Assessing Teacher Digital Competence. An analysis integrating descriptive, inferential, and multivariate perspectives

Evaluación de la Competencia Digital Docente. Un análisis que integra las perspectivas descriptiva, inferencial & multivariada

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ABSTRACT

The holistic development of educators is of paramount importance for the successful integration of technological innovations into the curriculum, which will ultimately facilitate learners' progression through their educational journey. The construct of teaching digital competence (TDC) is instrumental within the realm of tertiary education, fostering both the pedagogical advancement of educators and the digital literacy of students. This research, which was undertaken at the Universidad Nacional de Chimborazo (UNACH) in Ecuador, employs the COMDID-A theoretical framework to examine the manifestation of digital competence (DC) among its faculty members. The study uses a descriptive-correlational method with a cross-sectional, non-experimental design and subjects selected probabilistically in the second half of the 2022 academic year. The integrity of the research was ensured through the application of rigorous reliability and validity assessments. The outcomes of the confirmatory factor analysis (CFA) revealed a commendable model fit, discerning four pivotal factors that explain 65 % of the variance and coincide with the dimensions delineated in the model. Only 39 % of the faculty sample surpassed the median level of TDC, with significant interdimensional correlations underscoring the pivotal role of the academic department and discipline. A correlation with doctoral qualifications suggests that advanced educational attainment fosters the enrichment of advanced TDC. The absence of significant correlations between educators' field of knowledge, employment status and time investment further illustrate the complexity of TDC development. A linear model analysis suggests a perceptual bias, rating adjunct faculty members as possessing superior competences compared to their tenured counterparts. These findings emphasize the crucial need for concerted competence development endeavors to increase the level of mastery in digital technologies (DT) within educational settings.

Keywords: digital literacy; digital technologies; teacher training; ICT; assessing digital competence; continuous teacher training.

RESUMEN

La formación integral de los educadores es fundamental para integrar la tecnología en el plan de estudios y guiar a los estudiantes en su proceso de aprendizaje. La Competencia Digital Docente (CDD) es clave en la educación universitaria, contribuyendo al crecimiento profesional y la alfabetización digital de los estudiantes. Este estudio en la Universidad Nacional de Chimborazo (Unach), Ecuador, usa el marco conceptual COMDID A para analizar la Competencia Digital (CD) en sus profesores. La metodología es descriptivo-correlacional con diseño transversal no experimental. La muestra, fue seleccionada probabilísticamente en el segundo período académico de 2022, y se sometió a pruebas de confiabilidad y validez. Los resultados del Análisis Factorial Confirmatorio (AFC) indican una adecuada adaptación, identificando cuatro factores que explican el 65 % de la variabilidad y se relacionan con las cuatro dimensiones del modelo adoptado. Solo el 39 % de los profesores supera el nivel medio de CDD. Se encontraron relaciones significativas entre las dimensiones del instrumento, destacando la importancia de la facultad y la carrera del profesor. La correlación con el grado doctoral sugiere que niveles más altos de formación influyen en el desarrollo de CDD avanzadas. No se observaron correlaciones con el área del conocimiento de la formación y el tiempo de dedicación del profesorado. El modelo lineal evidencia que los profesores ocasionales son percibidos como más competentes que los titulares. Estos resultados resaltan la necesidad de enfocarse en el desarrollo de competencias para mejorar el dominio de las Tecnologías Digitales (TD) en el aula.

Palabras clave: alfabetización digital; tecnologías digitales; formación del profesorado; TIC; evaluación de competencias digitales; formación continua docente.

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INTRODUCTION

In the early 21st century, educators are faced with the crucial need to acquire skills that enable the seamless integration of digital technologies (DT) into the pedagogical process (Bond et al., 2018; Cabero-Almenara et al., 2021). This necessity is underscored by a paradigm shift in which higher education institutions are urged to transcend mere digitization and to instead aspire to genuine digital renewal. Such an endeavor aims to leverage the full spectrum of digital resource capabilities, thereby optimizing the educational potential of the academic landscape (García-Peñalvo et al., 2020).

The advent of the Internet and DT has ushered in an age of unlimited access to information and opportunities. Yet, disparities in individual capacities to harness these opportunities has given rise to a digital divide that has impeded inclusive development. This skills gap poses significant challenges, particularly for those lacking basic digital competence (DC), which affects their access to employment, education services, and civic engagement (Juárez Arall & Marqués Molías, 2019).

This contemporary challenge brings with it the need to encourage educators to deliberate, analyze, and comprehend the omnipresence of DT within the instructional milieu (Gallardo Echenique et al., 2011). It is therefore a challenge that can only be taken on by recognizing the importance of engaging in continual professional development processes aimed at enhancing teaching, research, and administrative competences in the use of digital tools (Cuadrado et al., 2020; Esteve-Mon et al., 2016; Silva Quiroz & Miranda Arredondo, 2020). The application of cooperative learning strategies in higher education, especially within the context of the training of future educators, has emerged as a critical endeavor. The integration of digital teaching skills is thus a pressing necessity, and the incorporation of digital tools (DTs) must be advocated for within higher education classrooms (Huertas Abril, 2018).

The symbiotic relationship between DC and teacher digital competence (TDC) is intricate and interconnected. DC encapsulates the range of skills and understanding required for the effective use of DT across diverse contexts, encompassing both personal and professional domains. Conversely, TDC accentuates the specific spectrum of DC that educators must cultivate to effectively integrate DT into their instructional practices and the teaching-learning process. DC lays the foundational bedrock for TDC, empowering educators to navigate technologies more adeptly in their classrooms. TDC thus includes the ability to use DTs, critically evaluate online resources, foster digital literacy among students, and adapt pedagogical strategies for the successful incorporation of technologies within the educational setting.

The centrality of TDC in embedding DT into teaching and learning processes cannot be overstated. The construct not only catalyzes the professional development of educators but also nurtures students' digital literacy, thus fostering a digitally competent future workforce (Domingo-Coscollola et al., 2020). Institutions of higher education are advised to initiate and support instructional programs designed to furnish educators with the DC they require. These types of initiatives are fundamental in the process of equipping students with capabilities essential to success in both the academic and professional arenas (Gutiérrez-Castillo et al., 2017; Juárez Arall & Marqués Molías, 2019; Sánchez-Caballé et al., 2020). The formal acknowledgment and validation of these competences via certification processes are deemed crucial milestones in the continuum of teacher professional development (Verdú-Pina et al., 2023). Such certifications reflect educators' adeptness in the integration of DT into

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their pedagogical practices, concurrently fostering a rise in educational quality benchmarks. Thus, systematically monitoring and critically assessing the relevance and applicability of these certifications is of paramount importance to ensure they are aligned with the evolving requirements of the digital educational landscape.

Within this dynamic and perpetually evolving educational landscape, myriad factors surface that are fundamentally linked to both DC and the overarching higher education ecosystem. This interconnection extends to scholarly research and the theoretical delineation of DC and TDC (Cisneros-Barahona et al., 2024). Furthermore, this complexity encompasses the methods employed in assessing the proficiency levels and developmental trajectories of these competences.

Study and conceptual basis

The academic discourse surrounding the conceptualization of digital skills is characterized by a rich tapestry of terminology (Biel & Ramos, 2019; Cateriano-Chávez et al., 2021; Gallardo Echenique, 2013). The interrelation between *media literacy* and *digital media literacy* is profound and encompasses the ability to navigate information across disparate modalities (Buckingham, 2007; Wilson et al., 2011).

Concurrently, *multimodal literacy* emphasizes the synergetic integration of various communicative modalities and cognitive processes, facilitating the discernment and interpretation of information presented in visual formats. This is juxtaposed with *multiple literacies*, which embodies a *multimodal* capacity including the creation of content using written, visual, auditory, gestural, or spatial approaches (Kress et al., 2014; Mills & Unsworth, 2017).

Computer literacy is defined as mastery of computer applications and the management of information (Buckingham, 2015; Poynton, 2005) and lays the groundwork for more nuanced competences such as *informational literacy*, *ICT literacy, e-competences, and e-literacy*. These competences are deeply entrenched in a critical perspective on DT, which advocates for ethical information management across diverse contexts (Oxbrow, 1998; Rockman, 2005; Schneckenberg & Wildt, 2006; Somerville et al., 2007).

The scholarly contribution of Spanish authors to the burgeoning corpus of literature on DC is noteworthy Cisneros-Barahona, Marqués Molías, Samaniego-Erazo, Uvidia-Fassler, De la Cruz-Fernández & Castro-Ortiz, 2023; Cisneros-Barahona, Marqués-Molías, Samaniego-Erazo, Uvidia-Fassler, Castro-Ortiz & Villa-Yánez, 2023). At the international level, *digital literacy* is the preferred nomenclature, while within the European discourse, it is synonymously employed with the concept of DC (Almås & Krumsvik, 2008). Digital literacy encapsulates the technical and procedural competence needed for the effective engagement with digital environments and includes the cognitive, motor, sociological, and emotional dimensions (Aviram & Eshet-Alkalai, 2006; Eshet-Alkalai, 2009; Jones-Kavalier & Flannigan, 2006; Martin & Grudziecki, 2006; Rangel Baca & Peñalosa Castro, 2013).

Digital competence is described as a holistic amalgamation of values, beliefs, knowledge, skills, and attitudes across technological, informational, multimedia, and communicative domains. It manifests as a multifaceted competence that educators cultivate to integrate DT into their pedagogical praxis (Gisbert Cervera & Esteve Mon, 2011). Its essence lies in the effective management of information for the construction of knowledge (Gutiérrez, 2011), encompassing safe, critical, and responsible use of DT for educational, social, and interactive purposes. This competence includes

information and data literacy, communication and collaboration, *media literacy*, digital content creation, online safety, intellectual property, problem solving, and critical thinking (Council of the European Union, 2018).

The construct of TDC is presented as a composite competence comprising an array of capabilities, skills, and attitudes acquired through professional development (Lázaro-Cantabrana et al., 2019). It is further described as a set of competences required for 21st-century educators to expand their educational praxis and facilitate their own continuous professional growth (INTEF, 2017).

DC baseline perspectives

In the contemporary educational context, the emergence of an array of TDC reference frameworks, developed by diverse institutions, organizations, and academics in the European arena, reflects the substantive evolution of the domain of DC (Cisneros-Barahona, Marqués Molías, Samaniego Erazo, Uvidia-Fassler & de la Cruz-Fernández, 2023; Cisneros-Barahona, Marqués-Molías, Samaniego-Erazo, Uvidia-Fassler, De la Cruz-Fernández & Castro-Ortiz, 2022). These frameworks have been instrumental in delineating conceptual models, essential dimensions, reference standards, key indicators, and pivotal components, thereby facilitating nuanced comprehension and fostering the propagation of TDC. The diversity inherent in these approaches is illustrated in Table 1, which summarizes some of the most significant contributions to this area of inquiry (Cabero-Almenara et al., 2020; Cisneros-Barahona, Marqués-Molías, Samaniego-Erazo, Uvidia-Fassler, Castro-Ortiz & Rosas-Chávez, 2022; Lázaro-Cantabrana et al., 2019; Palau et al., 2019; Pérez-Escoda et al., 2019). Each approach offers a distinctive and enriching perspective on the conceptualization and operationalization of TDC, allowing for the exploration of the multidimensional nature of these competences within education today.

Table 1
TDC frameworks and models developed over time

Year	Name	Reference
2000	National Educational Technology Standards for Teachers (NETS·T)	(ISTE, 2000)
2002	Raising the standards: A proposal for the development of an ICT competency framework for teachers	(CDEST, 2002)
2006	Technological pedagogical content knowledge: A framework for teacher knowledge	(Mishra & Koehler, 2006)
2006	A repository of techno-pedagogical skills for teaching staff	(Bérubé & Poellhuber, 2005)
2008	NETS for Teachers: National Educational Technology Standards for teachers	(ISTE, 2008)
2008	ICT competency framework for teachers	(Unesco, 2018)
2008	Professional standards for qualified teacher status and requirements for initial teacher training	(TDA, 2008)
2009	A teacher education model for the 21st century	(National Institute of Education, 2009)
2009	A proposal of framework for professional development of Turkish teachers with respect to information and communication technologies	(Kabakçi, 2009)

Year	Name	Reference
2009	The digital competence of higher education teaching staff for the knowledge society: A model for the integration of digital competence in teacher professional development	(Pozos Pérez, 2009)
2011	UNESCO ICT competency framework for teachers	(Unesco, 2011)
2011	Higher education computer science and internet certificate	(MESR, 2011)
2011	ICT competences and standards for the teaching profession	(Ministerio de Educación de Chile, 2011)
2013	Common framework for teaching digital competence: Draft with proposed descriptors v 1.0	(INTEF, 2013)
2013	DigiLit Leicester supporting teachers, promoting digital literacy, transforming learning initial project report DigiLit Leicester	(Fraser et al., 2013)
2013	ICT competences for teacher professional development	(Ministerio de Educación Nacional de Colombia, 2013)
2014	Teacher educators' digital competence	(Krumsvik, 2014)
2014	Web-based self- and peer-assessment of teachers' digital competences	(Põldoja et al., 2014)
2015	Development of a rubric to assess the teacher's digital competence	(Lázaro-Cantabrana & Gisbert-Cervera, 2015)
2016	ICT competences model for teachers: A proposal for the construction of innovative educational contexts and the consolidation of learning in higher education	(Hernández Suárez et al., 2016)
2016	Resolution ENS/1356/2016, by which the definition of digital teaching competence is published	(Departament d'Ensenyament. Generalitat Catalunya, 2016)
2017	Digital competence of educators DigCompEdu	(Redecker & Punie, 2017)
2017	Example title: Professional digital competence framework for teachers	(Kelentri et al., 2017)
2017	Common Framework for Teacher Digital Competence	(INTEF, 2017)
2017	Standards for educators	(ISTE, 2017)
2018	A rubric to assess the digital competence of higher education professors in the Latin American context	(Lázaro-Cantabrana et al., 2018)
2018	ICT Competency framework for teachers	(Unesco, 2018)
2018	Teaching digital competence of teachers in Catalonia	(Departament d'Ensenyament. Generalitat Catalunya, 2018)
2020	European Framework for the Digital Competence of Educators	(INTEF, 2020)
2022	Framework for teaching digital competence	(INTEF, 2022)

Moreover, the acknowledgment of accreditations for the purpose of validating TDC has emerged as a pivotal factor within this discourse. In the Spanish context, some of the more notable certifications include *ACTIC, CODIX, TuCertiCyL*, and the *DC Accreditation* in Asturias. However, the prominence of international certifications such as the *IC3 Digital Literacy Certification* offered by Pearson and the *I-SKILLS* program developed by the *Educational Testing Service* (ETS) points to a distinct evaluative approach towards essential digital skills. Beyond these, the *International Computer Driving License* (ICDL) represents a flagship accreditation spanning a wide range of DC. The French context further introduces the *Computer and Internet Certificate C2i*, specifically targeting the accreditation of DC among students, thereby accentuating the global landscape of TDC validation efforts (Verdú-Pina et al., 2022).

