

Lecture Notes in Networks and Systems 1694


João Vidal Carvalho ·
António Abreu · Manuel Silva ·
Eusébio Ferreira da Costa ·
José Alfredo Ferreira Costa *Editors*

Perspectives and Trends in Education and Technology, Volume 2

Selected Papers from ICITED25

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Preface

This book—*Perspectives and Trends in Education and Technology, Volume 2: Selected Papers from ICITED25*—from the LNNS Series is composed of the best selected papers accepted for presentation and discussion at the 2025 International Conference in Information Technology & Education (ICITED25). The ICITED is a multidisciplinary conference with a special focus on new technologies and systems in the education sector and was held between July 10 and 12, 2025. The ICITED25 was supported by the Federal University of Rio Grande do Norte, in Natal, Brazil, and by IADITI—International Association for Digital Transformation and Technological Innovation.

The International Conference in Information Technology & Education is an international forum for researchers and professionals in the education sector, which enables the discussion of the latest innovations, trends, and concerns in several areas, in the education sector, associated with information technologies and systems. It is an event for professionals in the sector, in search of technology solutions, where academics, IT experts, and business managers meet to discuss new ideas that help them maximize the potential of learning processes through technology.

The ICITED25 Scientific Committee is composed of a multidisciplinary group of 145 experts who assessed some 275 papers from 28 countries, received for each of the main topics proposed for the conference: a) ICT and Virtual learning; b) Pedagogical & Didactical Innovations; c) Technologies issues in Education in the different scientific areas; d) Quality in Education; e) Technological Issues in Education and Research; f) Educational Software and Serious Games; g) Curriculum Design and Innovation and h) University-Industry Collaboration; SPECIAL SESSIONS: DTLP'25—Digital Transformation in the Teaching and Learning Process; EU-AIEdu'25—EXPERIENCES IN THE USE OF ARTIFICIAL INTELLIGENCE IN EDUCATION; E4TLI—EDUCATION FOR TECHNOLOGICAL LITERACY AND INCLUSION. SPECIAL TRACKS: Digital Literacy x Media Literacy—New Literacies and Education in Brazil; Cultural Tourism, Education and Marketing; New Technologies in Accounting Education; Internationalization in Higher Education as a challenge; Education and the problems of the contemporary world.

The papers accepted for presentation and discussion at the conference are published by Springer and will be submitted for indexing by ISI, SCOPUS, EI-Compendex, Google Scholar, and SpringerLink. We thank all those who contributed to the ICITED25 conference (authors, committees, workshop organizers, and sponsors).

We deeply appreciate your involvement and support, which were crucial to the success of the conference.

July 2025

João Vidal Carvalho
António Abreu
Manuel Silva
Eusébio Ferreira da Costa
José Alfredo Ferreira Costa

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Assessing Digital and Info-Communication Competencies in Higher Education: A Blended Approach for e-Learning Environments

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Abstract. In an era increasingly shaped by information and communication technologies, assessing digital and info-communication competencies among students has become a focal point for academic and institutional initiatives. Various projects, both within and outside Academia, have sought to classify students' competencies at different levels, often relying on standardized tests and self-assessment questionnaires. However, as technological advancements rapidly evolve, universities face mounting pressure to align educational strategies with high levels of digital and info-communication proficiency and with the competitive demands of the labor market. It is, therefore, important to study these assessment tools further.

Blended assessment methods, combining practical tests with self-perception questionnaires, offer a more nuanced evaluation of students' digital competencies. By integrating objective skills assessments with self-reported proficiency, this approach captures a broader spectrum of abilities, recognizing the influence of diverse teaching models, students' academic backgrounds, prior digital exposure, and access to technological resources. This is particularly relevant in distance higher education, where continuous engagement in virtual learning environments provides ongoing opportunities for monitoring digital and info-communication competencies development.

Despite growing academic interest in this field, empirical research on digital and info-communication competencies in Portuguese higher education, particularly in e-learning contexts, remains limited. This paper presents the development of a digital literacy test and a questionnaire designed to assess students' digital and info-communication practices. These instruments were created as part of the ongoing research project Digital and Infocommunicational Competencies in Virtual Learning Environments: Practices in e-Learning Curricular Units in Portuguese Higher Education.

