence based on access to specific types of digital devices, the findings of this study indicate statistically significant differences in professors' digital competence depending on the type of device accessed (mobile and non-mobile). Our results showed that the use of tablets, e-book readers, notebooks, and iTVs was associated with higher digital competence. All these devices showed medium Cohen's effect sizes, suggesting a considerable impact of access to these digital technologies on educator digital competence. Notably, there were differences between mobile and non-mobile devices. Among mobile devices, only mobile phones showed no significant difference, while among non-mobile devices, only iTVs exhibited a statistically significant difference, indicating that access to mobile devices correlates more strongly with higher digital proficiency.

In response to RQ2, which examines whether there is a significant correlation between digital competence and the number of digital devices to which professors have access, the findings of this study identified a medium effect size. This relationship suggests that broader access to different digital devices can facilitate better integration and utilization of digital tools in educational contexts.

In response to RQ3, which explores the correlation between digital competence and the number of digital practices adopted by professors in the classroom, the findings of this study indicate statistically significant differences in all types of practices, including both sharing and communication practices. However, variation was observed in the effect size, which was medium for cloud file sharing practices but large for collaborative documents, VLEs, and calendar practices, suggesting that these three practices are more strongly associated with higher levels of digital competence. On the other hand, our results for communication practices indicated that only the use of synchronous videos was associated with a large effect size, while the other two practices exhibited a medium effect.

In response to RQ4, which examines the relationship between digital competence and the number of digital practices adopted by professors in the classroom, the findings of this study identified a strong positive correlation. This suggests that the more digital practices professors integrate into their teaching, the higher their digital competence tends to be. These results highlight the importance of adopting a diverse range of digital practices to enhance digital proficiency, reinforcing the notion that active engagement with digital tools in educational settings is a key factor in developing digital competence.

The findings of this study reveal an important contrast between the association of professors' digital competence with access to digital devices and with the adoption of digital practices. While access to certain devices, such as tablets, e-book readers, and notebooks, showed a moderate association with digital competence, not all devices yielded significant differences. By contrast, all of the digital practices investigated showed significant associations, with some, such as collaborative document sharing and the use of synchronous videos, demonstrating a stronger effect. These findings suggest that while access to devices is relevant, adopting digital practices in the classroom is more strongly associated with higher levels of digital competence among professors. Therefore, educational policies should not only ensure access to digital devices, but also promote their effective use through the integration of digital pedagogical practices to better support digital competence development in educational settings.

Although this study contributes to understanding the relationships between digital competence, access to digital devices, and digital practices in the classroom among higher education teachers in Portugal, certain limitations must be acknowledged. Firstly, the sample was confined to Portugal, which limits the generalizability of the findings to other international settings, where other cultural, technological, and political factors may play a role in shaping dynamics. Furthermore, the study's exclusive focus on higher education precludes comparisons with other educational stages, such as primary and secondary education, which display distinct pedagogical and technological characteristics.

Future research could replicate the methodological design of this study in different educational contexts, including primary and secondary education, to examine whether the relationships between the variables studied exhibit similar patterns. Additionally, applying the same methodology in other countries would enable a comparative and cross-cultural analysis.

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Contribution of each author

Cassio Cabral Santos: investigation (50%), methodology (50%), formal analysis, funding acquisition (50%), writing – original draft.
João Mattar: conceptualization, investigation (50%), methodology (50%), funding acquisition (50%), writing – review & editing.

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