Frame of reference: COMDID-A

The use of the COMDID-A questionnaire within the framework of this research is predicated on the need for an evaluative tool that has not only been customized for the nuanced appraisal of TDC, but that also reflects the specific requirements and the distinct contexts of the educational practitioners. The meticulous design and calibration of this instrument played an instrumental role in collecting data of profound relevance and significance with which to precisely address the objectives of the study.

The instrument's intrinsic strengths, derived from its prior validation and its tailored adjustment to the Latin American educational landscape, confer upon the COMDID-A questionnaire a high degree of efficacy and applicability (Cisneros-Barahona, Marqués-Molías, Samaniego-Erazo, Mejía-Granizo & De la Cruz-Fernández, 2023; Lázaro-Cantabrana et al., 2018; Lázaro-Cantabrana & Gisbert-Cervera, 2015; Usart Rodríguez et al., 2020). This regional adaptation provides the instrument added value, ensuring its cultural relevance and alignment with the unique attributes of the educational context in Latin America.

Furthermore, the process of developing a rubric for the assessment of TDC was informed by an extensive review of the literature and existing theoretical constructs, as shown in Table 2. This endeavor has culminated in the formulation of a proposed rubric that encompasses foundational elements such as dimensions, scopes, and key concepts required for the establishment of indicators and the definition of development levels. These elements are described in Lázaro-Cantabrana et al. (2018) and Lázaro-Cantabrana and Gisbert-Cervera (2015), which provide a detailed, structured overview of the rubric's critical components. It facilitates a deeper understanding of the rubric's construction, ensuring its uniform interpretation and application by evaluators, thereby enhancing the integrity and consistency of the TDC assessment process.

The principal aim of this research is to quantify the extent of DC among the faculty members at UNACH, Ecuador, employing the COMDID-A theoretical framework (Lázaro-Cantabrana et al., 2018). The research seeks not only to gauge the degree of DC among the teaching staff, but also to determine its interrelations with a multiplicity of variables pertinent to academic personnel, including the domain of knowledge associated with both undergraduate and postgraduate qualifications, departmental affiliation, academic program, employment status, and the acquisition of doctoral credentials. The methodological approach adopted for this purpose is descriptive-correlational, encapsulated within a non-experimental, cross-sectional study design. The sample was selected through probabilistic means during the second academic term of 2022. To ensure the robustness and integrity of the construct under study, a series of factors were observed to guarantee methodological rigor, including the application of Cronbach's alpha tests for reliability assessment and a confirmatory factor analysis (CFA) for validity verification. Spearman's Rho was used as a statistical tool to explain correlations among the variables, and a bifactorial general linear model (ANOVA) was applied to explain the impacts of specific variables, namely employment relationship and academic program, on levels of TDC, thereby contributing to a nuanced understanding of the factors influencing digital proficiency within the academic sphere.

Table 2
Theoretical references used for the definition of the elements of the COMDID rubric (adapted from Lázaro-Cantabrana & Gisbert-Cervera, 2015*)*

Theoretical Referent	Rubric Element	Result
(Ferrari et al., 2013; Generalitat de Catalunya, 2015; ISTE, 2008; Unesco, 2008, 2015)	TDC Areas	1. **Classroom:** Educators engage in the use of digital tools within the learning environment, orchestrating and scheduling teaching-learning (T-L) endeavors facilitated by digital innovations. This encompasses holistically managing the educational space, monitoring, and assessing learner progress via digital means, and strategically planning T-L initiatives aimed at improving students' DC. 2. **Center**: Faculty members are tasked with the use and maintenance of the educational institution's digital frameworks and technological assets. This role extends to upholding the digital ethos of the institution, executing pedagogical oversight, and coordinating the institution's digital resources. Furthermore, educators are expected to assimilate and personalize the institution's technological training methods, thereby fostering an integrated digital culture within the educational context. 3. **Educational community and environment:** Within the broader educational community and its environs, teachers are instrumental in mobilizing and systematizing the institution's resources towards fostering societal engagement. This facet underscores the pivotal role of educators in leveraging educational assets for broader community participation and digital inclusivity. 4. **Professional development:** Educators are expected to cultivate and refine their personal learning environments (PLEs), foster expansive professional networks, and maintain a digital presence. This includes an enduring commitment to professional growth and the exemplification and leadership in the adoption of digital technologies. Such endeavors not only improve their pedagogical practice but also serve as a model for the integration of digital technologies within the educational landscape.
(Ferrari et al., 2013; Fraser et al., 2013; ISTE, 2008; Larraz Rada, 2013; Ministerio de Educación de Chile, 2011; Unesco, 2008, 2015)	TDC Dimensions	1. Teaching, curriculum, and methods. 2. Planning, organization and management of digital spaces and technological resources 3. Relational, ethical and security issues 4. Personal and professional factors

(Ferrari et al., 2013; Generalitat de Catalunya, 2015; ISTE, 2008; Larraz Rada, 2013; Ministerio de Educación de Chile, 2011; Unesco, 2008, 2015)	Key Concepts for TDC Indicators Definition	1.1 Teacher planning and digital competence 1.2 Digital technologies as facilitators of learning 1.3 Data processing and knowledge creation 1.4 Attention to diversity 1.5 Student assessment, tutoring and monitoring 1.6 Methodological approach of the academic unit 2.1. Learning environments 2.2. Managing digital technologies and programming 2.3. Spaces with digital technologies at the educational center 2.4. Projects for the incorporation of digital technologies 2.5. Instructions for digital technologies 3.1. Ethics and safety 3.2. Digital inclusion 3.3. Communication, dissemination, and transfer of knowledge 3.4. Digital content and the educational community 3.5. Digital identity of the center 4.1. Free access to information, creation, and dissemination of teaching materials with open licenses 4.2. Leadership in the use of digital technologies 4.3. Lifelong learning 4.4. Virtual learning communities: formal, informal, and informal lifelong learning 4.5. Personal learning environment (PLE) 4.6. Identity and digital presence
(Churches, 2007; ISTE, 2008; Larraz Rada, 2013)	TDC Levels of development	1. Beginner 2. Intermediate 3. Expert 4. Transformer

METHODS

Design

This research is based on a methodological framework that makes use of a descriptive-correlational approach underpinned by a non-experimental, cross-sectional study design (Bisquerra, 1989; Ramos-Galarza, 2020).

Population and sample

The study's population consists of the professors at UNACH, totaling 690 faculty members during the academic term under study. A probabilistic sampling strategy was employed to ensure a representative cross-section of the population. The sample size exceeded the minimum threshold (452) (Badii et al., 2008), with 511 educators participating, surpassing the requisite ratio of 5 samples per item for confirmatory structural analysis. The study made use of the COMDID-A rubric, an instrument made up of 22 distinct items (Hair JR et al., 2022).

The resulting sample represents 50 % of the targeted academic population, a figure supported by a statistical confidence level of 97 %. Participation rates and distribution are shown in Table 3.

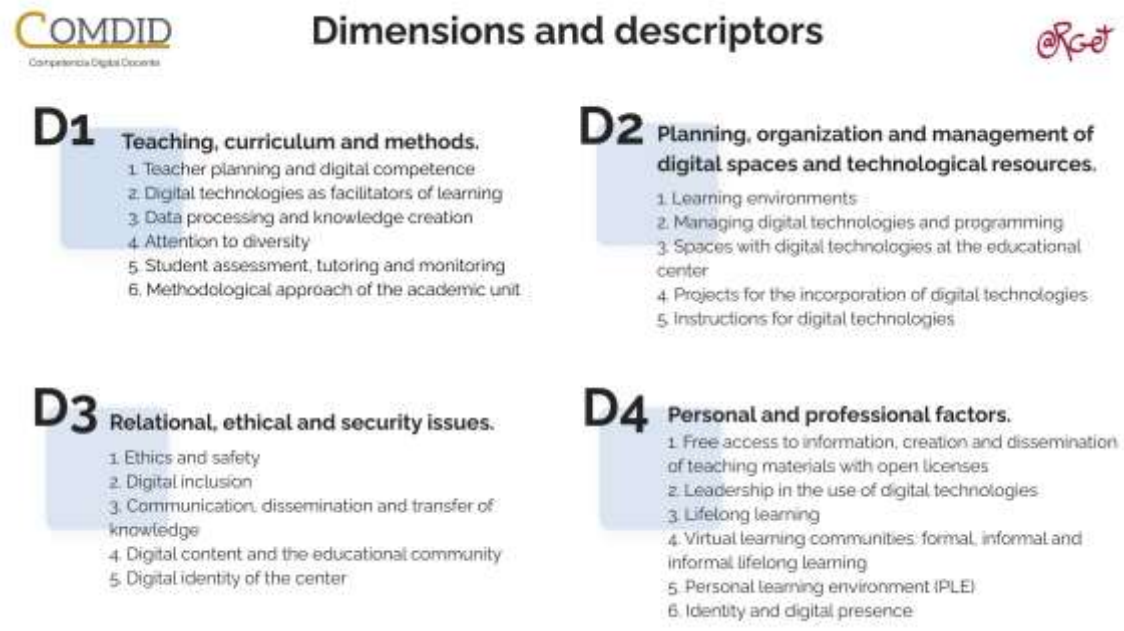
Table 3
Characterization by study variables: Sample

Graduate degree knowledge Area	Employment Relationship		Total
	Full	Adjunct	
Education	74	50	124
Art & Humanities	1	12	13
Social Sciences, Journalism, Information and Law	6	22	28
Administration	34	46	80
Natural Sciences, Mathematics and Statistics	10	17	27
Information and Communication Technologies	12	17	29
Engineering, Industry & Construction	17	39	56
Agriculture, Forestry, Fisheries and Veterinary	1	2	3
Health & Wellness	40	97	137
Services	10	4	14
Total	**205**	**306**	**511**

Data collection instrument

The data was collected for this study by means of the administration of the COMDID-A questionnaire, an instrument carefully designed to assess the DC of in-service educators. It is a specialized analytical tool offering a nuanced and comprehensive exploration of the critical dimensions inherent to DC within the pedagogical domain. Figure 1 shows the structured composition of the COMDID-A questionnaire, illustrating the interconnected dimensions and indicators that underpin this evaluative framework (Lázaro-Cantabrana et al., 2018; Lázaro-Cantabrana & Gisbert-Cervera, 2015).

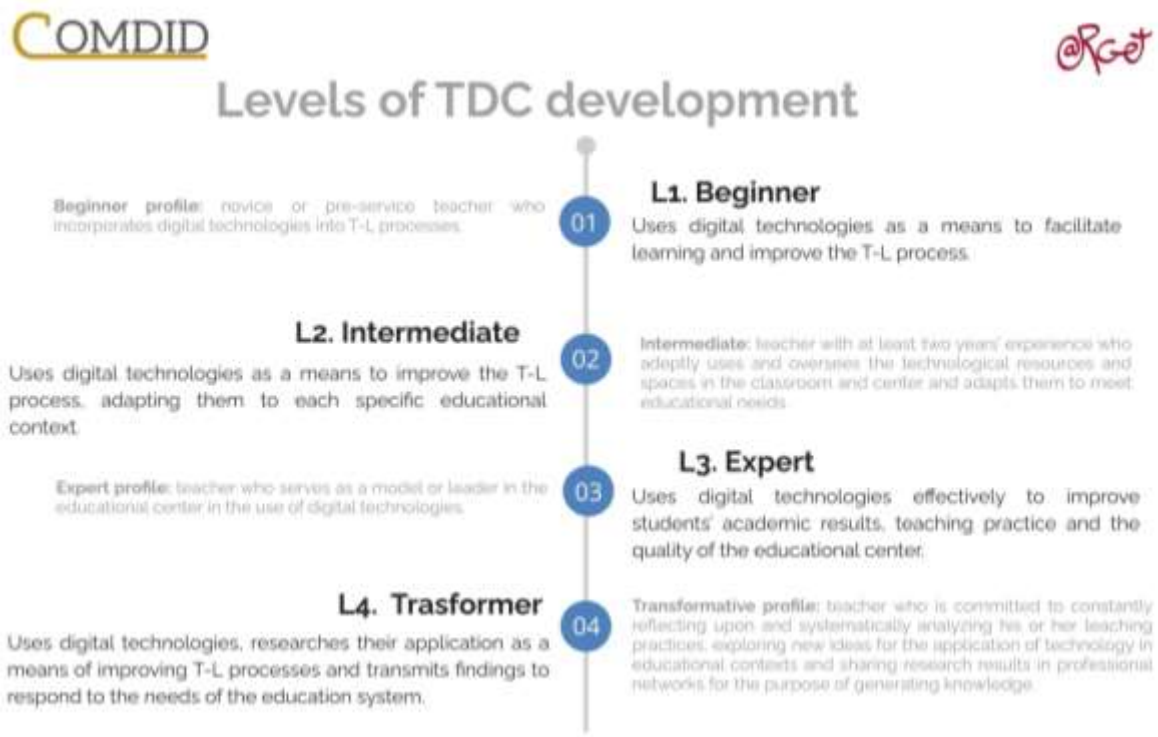
Figure 1
TDC dimensions and descriptors in the COMDID A model



Source: ARGET Research Group, Universitat Rovira i Virgili

The questionnaire is based on an evaluative scale with five response options, reflected in a scoring continuum with gradations at 0, 25, 50, 75, and 100. This structured scale facilitates a nuanced appraisal of each indicator, calibrated against its developmental progression. Figure 2 shows an expanded description of this categorization framework and the operationalization of the evaluative scale.