Keywords: Digital Competencies · Info-Communication Competencies · Higher Education

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1 Introduction

The rapid advancement of digital technologies has transformed various aspects of modern life, presenting both opportunities and challenges in personal, professional, and educational contexts. As digital interactions become more embedded in everyday activities, the concepts of digital and info-communication competencies have emerged as a crucial skills set required for active participation in a knowledge-intensive society (Council of the European Union, 2018). This growing emphasis, especially on digital competence, is reflected in numerous policy initiatives, particularly in Europe, where frameworks such as DigComp (Vuorikari et al., 2016) and DigCompEdu (Redecker, 2017) have been developed to standardize digital competencies assessment. However there remains significant variation in how digital competence is defined, measured, and evaluated in different educational and professional settings (Bawden, 2001), as well as info-communication competencies (Borges, 2018).

Researchers have long debated the terminology and conceptualization of digital competence, often using related terms such as digital skills, digital literacy, media literacy, information literacy, transversal skills, new media literacy, e-skills, e-competences (Spante et al., 2018). Initially, digital competence was primarily associated with technical skills, such as the ability to operate computers and software. However, as workplaces and educational environments integrate more interactive and collaborative digital tools, digital competence has evolved into a broader construct that encompasses knowledge, skills, and attitudes necessary for effective digital engagement (Van Laar et al., 2017). This shift underscores the need for comprehensive assessment methods that capture not only technical abilities but also cognitive and socio-emotional dimensions of digital competence (Falloon, 2020). This is also true for info-communication competencies, which need to be seen not as a domain of digital literacy, but as independent competence also operating in various media, one of which is digital.

To address these evolving demands, various digital and info-communication competencies frameworks have been introduced at international and national levels. Given the critical role of digital and info-communication competencies in higher education and beyond, there is a pressing need to develop robust and systematic assessment methods that reflect the complexities of this domains. This paper aims to explore the challenges associated with measuring digital and info-communication competencies among distance higher education students and the construction of valid assessment methods. With this objective in mind, this research seeks to deepen knowledge about literacies and competencies and how online higher education students operationalize them.

2 Digital and Info-Communication Competencies Frameworks in Higher Education: A Brief Review

Today's society demand new competencies for effective participation in professional and social spheres. These "21st century skills" - while context-dependent (Geisinger, 2016) - share a common purpose: enabling individuals to adapt their knowledge and behaviors to diverse situations. We operationalize competence as this context-responsive capacity

for adaptive action. The global expansion of higher education enrollment reflects institutions' dual mission of advancing knowledge and preparing graduates for labor market demands (Nyssen, 2018). This has driven international efforts to develop competence-based frameworks that define learning outcomes across knowledge, skills, and broader competencies (ESG, 2015).

Contemporary higher education aims to develop two complementary competence domains: discipline-specific expertise and generic transferable skills (Strijbos et al., 2015). Discipline-specific competences encompass the specialized knowledge systems (theories, models, and methodologies) required for professional practice within a given field (Allen et al., 2006). These contrast with generic competencies, which represent cross-disciplinary capacities for applying knowledge to solve complex, real-world problems across diverse contexts.

The integration of these competence domains reflects the fundamental demands of 21st century skills, where situational adaptability emerges through the synergy of specialized knowledge and transferable capacities. When considering different frameworks for 21st century skills in general, and concerning higher education outcomes in particular, we find several skills and outcomes overlap. The competence to communicate successfully in different situations using different means and the digital competence are not only part of several international 21st century skills frameworks, they are also part of international higher education qualification frameworks. As a result, a number of frameworks and models have been developed to assess and improve students' proficiency in these crucial areas.

The European Union's DigComp Framework (Vuorikari et al., 2016) outlines five key areas: information and data literacy, communication and collaboration, digital content creation, safety, and problem-solving. The Digital Competence Framework for Educators (DigCompEdu), one of the fundamental frameworks in this field, describes the digital competences that teachers must possess in order to successfully incorporate digital technology into their lesson plans (Redecker, 2017). DigCompEdu was first created for educators, but by highlighting the value of digital literacy at all educational levels, it has impacted the creation of student-focused examinations. Meanwhile, the ISTE Standards (<https://iste.org/standards>) and the UNESCO ICT Competency Framework for Teachers (<https://www.unesco.org/en/digital-competencies-skills/ict-cft>) provide guidelines for digital skill development in educational contexts.

On the other hand, as far as info-communication competencies are concerned, Jussara Borges' theoretical framework emphasizes the sociocultural and pedagogical dimensions, framing info-communication skills as dynamic and context-dependent rather than static or purely technical (Borges, 2018). Her approach aligns with constructivist and connectivist learning theories, arguing that digital literacy and info-communication competencies should be assessed through authentic, collaborative tasks that mirror real-world practices (Educação para a Informação, 2022). Unlike traditional assessment models that isolate discrete skills, Borges advocates for holistic evaluations that consider how students navigate digital environments, engage in knowledge co-creation, and critically reflect on their digital practices.