Figure 2
TDC levels of development



Source: ARGET Research Group, Universitat Rovira i Virgili.

Reliability and validation of the COMDID-A instrument

The instrument's reliability was verified with Cronbach's alpha coefficient (Cronbach, 1951). A factorial confirmatory analysis (FCA) was also applied in accordance with the methodological guidelines for its use (López-Aguado & Gutiérrez-Provecho, 2019).

Data analysis

Our data analysis process consisted of a two-pronged analytical approach that incorporated both descriptive and inferential statistical techniques performed with IBM SPSS statistics software (Version 28.0.1.1.15). The initial analytical phase attempted to detect central tendencies and dispersion metrics within the collected data, aiming to construct a foundational quantitative level of TDC among the faculty at UNACH in Ecuador. After the preliminary analysis, a phase of inferential statistical examination was begun using Spearman's Rho as a pivotal tool to determine potential associative dynamics among the variables of interest: the domain of knowledge corresponding to the subjects' undergraduate and graduate qualifications, their

academic department affiliation, academic program, employment status, and the attainment of doctoral-level education. Throughout the analysis, a suite of statistical metrics including correlation coefficients, statistical significance (Sig.), effect size (p), and statistical power (1-β) were assessed using Gpower software (version 3.1.9.6) (Erdfelder et al., 1996; Faul et al., 2007).

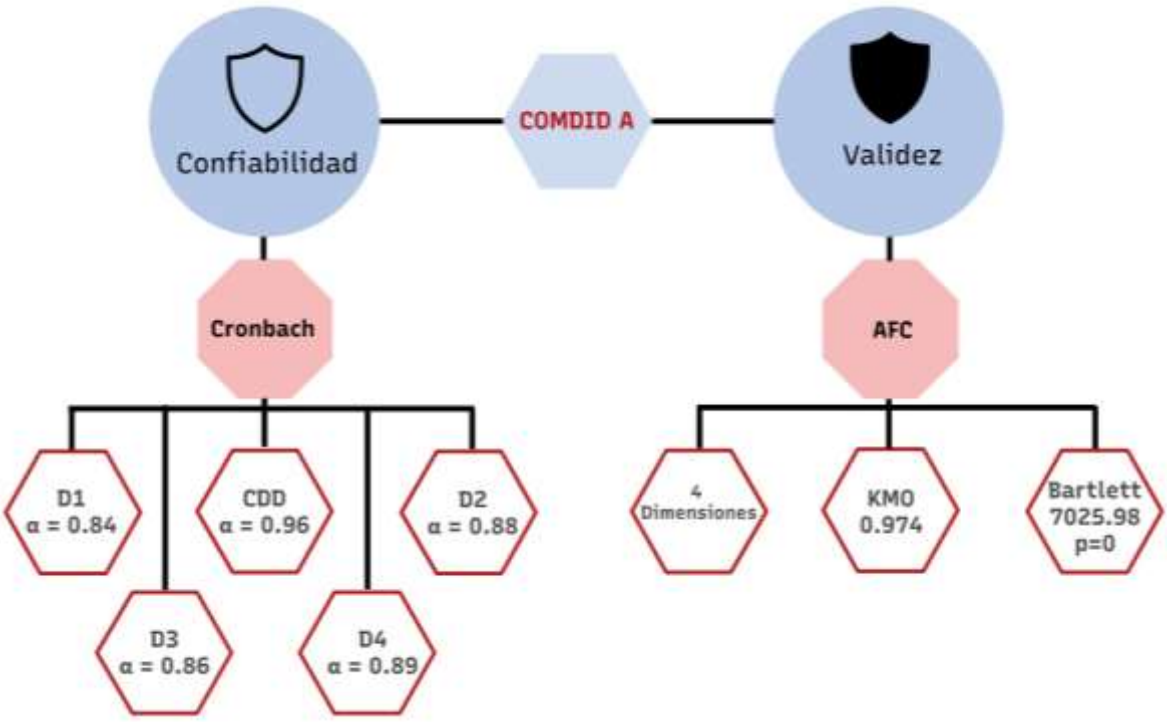
To further examine the intricacies of TDC, a factor analysis was applied with two fixed components: employment relationship and academic program. This analytical stratagem was chosen to detect any substantive effects exerted by these variables on levels of TDC. To this end, we used a general linear model (ANOVA) with an F-statistic as a means of quantification (Garibaldi et al., 2019).

RESULTS

Instrument reliability and construct validity

The principal component analysis (PCA) showed that the sample exhibited optimal congruence with the Kaiser-Meyer-Olkin (KMO) metrics. Furthermore, the determination of four distinct factors, cumulatively accounting for 65 % of the variance, is consistent with the dimensions defined by the COMDID-A framework (Cisneros-Barahona, Marqués-Molías, Samaniego-Erazo, Mejía-Granizo & De la Cruz-Fernández, 2023). The computation of Cronbach's alpha across the entirety of the instrument and its constituent dimensions revealed exemplary internal consistency, thereby confirming the robustness of the measuring tool (Figure 3).

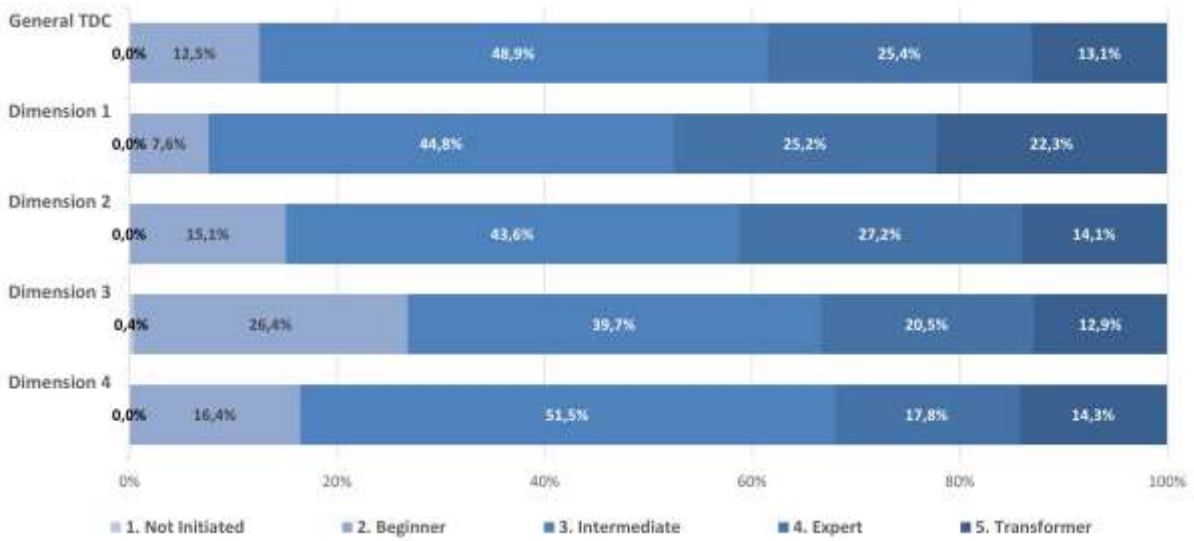
Figure 3
Reliability and validity of the COMDID-A instrument



Levels of TDC development

Figure 4 shows the TDC levels of the COMDID-A reference frame dimensions.

Figure 4
Teacher digital competence (TDC) proficiency across dimensional constructs



The representation of TDC levels, as framed by the COMDID-A reference structure, reveals a disparate distribution across the evaluated sample. Specifically, the "intermediate" and "expert" levels constitute approximately 49 % and 25 % of the sample, respectively, while the "beginner" and "transformer" levels are less prevalent, collectively representing about 13 %. Interestingly, there was a notable absence of educators within the "not initiated" category. Nevertheless, a nuanced examination across individual dimensions unveiled differing proficiency levels, signifying a diverse range of competences across the TDC spectrum.

Level of TDC development based on sample biodata

TDC in relation to area of knowledge of graduate-level degree

Figure 5 shows the analytical outcomes concerning TDC levels and the correlation of the disciplinary domains and the graduate qualifications of the professors at UNACH (República del Ecuador, 2023). A pervasive "intermediate" level of competence was observed across a broad spectrum of disciplinary fields, with prevalence rates oscillating between 33.33 % and 70.37 %. This distribution suggests that the educators at this institution have cultivated a moderate degree of proficiency in digital competences across diverse knowledge areas.

Conversely, the "transformer" level of TDC was less common, with incidences ranging from zero to 27.59 %. These findings point to a more infrequent integration of innovative pedagogical practices and technological applications within these disciplines.

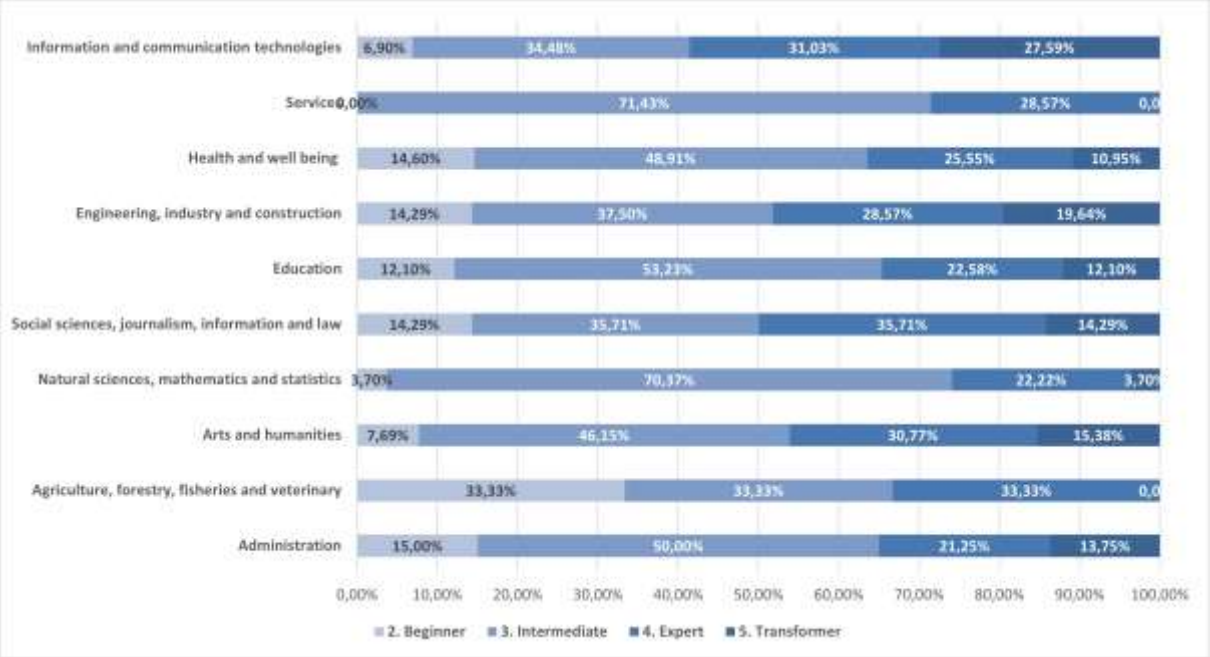
It is noteworthy that disciplines such as agriculture, forestry, fisheries and veterinary sciences and services exhibited lower propensities towards the

"transformer" level, indicating potential avenues for the enhancement of sophisticated digital skills within these fields. In contrast, 27.59 % of the subjects in the information and communication technologies domain scored at the "transformer" level, indicating the widespread adoption of educational technology innovations in that field.

A crucial observation was the absence of educators classified as "not initiated" across all fields of knowledge, signifying a foundational digital competency baseline among the faculty members. This revelation points to the ubiquitous presence of basic TDC across the academic landscape, setting a foundational platform for the further development of digital skills.

Figure 5

TDC levels in relation to area of knowledge of graduate-level degree



TDC in relation to area of knowledge of undergraduate-level degree

Figure 6 delineates the progression of TDC in juxtaposition with the disciplinary specialization of undergraduate degrees among faculty members at UNACH (República del Ecuador, 2023).

The prevalence of the "intermediate" competency level across diverse academic spheres, with figures oscillating between 38.46 % and 66.67 %, underscores a consistent trend towards moderate digital proficiency. Notably, this trend exhibits a spike at the "intermediate" level with an associated reduction across other competence levels, suggesting the pervasive acquisition of intermediate digital skills among the faculty.

Prominently, the domains of information and communication technologies and engineering, industry, and construction were found to have high percentages of subjects at the "transformer" level, at 40.63 % and 17.81 % respectively, indicating a predilection towards innovative pedagogical and technological paradigms within these fields. Moreover, a significant contingent of educators within the fields of natural

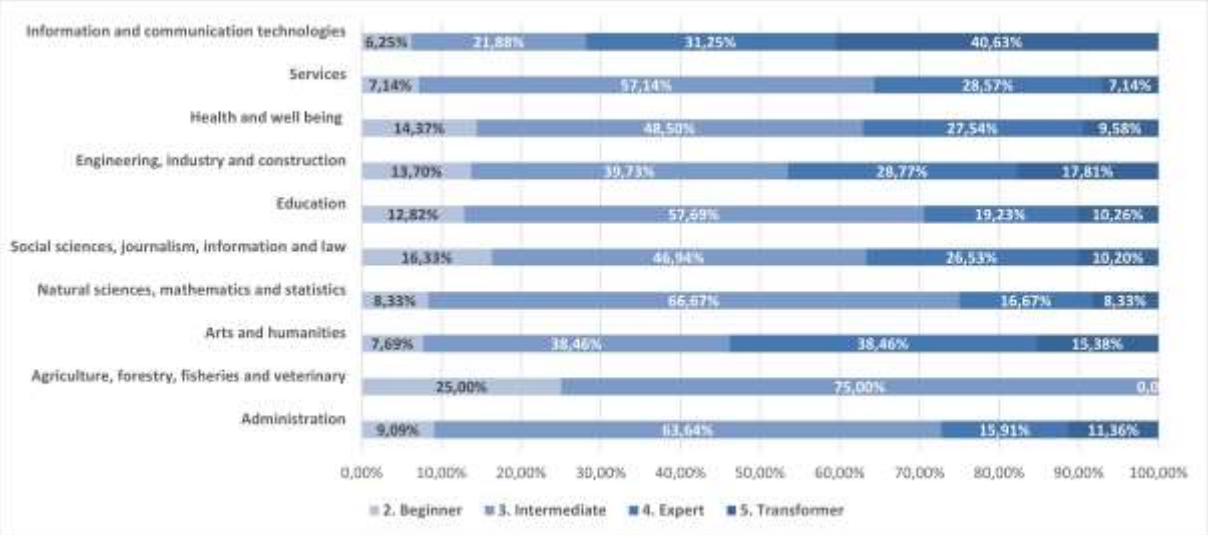
sciences, mathematics, and statistics (66.67 %) points to the overlapping relationship between these disciplines and the attainment of moderate DC.

Conversely, among subjects from the academic area of agriculture, forestry, fisheries, and veterinary sciences as well as from services, there was a conspicuous absence of scores at the "transformer" level, suggesting a potential gap in the advanced use of digital technologies. In this vein, strategies to foster a deeper integration of educational technologies within these sectors are imperative. Meanwhile, the information and communication technologies sector merge at the forefront, demonstrating a notable 40.63 % at the "transformer" level, indicative of its leadership in the adoption of cutting-edge DT in educational praxis.

The observation that no educators were categorized at the "not initiated" level across all disciplines is particularly salient, reflecting a universal baseline of digital competency among UNACH's faculty.

Figure 6

TDC levels in relation to area of knowledge of undergraduate-level degree



TDC by department

Figure 7 shows the findings pertaining to the development of TDC by the specific academic departments to which the professors are affiliated.

At present, the organizational structure of UNACH encompasses four distinct academic departments:

1. Department of Engineering (DE)
2. Department of Educational, Human Sciences and Technologies (DEHS&T)
3. Department of Health Sciences (DHS)
4. Department of Political and Administrative Sciences (DP&AS)

The educators affiliated with DEHS&T were found to have a predominant "intermediate" level of DC, with 53.17 % of staff members falling into this category. This is juxtaposed with a notably lower percentage of subjects at the "transformer" level (12.70 %). Conversely, the DHS exhibits a heightened proportion of faculty members

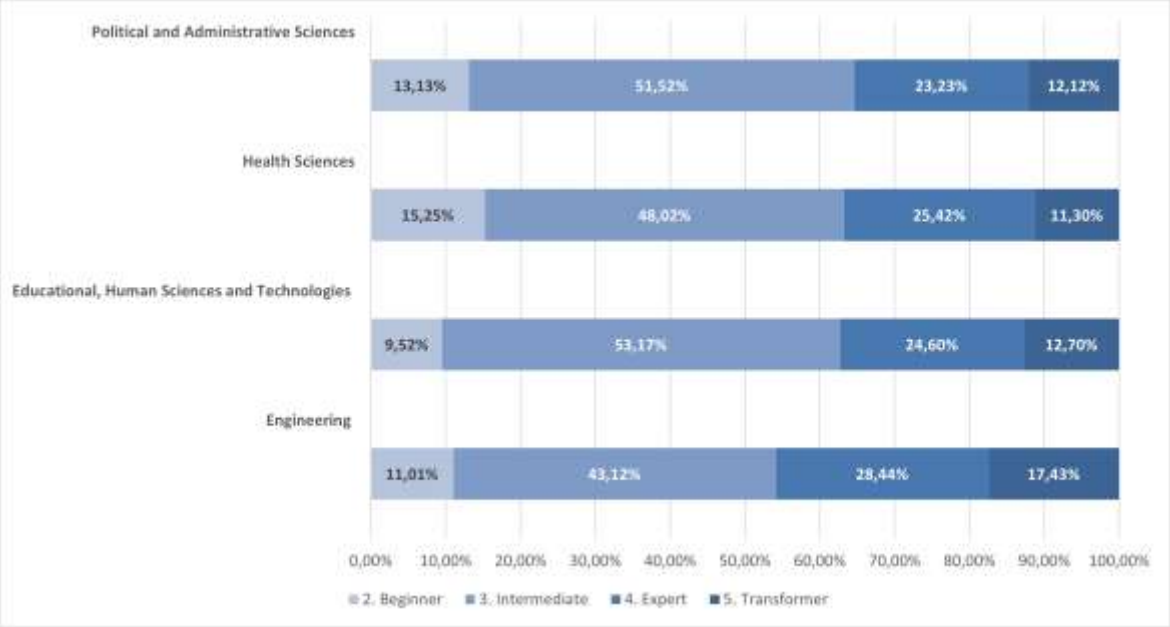
at the "beginner" level (15.25 %), with a lesser representation at the "transformer" level (11.30 %). The DE and the DP&AS were found to have a relatively equitable distribution of DC across varying proficiency levels. Notably, the categorization of faculty members within the "not initiated" level across these departments was conspicuously absent.

The "intermediate" level of DC proficiency was found to prevail across all departments, followed sequentially by the "expert," "beginner," and "transformer" levels. This distribution suggests an inverse correlation between the level of DC and the prevalence of faculty members at the "transformer" level within each department.

Strategically customizing training and professional development initiatives, attentively calibrated to department-specific, discipline-oriented, and educational level considerations, promises to enhance their effectiveness. By ensuring tailored adjustments to the distinct needs and attributes of educators across diverse academic landscapes, DC enhancement efforts can be optimized.

Figure 7

TDC levels in relation to affiliated departments



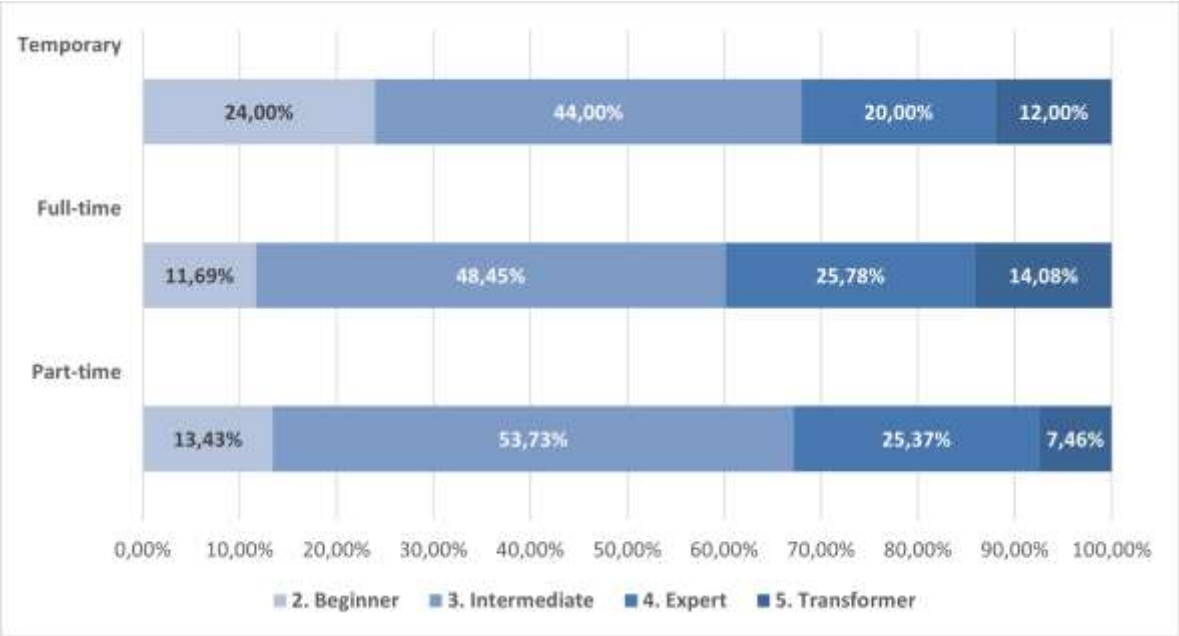
TDC in relation to employment status

Figure 8 shows the proportional distribution of TDC levels vis-à-vis the subjects' employment status, namely part-time, full-time, and temporary. Notably, the "intermediate" level of DC emerges as the predominant category across all employment status brackets. Nonetheless, it is worth emphasizing that the temporary and part-time statuses manifest comparatively higher incidences at the "transformer" level, with 12 % and 7.46 % respectively. This is in stark contrast to the full-time faculty, of which 14.08 % were ranked at this level. Additionally, a pronounced representation of educators at the "beginner" level (24 %) was found among teachers with temporary status.

The temporary and part-time employment status classifications stand out as having a higher proportion of faculty members at the "transformer" level. This pattern suggests that the reduced workload inherent to these employment statuses may

provide these teachers with enhanced flexibility, thereby facilitating the integration of innovative pedagogical methods and technological practices in their educational processes.

Figure 8
TDC in relation to employment status



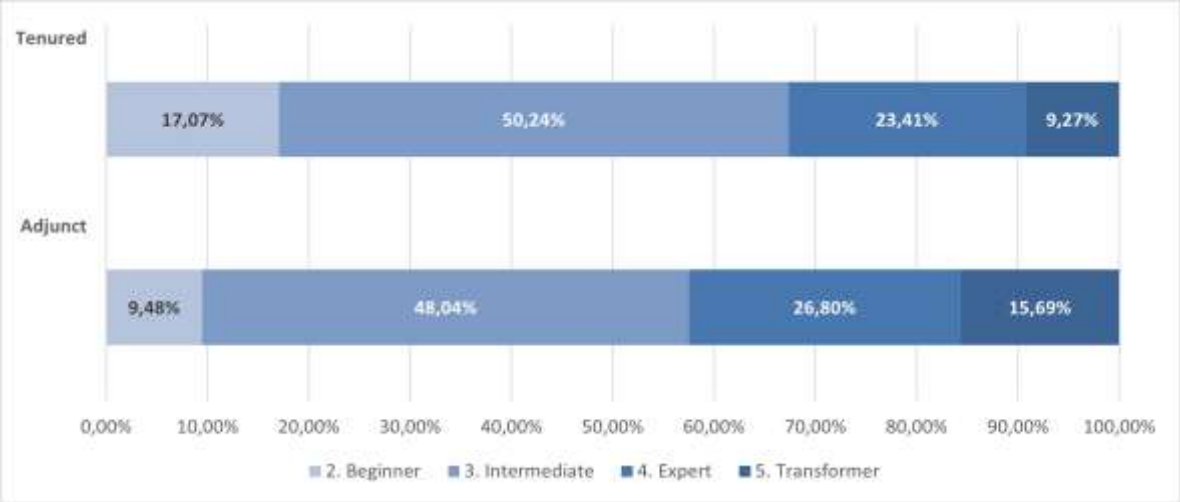
TDC in relation to employment relationship

Figure 9 shows the proportional distribution of TDC levels in relation to the employment status of the UNACH professors under study. Across the spectrum of employment categories, the "intermediate" level of TDC is consistently prominent, indicating a pervasive acquisition of DC within the academic context.

Particularly, we found a substantial number of professors with an "intermediate" level of TDC (50.24%) within the "full" (tenured) category. This prevalence suggests that tenured professors possess a foundational level of DC that is integral to their pedagogical functions. A similar trend was found among non-permanent teaching staff, with professors in the "adjunct" (non-permanent) employment category demonstrating a notable achievement of "intermediate" digital competences.

Overall, the "beginner" and "transformer" levels of TDC were found to be the least common, indicating a predilection for educators to attain either intermediate or advanced stages of DC.

Figure 9
TDC in relation to employment relationship

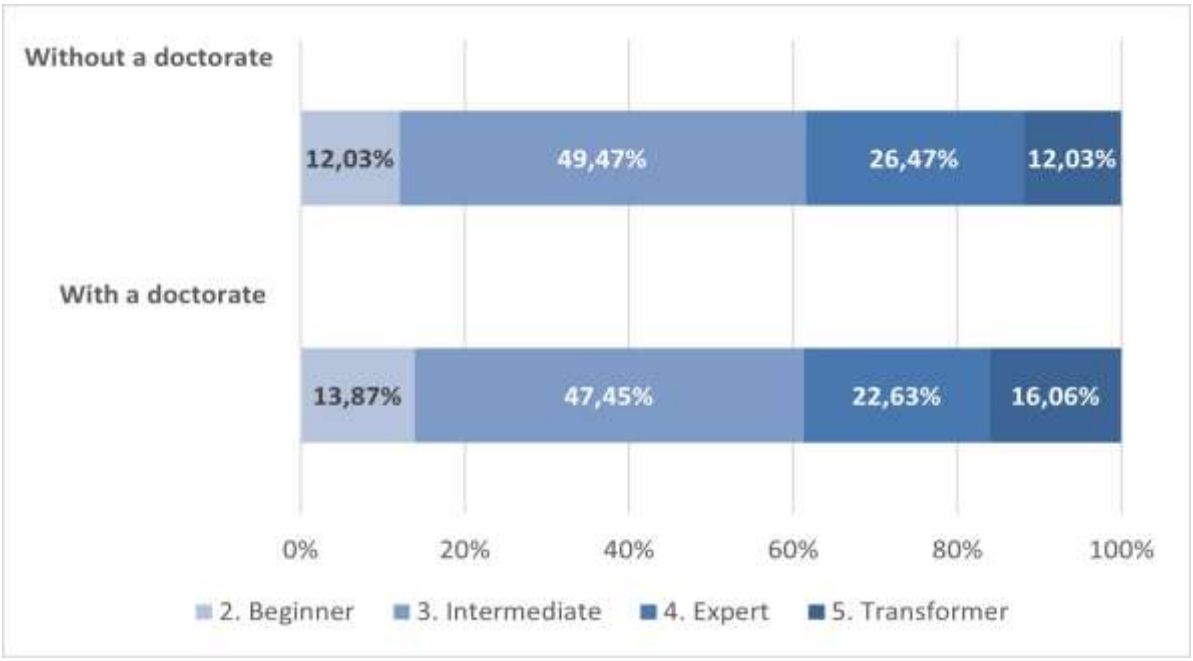


TDC in relation to possession of a doctoral degree

Figure 10 shows the proportional distribution of TDC levels vis-à-vis the attainment of doctoral qualifications among the faculty members of UNACH.