Despite the proliferation of such frameworks, there is no universally accepted method for assessing digital and info-communication competencies, and existing approaches

often lack consistency in their methodologies and effectiveness (Sparks et al., 2016). Challenges persist in the standardization and implementation of assessment tools. Sillat et al. (2021) noted a lack of uniformity in digital competence assessment instruments, calling for more cohesive and validated tools to ensure reliable evaluations. Additionally, Ilomäki et al. (2016) highlighted the variability in definitions and frameworks, which can lead to inconsistencies in assessment outcomes.

Many studies employ self-assessment surveys, yet research suggests that self-perceived competence does not always align with actual performance (Maderick et al., 2015). While self-report methods offer insights into students' confidence and awareness of their digital and info-communication abilities, they fail to capture objective measures of proficiency. As a result, the state of the art seems to demonstrate the advantages of mixed-method approaches that combine self-assessment with performance-based evaluations to obtain a more accurate picture of students' competencies.

3 Method

3.1 A Digital Literacy Test and a Questionnaire Designed to Assess Students' Digital and Info-Communication Competencies

The construction of a digital literacy test and a questionnaire to assess distance higher education students' digital and info-communication competencies is a multi-step process that requires careful consideration of various factors. In an era increasingly shaped by technological advancements, these tools aim to gauge how well students are prepared to navigate, communicate, evaluate, and apply digital technologies in academic and professional contexts.

According to Ilomäki et al. (2016), digital competence refers to the ability to use new technologies purposefully and effectively in learning, work, and leisure. It includes understanding how digital technologies shape society and personal life, and having the motivation to take part in the digital world as a responsible and engaged participant. According to Borges & Oliveira (2011), the intersection of all these concepts and fields of analysis then seems to lead to the term infocommunicational competencies in digital environments, which can be characterised as the convergence of knowledge, skills and attitudes that make it possible to act appropriately in digital environments, mobilise resources and new contacts, articulating them for the production of meaning and knowledge, based on legal and ethical precepts. These foundational definitions serve as a guiding principle for designing the test and the questionnaire, ensuring that they assess a wide range of competencies essential for distance learners.

The first step in constructing the digital literacy test and questionnaire was to establish a framework of competencies to be assessed. As we've already mentioned, various models exist in the literature, such as the European Digital Competence Framework for Citizens (DigComp) and the DigCompEdu framework for educators, with its five areas: information and data literacy, communication and collaboration, digital content creation, safety, and problem-solving (Redecker, 2017). In Portugal, it is important to add the Dynamic Reference Framework for Digital Competence – QDRCD (INCoDe.2030,

2019), a fundamental instrument developed under Portugal's National Digital Competence Initiative, INCoDe.2030, align with DigComp, and the work carried out, based on these references, by Academia Portugal Digital.

Regarding to info-communication competencies, Jussara Borges' theoretical and operational framework were adopted using what she called operational competencies, information competencies and communication competencies. Borges articulates that the contemporary information landscape, characterized by collaborative knowledge, construction and participatory culture, demands a reevaluation of traditional literacy models. She integrates concepts from Information Literacy (Alfin), New Media Literacy (NML), and Metaliteracy to propose a comprehensive framework for understanding info-communication competencies (Borges, 2018).

All the instruments mentioned share the same structure and objectives: the frameworks emphasize a comprehensive approach to digital and info-communication competencies, encompassing technical skills, cognitive abilities, and ethical considerations. And the areas worked on align closely with the demands of distance education, where students must engage with digital tools, evaluate and process online information, communicate and collaborate virtually, and manage their digital identity securely.

To ensure a comprehensive assessment, the digital literacy test and the questionnaire incorporated a mixed-methods approach, combining objective questions with practical tasks. Given the nature of distance education, the instruments were designed to assess competencies that are essential for online learning, such as information literacy, communication skills, data management, and cybersecurity awareness, in an accessible way, user-friendly, and capable of providing meaningful insights into students' digital and info-communication preparedness.

This study is being carried out as part of the PhD programme in Sociology at Iscte - Instituto Universitário de Lisboa, for the thesis entitled "Digital and Infocommunicational Competencies in Virtual Learning Environments: Practices in e-Learning Curricular Units in Portuguese Higher Education". The study is hosted by Cies_Iscte - Centre for Research and Studies in Sociology and has the support of the Foundation for Science and Technology (FCT) - FCT Doctoral Research Grant, reference 2021.08512.BD.