The comparative analysis reveals a notable parity at the "expert" level of TDC between professors holding doctoral degrees (22.63 %) and those without such qualifications (26.47 %). Notwithstanding, a discernible disparity emerges at the "transformer" level of TDC, with 16.06 % of educators holding doctorates documented at that level compared to 12.03 % among their counterparts without doctoral degrees.

Figure 10
TDC in relation to the possession of a doctoral degree



Correlational analysis

Given the non-normal distribution of the data pertinent to the variables examined, a non-parametric test was required for the correlation analyses. We chose the Spearman's Rho coefficient as the statistical measure (Creswell, 2011) due to the ordinal/nominal nature of the categorical variables. The correlation coefficients, statistical significance (Sig.), effect size (p), and statistical power (1-β) were also evaluated at the same time (Erdfelder et al., 1996).

Table 4 shows the interrelations between TDC and a range of variables pertinent to the faculty at UNACH (Creswell, 2011). The correlations observed were predominantly of a low magnitude. The analyses did not reveal any statistically significant associations between the variables of employment status or the disciplinary field of undergraduate- or graduate-level degrees and the level of TDC development.

Conversely, statistically significant correlations were discerned regarding department affiliation and academic program academic program. These findings suggest the potential impact of these variables on the cultivation of TDC. Furthermore, notable correlations were identified in relation to the possession of doctoral degrees, indicating a potential variation in TDC levels contingent upon the doctoral qualifications attained by educators.

Table 4

Correlations of TDC level at the item/dimension level with educational environment variables (n=511)

Variable	Spearman's Rho	D1	D2	D3	D4	TDC	D1.1	D1.2	D1.3	D1.4	D1.5	D1.6	D2.1	D2.2	D2.3	D2.4	D2.5	D3.1	D3.2	D3.3	D3.4	D3.5	D4.1	D4.2	D4.3	D4.4	D4.5	D4.6
Area of knowledge of undergraduate-level degree	Coef.	.03	.02	.02	.00	.01	.03	.06	.02	-.03	.00	-.03	.03	.01	.00	-.02	.07	.00	.01	.04	-.02	.03	-.02	-.01	.00	.07	-.02	.03
	Sig.	.44	.60	.57	.99	.91	.52	.16	.67	.47	.94	.54	.53	.86	.94	.71	.14	.97	.77	.37	.66	.48	.63	.89	.99	.11	.62	.55
	ρ	.17	.14	.14	.03	.10	.17	.24	.14	.17	.03	.17	.17	.10	.03	.14	.26	.03	.10	.20	.14	.17	.14	.10	.03	.26	.14	.17
	1-β	.99	.99	.99	.99	.94	.87	.99	.99	.99	.94	.99	.87	.97	.95	.99	.99	.98	.98	.99	.99	.99	.99	.99	.99	.99	.99	.99
Area of knowledge of graduate-level degree	Coef.	.03	.01	.01	-.01	.00	.05	.06	.02	.03	-.02	-.01	.02	.00	-.04	.01	.05	.00	.01	.05	.00	.02	-.03	-.01	-.03	.05	-.04	.02
	Sig.	.52	.74	.87	.78	.98	.26	.17	.64	.55	.59	.89	.62	.96	.38	.90	.24	.98	.84	.31	.95	.69	.44	.84	.51	.27	.37	.62
	ρ	.17	.10	.10	.10	.03	.22	.24	.14	.17	.14	.10	.14	.03	.20	.10	.22	.03	.10	.22	.03	.14	.17	.10	.17	.22	.20	.14
	1-β	.99	.98	.99	.98	.99	.99	.99	.99	.99	.99	.99	.99	.97	.99	.99	.99	.99	.99	.99	.96	.99	.99	.99	.99	.99	.99	.99
Department	Coef.	-.06	-.07	-.02	-.03	-.04	**-.09***	-.01	-.05	-.02	-.03	-.01	-.09	.01	-.04	-.02	**-.09***	-.01	-.03	.03	.01	-.05	.02	-.02	-.05	-.07	.02	-.04
	Sig.	.15	.14	.58	.46	.40	**.03**	.80	.28	.70	.54	.75	.05	.88	.34	.62	**.03**	.81	.47	.51	.88	.24	.69	.58	.29	.11	.64	.43
	ρ	.24	.26	.14	.17	.20	**.31**	.10	.22	.14	.17	.10	.30	.10	.20	.14	**.31**	.10	.17	.17	.10	.22	.14	.14	.22	.26	.14	.20
	1-β	.99	.99	.99	.99	.99	**1.00**	.98	.99	.99	.99	.98	.99	.99	.99	.99	**1.00**	.98	.99	.99	.99	.99	.99	.99	.99	.99	.99	.99
Academic program	Coef.	-.07	-.07	-.03	-.03	-.05	**-.11***	.00	-.05	-.02	-.05	-.03	**-.09***	.00	-.05	-.03	**-.11***	-.02	-.03	.03	.01	-.06	.01	-.02	-.04	-.07	.01	-.04
	Sig.	.12	.11	.54	.57	.30	**.01**	.92	.22	.73	.30	.52	**.05**	.98	.26	.52	**.02**	.73	.46	.52	.86	.20	.74	.64	.40	.12	.76	.39
	ρ	.26	.26	.17	.17	.22	**.33**	.03	.22	.14	.22	.17	**.29**	.03	.22	.17	**.33**	.14	.17	.17	.10	.24	.10	.14	.20	.26	.10	.20
	1-β	.99	.99	.99	.99	.99	**1.00**	.94	.99	.99	.99	.99	**1.00**	.98	.99	.99	**1.00**	.99	.99	.99	.99	.99	.98	.99	.99	.99	.98	.99
Employment status	Coef.	.00	-.08	-.05	-.05	-.08	-.02	.03	-.03	-.01	-.05	-.08	-.05	-.05	**-.09***	-.08	-.03	-.04	.01	-.04	-.07	.01	-.05	-.01	-.03	-.06	-.01	.01
	Sig.	.99	.09	.31	.27	.09	.73	.51	.54	.83	.24	.07	.28	.24	**.04**	.08	.44	.32	.75	.33	.13	.83	.23	.77	.43	.18	.79	.85
	ρ	.03	.28	.22	.22	.28	.14	.17	.17	.10	.22	.28	.22	.22	**.30**	.28	.17	.20	.10	.20	.26	.10	.22	.10	.17	.24	.10	.10
	1-β	.99	.99	.99	.99	.99	.99	.99	.99	.99	.99	.99	.99	.99	**1.00**	.99	.99	.99	.98	.99	.99	.99	.99	.98	.99	.99	.98	.99
Doctoral degree	Coef.	-.04	-.03	.02	-.05	.00	-.02	-.04	**-.09***	-.04	-.03	-.01	-.06	.00	-.01	-.06	-.02	.02	.06	.01	.00	-.03	-.05	-.02	-.04	-.02	-.01	.00
	Sig.	.37	.53	.63	.26	.92	.72	.39	**.04**	.36	.55	.83	.19	.96	.89	.19	.71	.69	.19	.77	.99	.44	.25	.60	.43	.68	.76	.95
	ρ	.20	.17	.14	.22	.03	.14	.20	**.30**	.20	.17	.10	.24	.03	.10	.24	.14	.14	.24	.10	.03	.17	.22	.14	.20	.14	.10	.03
	1-β	.99	.99	.99	.99	.94	.99	.99	**1.00**	.99	.99	.99	.99	.97	.99	.99	.99	.99	.99	.98	.99	.99	.99	.99	.99	.99	.98	.96

Note: *. The correlation is significant at the .05 (2-tailed) level; **. The correlation is significant at the .01 (2-tailed) level; ρ=.10 low, .30 medium, .50 high (Cohen, 1988); 1-β at least .80 to generalize the results (Cohen, 1992).

General linear model (ANOVA) between TDC and the fixed variables employment relationship and academic program

The modified Breusch-Pagan test (White's test) detected a discernible level of significance, corroborating the presence of heteroscedasticity within the sample. This indicates that the variance of the residuals does not maintain constancy across the spectrum of the predictor variables, namely employment relationship and academic program. Furthermore, the application of the Kolmogorov-Smirnov test for independent samples yielded significances surpassing the .05 threshold, thereby justifying the use of a general linear ANOVA model to analyze TDC based on the fixed factors of employment relationship and academic program.

This analysis sought to determine the impact of the variables employment relationship and academic program on level of TDC, including their interaction effects. The null hypothesis posits equality among the mean values of the designated populations for each factor, excluding the presence of interaction effects. The F statistic served as the analytical tool (Garibaldi et al., 2019).

Table 5 shows the test of between-subject effects. The subsequent ANOVA revealed discernible differences between the variables employment relationship and academic program and TDC level, at a significance threshold of .05. Moreover, the interaction effects, along with the intersection and the corrected model, were found to be statistically significant.

Table 5

Results of inter-subject effects, TDC and the fixed variables employment relationship and academic program

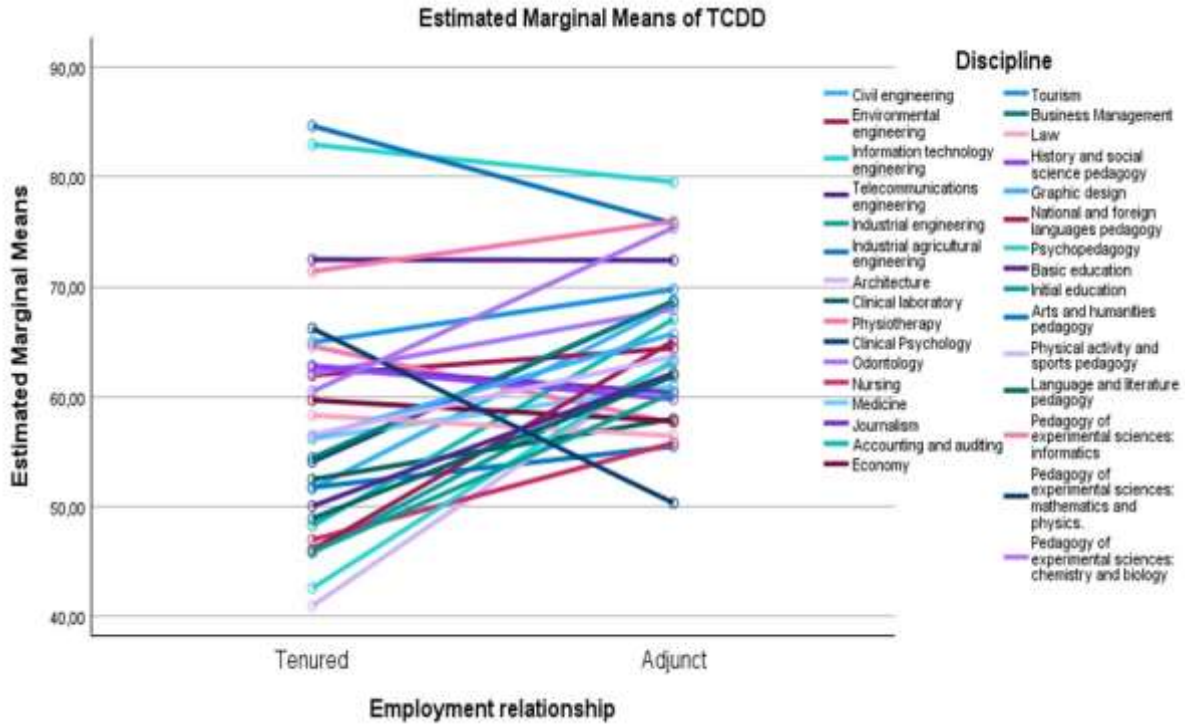
Dependent variable: TDC

Origin	Type III sum of squares	df	Quadratic mean	F	Sig.	Partial Eta squared
Corrected model	64.922[a]	61	1.064	1.499	0.012	0.169
Intersection	4230.310	1	4230.310	5958.002	0.000	0.930
Employment relationship	6.705	1	6.705	9.444	0.002	0.021
Academic program	38.644	30	1.288	1.814	0.006	0.108
Employment relationship * Academic program	21.564	30	0.719	1.012	0.451	0.063
Error	318.800	449	0.710			
Total	6261.000	511				
Total corrected	383.722	510				

a. R squared =.169 (Adjusted R squared =.056)

The factor analysis, as illustrated in Figure 11, shows the marginal means of the levels of TDC in relation to the employment relationship of the educators studied and their respective academic programs within the university. Among the 31 academic programs examined, 23 exhibit statistically significant variances, revealing a perception of higher competence in adjunct professors compared to their tenured counterparts.

Figure 11
Indicators with the highest average score in relation to employment relationship and the dimensions of the COMDID-A framework (estimated marginal averages of TDC)



DISCUSSION AND CONCLUSIONS

The reliability of the instrument within the sampled demographic was confirmed by means of Cronbach's alpha.

A confirmatory factor analysis (CFA) served to refine the precision and validity of the constructs delineated by the COMDID-A framework, which improved the quality and empirical credibility of the research outcomes. The alignment of the proposed structural construct with the sampled data validated the interrelation between the theoretical model and the empirical items. Moreover, the establishment of a coherent dimensional structure, characterized by substantial correlations among the dimensions, further corroborated the instrument's internal consistency.

Understanding the interrelationships within the correlation matrix is instrumental in deciphering the complex dynamics of the COMDID-A model. The evidence of convergent validity improved the coherence among variables within identical dimensions, whereas discriminant validity distinctly separated the dimensions from one another. The Kaiser-Meyer-Olkin (KMO) measure and Bartlett's test outcomes substantiate the CFA's appropriateness, revealing a significant underlying structure within the data. The presence of moderately high communalities suggests that the derived factors are intimately linked to the observed variables, thereby reinforcing the model's overarching validity.

Echoing prior research that made use of the COMDID-A rubric, in our study, Dimension 1 exhibited a more advanced level of development (Palau et al., 2019; Paz Saavedra & Gisbert Cervera, 2023). Conversely, while preceding studies have

accentuated the integrity of Dimension 3 (Lázaro-Cantabrana et al., 2019; Silva et al., 2019), our research found a diminished mean rating within this domain. Variations such as these clearly reflect the contextual and demographic specificities inherent to the study.

The prevailing "intermediate" level of TDC across all evaluated dimensions is consistent with the corpus of existing literature (Santos et al., 2021). Nevertheless, the fact that not even 50 % of the subjects surpassed that competency level is noteworthy. Moreover, a minimal contingent of educators fell into the "not initiated" level within Dimension 3, and that lowest level was completely absent in Dimensions 1, 2, and 4. These patterns indicate that most teachers possess moderate digital skills, while drawing attention to a niche demographic yet to embark on their TDC development, particularly within Dimension 3. These results emphasize the importance of a call to action for intensified focus and investment in competence development initiatives aimed at elevating DT and DC mastery within academia.

In alignment with the overarching trends detected in relation to TDC levels, the "intermediate" level was found to be prevalent across most indicators within Dimension 1. Notably, the "not initiated" level was minimally represented across all indicators, suggesting an elemental familiarity amongst educators with DT and their pedagogical applications. Certain indicators, notably "1.1. Teacher planning and digital competence" and "1.3. Data processing and knowledge creation", were found to have a significant contingent at the "expert" and "transformer" levels, indicative of advanced proficiencies in instructional planning and the use of digital information for knowledge generation. Conversely, the indicator "1.2. Digital technologies as facilitators of learning" showed a prevalence of "beginner" level scores, signifying potential areas for pedagogical enhancement. Furthermore, "1.3. Data processing and knowledge creation" and "1.4. Attention to diversity" within Dimension 1, when evaluated at the "expert" and "transformer" levels, underscore a symbiotic relationship between these domains and elevated levels of TDC. These observations are congruent with scholarly assertions advocating for comprehensive training in DT and curriculum integration, particularly emphasizing improved pedagogical competences which occasionally manifest suboptimal levels in contrast to other dimensions (Ayale-Pérez & Joo-Nagata, 2019; Lago Martínez et al., 2017).

The analysis of Dimension 2 revealed a pronounced proficiency at the "expert" and "transformer" levels within the "2.1 Learning environments" and "2.2 Managing digital technologies and programming" indicators, denoting advanced competences. Conversely, "2.3 Spaces with digital technologies of the educational center" exhibited a notable presence of "beginner" and "intermediate" level teachers, pointing to avenues for capacity development and reinforcement.

Dimension 3 consistently exhibited distributions across the "intermediate" and "beginner" levels, with "expert" and "transformer" levels also present, albeit less prominently. The "3.4 Digital content and the educational community" indicator is particularly noteworthy for its diverse distribution across the "beginner", "intermediate", and "expert" levels, highlighting a concerted focus on generating apt digital content. These parallel findings suggesting that ethical dimensions, such as "3.1 Ethics and safety", are often documented at lower competency levels (Arango et al., 2020; Gallego-Arrufat et al., 2019).

Additionally, both "3.3 Communication, dissemination and transfer of knowledge" in Dimension 3, and "4.5 Personal learning environment (PLE)" in Dimension 4, were identified with diminished levels of TDC, which is consistent with the findings of other

researchers (Basantes-Andrade et al., 2020; Biel & Ramos, 2019; Cabero-Almenara et al., 2021; Gutiérrez-Castillo et al., 2017). This accentuates the imperative for curating training modalities aimed at improving TDC levels, confronting the pedagogical exigencies emergent when DT and DC are not integrally woven into the teaching and learning (T-L) schema (Romero-Tena et al., 2020; Wu, 2014; Zhao et al., 2019).

Within Dimension 4, the indicators "4.3 Lifelong learning" and "4.5 Personal learning environment (PLE)" are notably distinguished by a pronounced prevalence of "intermediate" and "expert" levels. Specifically, "4.3 Lifelong learning" is characterized by elevated proportions of "experts" and "transformers", reflecting a strategic emphasis on continuing professional development and the cultivation of personal learning environments at an institutional scale.

These findings are congruent with those in the published literature and underscore the nuanced variability of TDC across disparate cohorts of educational professionals (Zhao et al., 2021). Such distinctions are pivotal for contextualizing TDC evaluations amidst the evolving complexities and heterogeneity inherent to contemporary educational landscapes.

The marked disparities between groups highlights the instrumental role of DT in the configuration of educators' DC (Guillén-Gámez et al., 2021), which strengthens the imperative to incorporate these factors into the framework of professional development initiatives aimed at improving TDC (Amhag et al., 2019; Nascimbeni, 2020). The tailoring and customization of these interventions are deemed crucial for bridging the competence gaps identified in this work and fostering the equitable ascension of DC within the educational community (Juárez Arall & Marqués Molías, 2019; Silva Quiroz, 2017).

The use of Spearman's Rho to ascertain correlation coefficients brought to light significant positive correlations between TDC as a whole and its constituent dimensions (D1, D2, D3, D4), in agreement with prior research findings (Cabrera, 2009; Reguant-Álvarez et al., 2018). This interconnection reinforces the assertion that advancements within a singular dimension invariably precipitate beneficial impacts across the TDC spectrum, thereby fostering a multifaceted skills profile. Such a pattern of synergy and mutual reinforcement among the various facets of TDC aligns with other observations within the Latin American educational context (Paz Saavedra & Gisbert Cervera, 2023)

These interdimensional dynamics offer profound insight into the integrative essence of TDC (Gutiérrez-Castillo et al., 2017). Acknowledging that progression in one dimension catalyzes advancements in others underscores the need for holistic approaches in the design and execution of training and professional development programs (Garita-González et al., 2019). This comprehensive viewpoint is indispensable for navigating the intricacies of TDC and ensuring the balanced development of skills (Biel & Ramos, 2019; Vallejo & Aguayo, 2021).

The coherence observed amongst competency levels across dimensions indicates that the enhancement of digital skills transcends specific domains, fostering an effective interdimensional transfer and integration of DC. This pattern strengthens the argument for the holistic development of such competences (Romero-Tena et al., 2020), as the consistent skill levels across the diverse dimensions attest to the depth and scope of the DC profile cultivated within the subject group (Santos et al., 2021).

Exploring the diversity of correlations sheds light on the multifaceted nature of TDC and underscores its inherent complexity (Gisbert Cervera & Esteve Mon, 2011).

The absence of definitive patterns in its development suggests the convergence of several subtly interacting factors, thus highlighting the intricate and individualized journey educators embark on in acquiring DC (Fernández Sánchez et al., 2016; Padilla-Hernández et al., 2020).

The negligible correlations with educators' fields of study at both the undergraduate and graduate levels, as well as their employment relationship, suggest that these variables may not significantly sway TDC levels within this study's context. Understanding these complex and indirect correlations is pivotal in formulating professional development strategies and educational policies, demonstrating the need for interventions tailored to educators' unique contextual and educational requirements (Cisneros-Barahona, Marqués-Molías, Samaniego-Erazo & Mejía-Granizo, 2023).

Notably, the discernible correlations with departmental affiliation and academic program underscore the impact of structured programs on the various levels of TDC observed (González et al., 2020). This finding accentuates the role of the academic context in shaping educators' DC, emphasizing the importance of integrating these elements into the design of targeted training and intervention strategies.

Moreover, the correlation with doctoral qualifications underscores the critical role of academic attainment in TDC (Sarango Lapo, 2021). This correlation suggests a propensity among more highly educated educators towards advanced DC, thereby linking educational achievement with the acquisition of sophisticated digital skills and highlighting the value of promoting academic progression as part of TDC enhancement initiatives (Amhag et al., 2019; Gutiérrez-Castillo et al., 2017).

The linear factor analysis indicated statistically significant variances, revealing that adjunct professors are often perceived as more digitally competent than their tenured counterparts, a finding which diverges from other studies suggesting the opposite (Rodríguez Espinosa, 2016). This discrepancy invites further inquiry into training modalities, exposure to digital educational technologies, and opportunities for professional development, potentially elucidating the underlying causes for these observed differences.

These insights not only contribute to a nuanced understanding of TDC within the examined context but also establish a foundation for future research and informed educational policymaking. Recognizing variables associated with DT enhances the precision of TDC assessments and accentuates the need for strategic, personalized approaches to effectively improve DC among educators. Furthermore, employing advanced data analysis techniques (Cisneros-Barahona et al., 2021; Uvidia Fassler et al., 2017; Uvidia Fassler et al., 2018; Uvidia Fassler et al., 2019; Uvidia Fassler et al., 2020) to explore the reciprocal influences among competences across different dimensions could provide a more comprehensive understanding of the interrelations among skills, thereby enriching the overall conceptualization of TDC.

Data availability

The data used for the experimental replication is available at the following link: https://zenodo.org/doi/10.5281/zenodo.10655922

REFERENCES

Almås, A. G., & Krumsvik, R. (2008). Digitally literate teachers in leading edge schools in Norway. *Journal of In-Service Education*, *33*(4), 479-497. https://doi.org/10.1080/13674580701687864

Amhag, L., Hellström, L., & Stigmar, M. (2019). Teacher Educators' Use of Digital Tools and Needs for Digital Competence in Higher Education. *Journal of Digital Learning in Teacher Education*, *35*(4), 203-220. https://doi.org/10.1080/21532974.2019.1646169

Arango, D. A. G., Fernández, J. E. V., Rojas, Ó. A. C., Gutiérrez, C. A. E., Villa, C. F. H., & Grisales, M. A. B. (2020). Competencia digital en docentes universitarios: evaluación de relación entre actitud, formación & alfabetización en el uso de TIC en entornos educativos. *Revista Ibérica de Sistemas e Tecnologias de Informação*, *E29*, 538-552. https://bit.ly/3N94Aui

Aviram, A., & Eshet-Alkalai, Y. (2006). Towards a theory of digital literacy: three scenarios for the next steps. *European Journal of Open, Distance and E-Learning*, *9*(1), 1-16. https://bit.ly/3t2P9wI

Ayale-Pérez, T., & Joo-Nagata, J. (2019). The digital culture of students of pedagogy specialising in the humanities in Santiago de Chile. *Computers and Education*, *133*(January), 1-12. https://doi.org/10.1016/j.compedu.2019.01.002

Badii, M. H., Castillo, J., & Guillen, A. (2008). Tamaño óptimo de la muestra (Optimum sample size). *Innovaciones de Negocios*, *5*(1), 53-65. https://bit.ly/3SRUH66

Basantes-Andrade, A., Cabezas-González, M., & Casillas-Martín, S. (2020). Digital Competences Relationship between Gender and Generation of University Professors. *International Journal on Advanced Science, Engineering and Information Technology*, *10*(1), 205. https://doi.org/10.18517/ijaseit.10.1.10806

Bérubé, B., & Poellhuber, B. (2005). *Un référentiel de compétences technopédagogiques*. https://bit.ly/3SnvP6i

Biel, L. A., & Ramos, E. Á. (2019). Digital teaching competence of the university professor 3.0. *Caracteres*, *8*(2), 205-236. https://bit.ly/3arv0aB

Bisquerra, R. (1989). *Métodos de investigación educativa: Guía práctica*. 55-69. https://bit.ly/46EsFzO

Bond, M., Marín, V. I., Dolch, C., Bedenlier, S., & Zawacki-Richter, O. (2018). Digital transformation in German higher education: student and teacher perceptions and usage of digital media. *International Journal of Educational Technology in Higher Education*, *15*(1), 48. https://doi.org/10.1186/s41239-018-0130-1

Buckingham, D. (2007). Digital Media Literacies: Rethinking Media Education in the Age of the Internet. *Research in Comparative and International Education*, *2*(1), 43-55. https://doi.org/10.2304/rcie.2007.2.1.43

Buckingham, D. (2015). Defining digital literacy - What do young people need to know about digital media? *Nordic Journal of Digital Literacy*, *10*(Jubileumsnummer), 21-35. https://doi.org/10.18261/ISSN1891-943X-2015-Jubileumsnummer-03

Cabero-Almenara, J., Barroso-Osuna, J., & Palacios-Rodríguez, A. (2021). Digital competences of educators in Health Sciences: Their relationship with some variables | Estudio de la competencia digital docente en Ciencias de la Salud. Su relación con algunas variables. *Educacion Medica*, *22*(2), 94-98. https://doi.org/10.1016/j.edumed.2020.11.014

Cabero-Almenara, J., Romero-Tena, R., Barroso-Osuna, J., & Palacios-Rodríguez, A. (2020). Marcos de Competencias Digitales Docentes & su adecuación al profesorado universitario & no universitario. *Revista Caribeña de Investigación Educativa (RECIE)*, *4*(2),