As this is an ongoing research project, both instruments are currently being applied exclusively and without the possibility of opening them up to other audiences, to a sample of students enrolled and registered for the first time in e-learning courses or curricular units at Portuguese public and private higher education institutions (the aim is to have an effective sample of no less than 500). Bearing in mind that we are talking about students starting their academic career at higher education level, the respondents will be over 17/18 years old, and there is no upper age limit. The way to reach the desired sample is by contacting Portuguese public and private higher education institutions with curricular units or e-learning courses which, with the appropriate authorisation, are responsible for sending the analysis instruments to their students.

This project follows the *Código de Conduta Ética em Investigação* of Iscte (s/d), having received a favourable opinion from the *Conselho de Ética do Iscte – Instituto Universitário de Lisboa* on 21/03/2025 - *Parecer 02/2025*. Specifically through compliance with its general principles of responsibility, honesty, reliability and rigour, objectivity and integrity. For both the test and the questionnaire, free and informed consent, with

informative content, is obtained online at the beginning of filling, and the instruments are only available after the respondents have validated this step. At the end of filling in both instruments, a thank-you message is left with the contact details of the researcher responsible, so that any respondent can clarify any questions or doubts.

This means that all participants in the study are being contacted in the light of the guarantee of informed consent, also in compliance with the General Data Protection Regulation (Parlamento Europeu e Conselho da União Europeia, 2016; Assembleia da República Portuguesa, 2019). The information provided will be treated confidentially, and at no time will there be access to personal data that implies that a person/respondent can be identified or identifiable. This is because, given the subject matter, no name, identification numbers, location data, electronic identifiers or other elements that could identify a respondent on a singular level are requested.

The test was built following the example of the digital skills self-diagnostic tool from the Portugal Digital Academy (available at <https://academiaportugaldigital.pt/testes>), and the questionnaire was designed based on instruments that have already been applied and tested in this area (Borges, 2018).

3.2 Analysis Dimensions

Based on the QDRCD, the test to be applied to distance higher education students was designed in line with other digital proficiency assessment tools for citizens available in Portugal (such as the Portugal Digital Academy). The aim was to create a comprehensive digital skills assessment designed to evaluate individuals across several key dimensions, ensuring a holistic understanding of their digital competencies. These dimensions were: Communication and Citizenship, Content Creation, Solution Development, Information Literacy, and Security and Privacy.

Communication and Citizenship focused on an individual's ability to effectively use digital tools for communication and to participate responsibly in online communities. This dimension included questions and tasks related to proficiency in managing email, navigating social networks, using collaboration tools and understanding the principles of digital citizenship. Content Creation assessed the capability to produce and edit various forms of digital content, including text documents, images, audio, and video. This dimension evaluated skills in using software tools for creating and modifying content, understanding design principles, and ensuring accessibility and inclusivity in digital materials.

Solution Development examined the ability to address technical challenges and efficiently utilize operating systems. This included troubleshooting hardware and software issues, customizing system settings, and optimizing device performance. Information Literacy, meanwhile, included questions and tasks related to the skills needed to analyse, store and retrieve information effectively. This dimension focused on the ability to use search engines proficiently, evaluate the credibility of online sources, and organize digital documents systematically. Security and Privacy assessed knowledge and practices related to protecting personal data, ensuring privacy, and understanding cybersecurity principles.

On the other hand, the questionnaire was mainly based on info-communication competencies and on Jussara Borges work. To translate the key dimensions essential for

assessing info-communication competencies into measurable indicators, we developed a structured assessment approach: specific questions aligned with each competence dimension to evaluate individuals' behaviors and attitudes in digital contexts (Information and Communication in Contemporary Times; Sources, Research, and Selection of Information; Comprehension, Organization, and Synthesis of Information; Critical Evaluation of Information; Production of Content; Intellectual Property, Copyright, and Plagiarism; Communication; Participation in Collaborative Media Environments and Development of Social Networks; Privacy and Ethics in the Communication of Information; Lifelong Learning and Metaliteracy; and the Learning and Internet dimension).