137-158. https://doi.org/10.32541/recie.2020.v4i2.pp137-158

Cabrera, E. (2009). El coeficiente de correlación de los rangos de Spearman. Caracterización. *Rev haban cienc méd La Habana*, *VIII*(2). https://bit.ly/3wlPXOy

Cateriano-Chávez, T. J., Rodríguez-Rios, M. L., Patiño-Abrego, E. L., Araujo-Castillo, R. L., & Villalba-Condori, K. O. (2021). Digital skills, methodology and evaluation in teacher trainers | Competencias digitales, metodología & evaluación en formadores de docentes. *Campus Virtuales*, *10*(1), 153-162. https://bit.ly/3FCCP97

CDEST. (2002). *Raising the Standards A Proposal for the Development of an ICT Competency Framework for Teachers*. https://bit.ly/3HU2r2J

Churches, A. (2007). *Taxonomía de Bloom para la era digital*. https://bit.ly/3Uz8roT

Cisneros Barahona, A. S., Marqués Molías, L., Samaniego Erazo, N., & Mejía-Granizo, C. M. (2023). La Competencia Digital Docente. Diseño & validación de una propuesta formativa. *Pixel-Bit, Revista de Medios & Educación*, *68*, 7-41. https://doi.org/10.12795/pixelbit.100524

Cisneros-Barahona, A., Marqués Molías, L., Samaniego Erazo, G., Uvidia-Fassler, M. I., & de la Cruz-Fernández, G. (2023). Bibliometric Mapping of Scientific Literature Located in Scopus on Teaching Digital Competence in Higher Education. In O. S. and R. M. R. and D. C. A. and L.-E. W. Botto-Tobar Miguel and Gómez (Ed.), *Trends in Artificial Intelligence and Computer Engineering* (pp. 167-180). Springer Nature Switzerland. https://doi.org/10.1007/978-3-031-25942-5_14

Cisneros-Barahona, A., Marqués Molías, L., Samaniego Erazo, G., Uvidia-Fassler, M. I., De la Cruz-Fernández, G., & Castro-Ortiz, W. (2023). Teaching Digital Competences in University Professors: A Meta-analysis and Systematic Literature Review in Web of Science. In M. Botto-Tobar, O. S. Gómez, R. R. Miranda, A. Díaz Cadena & W. Luna-Encalada (Eds.), *Applied Technologies* (pp. 61-74). Springer Nature Switzerland. https://doi.org/10.1007/978-3-031-24985-3_5

Cisneros-Barahona, A., Marqués Molías, L., Samaniego-Erazo, N., Uvidia-Fassler, M. I., Castro-Ortiz, W., & Villa-Yánez, H. (2023, febrero 8). Digital competence, faculty and higher education: Bibliometrics from the Web of Science. *Human Review. International Humanities Review / Revista Internacional de Humanidades*, *16*(5). https://doi.org/10.37467/revhuman.v12.4680

Cisneros-Barahona, A., Marqués-Molías, L., Samaniego-Erazo, G., Gisbert-Cervera, M., Mejía-Granizo, C. M., Cejas, M., Mendoza-Trujillo, B., & de la Cruz-Fernández, G. (2024). Conceptualization and Frames of Reference of the Teaching Digital Competence. An Approach from Higher Education. In A. K. Nagar, D. S. Jat, D. Mishra & A. Joshi (Eds.), *Intelligent Sustainable Systems* (pp. 11-20). Springer Nature Singapore. https://doi.org/10.1007/978-981-99-8031-4_2

Cisneros-Barahona, A., Marqués-Molías, L., Samaniego-Erazo, G., Uvidia-Fassler, M., De la Cruz-Fernández, G., & Castro-Ortiz, W. (2022). Teaching Digital Competence in Higher Education. A Comprehensive Scientific Mapping Analysis with Rstudio. *Communications in Computer and Information Science*, 14-31. https://doi.org/10.1007/978-3-031-18347-8_2

Cisneros-Barahona, A., Marqués-Molías, L., Samaniego-Erazo, N., Uvidia-Fassler, M., Castro-Ortiz, W., & Rosas-Chávez, P. (2022, diciembre 27). Digital competence of university teachers. An overview of the state of the art. *HUMAN REVIEW. International Humanities Review / Revista Internacional de Humanidades*, *11*(Monográfico), 1-25. https://doi.org/10.37467/revhuman.v11.4355

Cisneros-Barahona, A. S., Marqués-Molías, L., Samaniego-Erazo, N., Mejía-Granizo, C., & De la Cruz-Fernández, G. (2023). Multivariate data analysis: Validation of an instrument for the evaluation of teaching digital competence.

F1000Research, *12*, 866. https://doi.org/10.12688/f1000research.135194.2

Cisneros-Barahona, A., Uvidia-Fassler, M., Samaniego-Erazo, G., Dumancela-Nina, G., & Casignia-Vásconez, B. (2021). Complementary Admission Processes Implemented by Ecuadorian Public Universities Promote Equal Opportunities in Access: An Analysis Through Knowledge Discovery in Databases. *Advances in Intelligent Systems and Computing*, *1273 AISC*, 208-222. https://doi.org/10.1007/978-3-030-59194-6_18

Cohen, J. (1988). *Statistical Power Analysis for the Behavioral Sciences* (New York University). Department of Psychology. https://bit.ly/3SiXlU0

Cohen, J. (1992). A power primer. *Psychological bulletin*, *112*(1), 155-159. https://doi.org/10.1037//0033-2909.112.1.155

Council of the European Union. (2018). Recomendación del Consejo, relativa a las competencias clave para el aprendizaje permanente. In *Diario Oficial de la Unión Europea, C189/1*(2). https://bit.ly/3T5Ojdk

Creswell, J. (2011). *Educational Research. Planning, conducting and evaluating quantitative and qualitative research*. Pearson. https://bit.ly/3EwIDk2

Cronbach, L. J. (1951). Coefficient alpha and the internal structure of tests. *Psychometrika*, *16*(3). Springer-Verlag. https://doi.org/10.1007/BF02310555

Cuadrado, A. M. M., Sánchez, L. P., & Torre, M. J. de la. (2020). Teachers digital competences in Digcomp-based university environments. *Educar em Revista*, *36*, 1-21. https://doi.org/10.1590/0104-4060.75866

Departament d'Ensenyament. Generalitat Catalunya. (2016). *Resolución ENS/1356/2016. Per la qual es dóna publicitat a la definició de la competència digital docent*. https://bit.ly/3uCHl5x

Departament d'Ensenyament. Generalitat Catalunya. (2018). *Competència digital docent del professorat de Catalunya*. https://bit.ly/3R68UeS

Domingo-Coscollola, M., Bosco, A., Segovia, S. C., & Valero, J. A. S. (2020). Fostering teacher's digital competence at university: The perception of students and teachers. *Revista de Investigacion Educativa*, *38*(1), 167-182. https://doi.org/10.6018/rie.340551

Erdfelder, E., Faul, F., & Buchner, A. (1996). GPOWER: A general power analysis program. *Behavior Research Methods, Instruments, & Computers*, *28*(1), 1-11. https://doi.org/10.3758/BF03203630

Eshet-Alkalai, Y. (2009). Real-Time Thinking in the Digital Era. In D. B. A. Khosrow-Pour (Ed.), *Encyclopedia of Information Science and Technology, Second Edition* (The Open U, pp. 3219-3223). IGI Global. https://doi.org/10.4018/978-1-60566-026-4.ch514

Esteve-Mon, F. M., Cela-Ranilla, J. M., & Gisbert-Cervera, M. (2016). ETeach3D: Designing a 3D Virtual Environment for Evaluating the Digital Competence of Preservice Teachers. *Journal of Educational Computing Research*, *54*(6), 816-839. https://doi.org/10.1177/0735633116637191

Faul, F., Erdfelder, E., Lang, A.-G., & Buchner, A. (2007). G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods*, *39*(2), 175-191. https://doi.org/10.3758/BF03193146

Fernández Sánchez, M. R., Sánchez-Oro Sánchez, M., & Robina Ramírez, R. (2016). La evaluación de la competencia digital en la docencia universitaria: el caso de los grados de empresariales y económicas. *Revista Colombiana de Ciencias Sociales*, *7*(2), 332. https://doi.org/10.21501/22161201.1726

Ferrari, A., Punie, Y., & Brečko, B. (2013). *DIGCOMP: A Framework for Developing and Understanding Digital Competence in Europe*. https://doi.org/10.2788/52966

Fraser, J., Atkins, L., & Hall, R. (2013). DigiLit Leicester. Supporting Teachers, Promoting Digital Literacy,

Transforming Learning. *Leicester City Council*, *June*, 44. https://bit.ly/3Gpvf2a

Gallardo Echenique, E., Marqués Molías, L., & Gisbert Cervera, M. (2011). Importancia de las competencias TIC en el marco del PRONAFCAP. *Edutec. Revista Electrónica de Tecnología Educativa*, *36*(36), a167. https://doi.org/10.21556/edutec.2011.36.403

Gallardo Echenique, E. (2013). Competencia digital: revisión integradora de la literatura. *Revista de ciencias de la educación Academicus*, *1*(3), 56-62. https://bit.ly/3t7fp9c

Gallego-Arrufat, M. J., Torres-Hernández, N., & Pessoa, T. (2019). Competence of future teachers in the digital security area. *Comunicar*, *27*(61), 53-62. https://doi.org/10.3916/C61-2019-05

García-Peñalvo, F. J., Corell, A., Abella-García, V., & Grande, M. (2020). Online assessment in higher education in the time of COVID-19. *Education in the Knowledge Society*, *21*, 26. https://doi.org/10.14201/eks.23086

Garibaldi, L., Oddi, F., Aristimuño, F., & Behnisch, A. (2019). *Modelos estadísticos en lenguaje R*. https://bit.ly/3t0qTLR

Garita-González, G., Gutierrez-Durán, J.-E., & Godoy-Sandoval, V. (2019). Percepción docente sobre las competencias digitales & la mediación pedagógica aplicadas en la elaboración de materiales didácticos de la Cátedra de Administración de la Universidad Estatal a Distancia (UNED). *Revista Electrónica Calidad en la Educación Superior*, *10*(1), 125-159. https://doi.org/10.22458/caes.v10i1.2181

Generalitat de Catalunya. (2015). *Competències bàsiques de l'àmbit digital*. https://bit.ly/3w4OVq5

Gisbert Cervera, M., & Esteve Mon, F. (2011). Digital Leaners: la competencia digital de los estudiantes universitarios. *La cuestión universitaria*, *7*(May), 48-59. https://bit.ly/45XaJke

González, M. J. M., Rivoir, A., Lázaro-Cantabrana, J. L., & Gisbert-Cervera, M. (2020). ¿Cuánto importa la competencia digital docente? Análisis de los programas de formación inicial docente en Uruguay. *Innoeduca. International Journal of Technology and Educational Innovation*, *6*(2), 128-240. https://doi.org/10.24310/innoeduca.2020.v6i2.5601

Guillén-Gámez, F., Mayorga-Fernández, M., & Contreras-Rosado, J. (2021). Incidence of gender in the digital competence of higher education teachers in research work: Analysis with descriptive and comparative methods. *Education Sciences*, *11*(3), 1-14. https://doi.org/10.3390/educsci11030098

Gutiérrez, I. (2011). Competencias del profesorado universitario en relación al uso de tecnologías de la información & comunicación: análisis de la situación en España & propuesta de un modelo de formación. In *[Tesis Doctoral] Universitat Rovira I Virgili. Departamento de Pedagogía*. https://bit.ly/3GnMZuJ

Gutiérrez-Castillo, J. J., Cabero-Almenara, J., & Estrada-Vidal, L. I. (2017). Design and validation of an instrument for evaluation of digital competence of University student. *Espacios*, *38*(10), 16. https://bit.ly/3Popmex

Hair JR, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2022). *Multivariate Data Analysis* (Cengage Learning). https://bit.ly/3sLFHxj

Hernández Suárez, C. A., Ayala García, E. T., & Gamboa Suárez, A. A. (2016). Modelo de competencias TIC para docentes: Una propuesta para la construcción de contextos educativos innovadores & la consolidación de aprendizajes en educación superior. *Katharsis*, *22*, 221. https://doi.org/10.25057/25005731.821

Huertas Abril, C. A. (2018). Creación de vídeos en animación 3D mediante aprendizaje cooperativo en el aula de inglés: innovación docente para la formación de profesorado de Educación Primaria. *El Guiniguada. Revista de investigaciones & experiencias en Ciencias de la Educación*, *27*, 14-21. https://doi.org/10.20420/ElGuiniguada.2018.202

INTEF. (2013). *Marco Común de Competencia Digital Docente. Borrador con propuesta de descriptores V 1.0*. https://bit.ly/47EeWKK

INTEF. (2017). *Marco Común de Competencia Digital Docente*. https://bit.ly/3Pg61pi

INTEF. (2020). *Marco Europeo para la Competencia Digital de los Educadores*. https://doi.org/10.2760/159770

INTEF. (2022). *Marco de referencia de la Competencia Digital Docente*. https://bit.ly/4a3mmJo

ISTE. (2000). *National Educational Technology Standards for Teachers (NETS·T)*. https://bit.ly/48tOH9F

ISTE. (2008). *NETS for Teachers: National Educational Technology Standards for Teachers*. https://bit.ly/3uJoBOQ

ISTE. (2017). *Standars for educators*. https://bit.ly/49Z7z22

Jones-Kavalier, B., & Flannigan, S. (2006). Connecting the Digital Dots: Literacy of the 21st Century. *EDUCAUSE Quarterly*, *29*(2), 8-10. https://bit.ly/3R1lg87

Juárez Arall, J., & Marqués Molías, L. (2019). Aspectos de la competencia digital para la empleabilidad//Digital competence aspects for employability. *REOP - Revista Española de Orientación & Psicopedagogía*, *30*(2), 67. https://doi.org/10.5944/reop.vol.30.num.2.2019.25339

Kabakçi, A. (2009). A proposal of framework for professional development of turkish teachers with respect to information and communication technologies. *Turkish Online Journal*. https://bit.ly/3sUb89h

Kelentri, M., Helland, K., & Arstorp, A.-T. (2017). *Professional Digital Competence Framework for Teachers*. https://bit.ly/3uKHGTu

Kress, G., Jewitt, C., Ogborn, J., & Tsatsarelis, C. (2014). Multimodal Teaching and Learning: The Rhetorics of the Science Classroom. In *Multimodal Teaching and Learning : The Rhetorics of the Science Classroom* (Continuum). Bloomsbury Academic. https://doi.org/10.5040/9781472593764

Krumsvik, R. J. (2014). Teacher educators' digital competence. *Scandinavian Journal of Educational Research*, *58*(3), 269-280. https://doi.org/10.1080/00313831.2012.726273

Lago Martínez, S., Méndez, A., & Gendler, M. (2017). Contribuciones al estudio de procesos de apropiación de tecnologías. In *Del Gato Gris*. https://bit.ly/47UCPoh

Larraz Rada, V. (2013). *La competència digital a la Universitat* [Universitat d'Andorra]. https://bit.ly/3LgSgHr

Lázaro-Cantabrana, J. L., & Gisbert-Cervera, M. (2015). Elaboración de una rúbrica para evaluar la competencia digital del docente. *UT. Revista de Ciències de l'Educació*. https://doi.org/10.17345/ute.2015.1.648

Lázaro-Cantabrana, J. L., Gisbert-Cervera, M., & Silva-Quiroz, J. E. (2018). Una rúbrica para evaluar la competencia digital del profesor universitario en el contexto latinoamericano. *Edutec. Revista Electrónica de Tecnología Educativa*, *63*. https://doi.org/10.21556/edutec.2018.63.1091

Lázaro-Cantabrana, J. L., Usart, M., & Cervera, M. G. (2019). Assessing teacher digital competence: The construction of an instrument for measuring the knowledge of pre-service teachers. *Journal of New Approaches in Educational Research*, *8*(1), 73-78. https://doi.org/10.7821/naer.2019.1.370

López-Aguado, M., & Gutiérrez-Provecho, L. (2019). Cómo realizar e interpretar un análisis factorial exploratorio utilizando SPSS. *REIRE. Revista de Innovació i Recerca en Educació*, *12 (2)*. https://doi.org/10.1344/reire2019.12.227057

Martin, A., & Grudziecki, J. (2006). DigEuLit: Concepts and Tools for Digital Literacy Development. *Innovation in Teaching and Learning in Information and Computer Sciences*, *5*(4), 249-267. https://doi.org/10.11120/ital.2006.05040249

MESR. (2011). *Certificat informatique et internet de l'enseignement supérieur*. https://bit.ly/49XJdWB

Mills, K. A., & Unsworth, L. (2017). Multimodal Literacy. In *Oxford Research Encyclopedia of Education* (Número December). Oxford University Press. https://doi.org/10.1093/acrefore/9780190264093.013.232

Ministerio de Educación de Chile. (2011). *Competencias & estándares TIC para la profesión docente*. https://bit.ly/3u0PWz3

Ministerio de Educación Nacional. Colombia. (2013). *Competencias TIC para el desarrollo profesional docente*. https://bit.ly/3R6eHBn

Mishra, P., & Koehler, M. J. (2006). Technological Pedagogical Content Knowledge: A Framework for Teacher Knowledge. *Teachers College Record: The Voice of Scholarship in Education*, *108*(6), 1017-1054. https://doi.org/10.1177/016146810610800610

Nascimbeni, F. (2020). Empowering University Educators for Contemporary Open and Networked Teaching. In *Lecture Notes in Educational Technology* (pp. 123-134). https://doi.org/10.1007/978-981-15-4276-3_8

National Institute of Education. (2009). *A Teacher Education Model for the 21st Century*. https://bit.ly/3Sh8a7j

Oxbrow, N. (1998). Information literacy — The final key to an information society. *The Electronic Library*, *16*(6), 359-360. https://doi.org/10.1108/eb045661

Padilla-Hernández, A. L., Gámiz-Sánchez, V. M., & Romero-López, M. A. (2020). Evolución de la competencia digital docente del profesorado universitario: incidentes críticos a partir de relatos de vida. *Educar*, *56*(1), 109-127. https://doi.org/10.5565/rev/educar.1088

Palau, R., Usart, M., & Ucar Carnicero, M. J. (2019). The digital competence of teachers in music conservatories. A study of self-perception in Spain. *Revista Electronica de LEEME*, *44*, 24-41. https://doi.org/10.7203/LEEME.44.15709

Paz Saavedra, L. E., & Gisbert Cervera, M. (2023). Autopercepción del profesorado universitario sobre la competencia digital docente. *Educar*, 1-19. https://doi.org/10.5565/rev/educar.1614

Pérez-Escoda, A., García-Ruiz, R., & Aguaded, I. (2019). Dimensions of digital literacy based on five models of development / Dimensiones de la alfabetización digital a partir de cinco modelos de desarrollo. *Cultura & Educación*, *31*(2), 232-266. https://doi.org/10.1080/11356405.2019.1603274

Põldoja, H., Väljataga, T., Laanpere, M., & Tammets, K. (2014). Web-based self- and peer-assessment of teachers' digital competencies. *World Wide Web*, *17*(2), 255-269. https://doi.org/10.1007/s11280-012-0176-2

Poynton, T. A. (2005). Computer literacy across the lifespan: a review with implications for educators. *Computers in Human Behavior*, *21*(6), 861-872. https://doi.org/10.1016/j.chb.2004.03.004

Pozos Pérez, K. (2009). La competencia digital del profesorado universitario para la sociedad del conocimiento: Un modelo para la integración de la competencia digital en el desarrollo profesional docente. *V Congreso de formación para el trabajo. Granada*. https://bit.ly/3tok9h6

Ramos-Galarza, C. A. (2020). Alcances de una investigación. *CienciAmérica*, *9*(3), 1-6. https://doi.org/10.33210/ca.v9i3.336

Rangel Baca, A., & Peñalosa Castro, E. A. (2013). Digital literacy in Higher Education professors: construction and empirical test of an assessment instrument. *Pixel-Bit. Revista de Medios & Educación*, *43*, 9-23. https://doi.org/10.12795/pixelbit.2013.i43.01

Redecker, C., & Punie, Y. (2017). *Digital Competence of Educators DigCompEdu*. https://bit.ly/3SYHvOG

Reguant-Álvarez, M., Vilà-Baños, R., & Torrado-Fonseca, M. (2018). La relación entre dos variables según la escala de medición con SPSS. *REIRE. Revista d'Innovació i Recerca en Educació*, *11(2)*.

https://doi.org/10.1344/reire2018.11.221733

República del Ecuador. (2023). *Suplemento al Registro Oficial No. 322*. https://bit.ly/3GiMDp9

Rockman, I. F. (2005). ICT literacy. *Reference Services Review*, *33*(2), 141-143. https://doi.org/10.1108/00907320510597345

Rodríguez Espinosa, H. (2016). Desarrollo de habilidades digitales docentes para implementar ambientes virtuales de aprendizaje en la docencia universitaria. *Sophia*, *12*(2), 261-270. https://doi.org/10.18634/sophiaj.12v.2i.561

Romero-Tena, R., Barragán-Sánchez, R., Llorente-Cejudo, C., & Palacios-Rodríguez, A. (2020). The challenge of initial training for early childhood teachers. A cross sectional study of their digital competences. *Sustainability (Switzerland)*, *12*(11), 4782. https://doi.org/10.3390/su12114782

Sánchez-Caballé, A., Gisbert-Cervera, M., & Esteve-Mon, F. (2020). The digital competence of university students: a systematic literature review. *Aloma: Revista de Psicologia, Ciències de l'Educació i de l'Esport*, *38*(1), 63-74. https://doi.org/10.51698/aloma.2020.38.1.63-74

Santos, C. C., Pedro, N. S. G., & Mattar, J. (2021). Assessment of the proficiency level in digital competences of higher education professors in Portugal. *Educação (UFSM)*, *46*(1). https://doi.org/10.5902/1984644461414

Sarango Lapo, C. (2021). *Competencia digital docente como contribución a estimular procesos de Innovación educativa* [Universidad de Salamanca]. https://bit.ly/46En7pf

Schneckenberg, D., & Wildt, J. (2006). Understanding the concept of ecompetence for academic staff. *The challenge of ecompetence in academic staff development*, 29–35. https://bit.ly/3t7uTKm

Silva, J., Morales, M.-J., Lázaro-Cantabrana, J.-L., Gisbert, M., Miranda, P., Rivoir, A., & Onetto, A. (2019). Digital teaching competence in initial training: Case studies from Chile and Uruguay. *Education Policy Analysis Archives*, *27*(93), 93. https://doi.org/10.14507/epaa.27.3822

Silva Quiroz, J. (2017). Inserción de TIC en pedagogías del área de las humanidades en una universidad chilena. *Psicología Conocimiento & Sociedad*, *7*(2). https://doi.org/10.26864/PCS.v7.n2.6

Silva Quiroz, J., & Miranda Arredondo, P. (2020). Presencia de la competencia digital docente en los programas de formación inicial en universidades públicas chilenas. *Revista de Estudios & Experiencias en Educación*, *19*(41), 149-165. https://doi.org/10.21703/rexe.20201941silva9

Somerville, M. M., Lampert, L. D., Dabbour, K. S., Harlan, S., & Schader, B. (2007). Toward large scale assessment of information and communication technology literacy. *Reference Services Review*, *35*(1), 8-20. https://doi.org/10.1108/00907320710729337

TDA. (2008). *Professional Standards for Qualified Teacher Status and Requirements for Initial Teacher Training*. https://bit.ly/47YfUkG

Unesco. (2008). *Estándares de Competencia en TIC para docentes*. https://bit.ly/47Njfmd

Unesco. (2011). *Unesco ICT competency framework for teachers*. https://bit.ly/47CoOSo

Unesco. (2015). *Enseñanza & aprendizaje: Lograr la calidad para todos*. https://doi.org/https://doi.org/10.54676/NFKC5496

Unesco. (2018). *ICT Competency Framework for Teachers*. https://bit.ly/3N76lrW

Usart Rodríguez, M., Lázaro Cantabrana, J. L., & Gisbert Cervera, M. (2020). Validation of a tool for self-evaluating teacher digital competence. *Educación XX1*, *24*(1), 353-373. https://doi.org/10.5944/educxx1.27080

Uvidia Fassler, M. I., Cisneros Barahona, A. S., Méndez Naranjo, P. M., & Villa Yánez, H. M. (2019). Minería de datos para la toma de decisiones en la unidad de

nivelación & admisión universitaria ecuatoriana. *Cumbres*, *4*(2), 55-67. https://doi.org/10.48190/cumbres.v4n2a5

Uvidia-Fassler, M., Cisneros-Barahona, A., Ávila-Pesántez, D., & Rodríguez Flores, I. (2018). Moving towards a methodology employing knowledge discovery in databases to assist in decision making regarding academic placement and student admissions for universities. *Communications in Computer and Information Science*, *798*, 215-229. https://doi.org/10.1007/978-3-319-72727-1_16

Uvidia-Fassler, M., Cisneros-Barahona, A., Samaniego-Erazo, G., Dumancela-Nina, G., & Villacrés-Cevallos, P. (2020). Application of Knowledge Discovery in Data Bases Analysis to Predict the Academic Performance of University Students Based on Their Admissions Test. In *Advances in Intelligent Systems and Computing* (Vol. 1066). https://doi.org/10.1007/978-3-030-32022-5_45

Uvidia-Fassler, M., Cisneros-Barahona, A., & Viñan-Carrera, J. (2017). Minería de Datos de la Evaluación Integral del Desempeño Académico de la Unidad de Nivelación. *Descubre*, 44-54. https://doi.org/10.36779/mktdescubre.v09.127

Vallejo, A. P., & Aguayo, B. B. (2021). Digital Competences in European University Teaching Staff: Teaching and Guidance. In *Advances in Intelligent Systems and Computing: Vol. 1367 AISC* (pp. 3-11). https://doi.org/10.1007/978-3-030-72660-7_1

Verdú-Pina, M., Lázaro-Cantabrana, J. L., Grimalt-Álvaro, C., & Usart, M. (2023). El concepto de competencia digital docente: revisión de la literatura. *Revista Electrónica de Investigación Educativa*, *25*, 1-13. https://doi.org/10.24320/redie.2023.25.e11.4586

Verdú-Pina, M., Usart, M., & Grimalt-Álvaro, C. (2022). *Report on the process for evaluating and certifying Teacher Digital Competence An international perspective*. https://bit.ly/3ToUj7d

Wilson, C., Grizzle, A., Tuazon, R., Kwame, A., & Cheung, C.-K. (2011). *Media and Information Literacy. Curriculum for Teachers*. United Nations Educational, Scientific and Cultural Organization. https://bit.ly/3GlYItZ

Wu, C. M. (2014). Applied technology with electronic materials and information in autonomous learning of learners. In *Advanced Materials Research* (Vol. 951). https://doi.org/10.4028/www.scientific.net/AMR.951.177

Zhao, Y., Llorente, A. M. P., & Gómez, M. C. Sá. (2019). An empirical study of students and teaching staff's digital competence in Western China: Based on a case study of gansu agricultural university. *ACM International Conference Proceeding Series*, 1012-1019. https://doi.org/10.1145/3362789.3362924

Zhao, Y., Pinto Llorente, A. M., Sánchez Gómez, M. C., & Zhao, L. (2021). The Impact of Gender and Years of Teaching Experience on College Teachers' Digital Competence: An Empirical Study on Teachers in Gansu Agricultural University. *Sustainability*, *13*(8), 4163. https://doi.org/10.3390/su13084163

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