The framework emphasizes technical skills, socio-cultural awareness, and the ability to navigate vast information repositories while avoiding misinformation. Additionally, it highlights competencies like organizing and synthesizing information, producing original content, and understanding intellectual property laws. Effective communication, collaboration in digital spaces, and ethical considerations in information sharing are also central to the assessment. The framework further underscores the importance of lifelong learning and metaliteracy to adapt to evolving digital landscapes. The need for critical thinking, creativity, and ethical awareness in both consuming and producing digital content was also a constant in the preparation of the questionnaire. Key aspects included safeguarding privacy, engaging in collaborative media, and fostering social networks. Finally, the Learning and Internet dimension of the questionnaire assessed how students integrate digital tools into their academic activities. This dimension is critical for understanding how digital skills translate into educational success, particularly in distance learning environments.

3.3 The Supports

The questionnaire, aimed to capture students' self-perceptions of their digital and info-communication competencies, was designed on the Qualtrics platform, which allowed flexibility in assessing different aspects of these competencies.

We focused on a main type of questions, the Likert scale questions (e.g., "I can easily search for reliable information online"), which allows students to rate their abilities on a scale from "strongly agree" to "strongly disagree" for a series of statements. Likert-scale questions are a scientifically validated and widely used method for assessing skills due to their ability to quantify subjective constructs, such as perceived competence or behavioral frequency, while maintaining psychometric reliability and internal consistency (Boone & Boone, 2012). Their structured format ensures scalability and practicality, reducing respondent burden compared to open-ended questions while allowing for robust statistical analysis (Norman, 2010).

According to Yan et al. (2023), self-assessment tools provide valuable insights into learners' perceptions of their competencies, though they may not always correlate with actual performance. As a result, the questionnaire balanced self-reported data with more objective measures achieved through the test, with the intention of creating a comprehensive profile of digital and info-communication competencies.

The test was elaborated on the FlexiQuiz, a platform which supports various question types, making it ideal for diverse assessments. To ensure comprehensive assessment, the test incorporated a variety of question formats. Multiple-choice and true/false questions

for evaluating theoretical knowledge, while matching exercises and fill-in-the-blank questions for testing applied understanding. Additionally, scenario-based questions, in which students must choose the best digital tool or response for a given situation, assessed problem-solving and critical thinking abilities.

Beyond self-assessment, the digital literacy test assessed practical competencies, focusing on how students apply their knowledge in real-world contexts. The test incorporated tasks such as identifying phishing attempts in emails, creating and sharing a digital document, or performing basic troubleshooting on an online platform. As Vlachopoulos & Makri (2024) suggest, authentic assessments that simulate real-world problems are more likely to reflect students' true abilities in digital environments. This approach ensures that students not only demonstrate theoretical knowledge but also practical problem-solving skills that are critical for success in distance education.

A key consideration was to ensure fairness and accessibility. With this in mind, the test and the questionnaire were designed to accommodate the fact that there were students with different levels of experience, and clear and concise language was used. The instruments were accessible on different devices, including desktops, tablets, and smartphones.

3.4 Questions and Tasks

As we have already seen, the assessment of digital competence in distance higher education requires a robust and multidimensional approach, grounded in established frameworks such as DigCompEdu (Redecker, 2017) and informed by validated assessment models like those employed by the Portugal Digital Academy. A comprehensive evaluation should encompass both self-reported competencies and performance-based tasks, ensuring a holistic measurement of students' digital skills. This dual approach captures not only learners' perceived abilities but also their practical application of digital competencies in authentic educational contexts.

Based on the Dynamic Reference Framework of Digital Competence for Portugal - QDRCD and the tests prepared by the Portugal Digital Academy, the test in focus in this article includes four levels of proficiency: Basic; Intermediate; Advanced and Highly Specialised, with the different digital competencies grouped into five areas: Information Literacy; Communication and Citizenship; Content Creation; Security and Privacy and Solution Development.

The test consists of 80 questions, grouped into the five areas of competences, which seek to understand how distance higher education students search, filter and evaluate information (and how they store and retrieve it); how they interact and collaborate through digital technologies, how they share information and content and how they approach the issue of citizenship through digital technologies; how they produce digital content, the issues of integration, reworking and copyright and licences; how they protect devices, personal data, health and the environment; and how they solve technical problems, innovate and use technology creatively, and identify gaps in digital competence.

The 80 questions cover topics such as basic computer operations, internet safety, online communication, and the use of productivity tools like word processors and spreadsheets. They were designed to evaluate both theoretical knowledge and practical abilities and, for that, they include multiple-choice questions, scenario-based tasks, and interactive simulations.

On the other hand, to effectively assess info-communication competencies in distance higher education students, a diagnostic questionnaire was used, in which students reflect on and declare their own competences through self-assessment Likert-scale items.

A total of 27 phrases referring to info-communication behaviours were drawn up, and for each one the students had to tick the option that best reflected their ease/difficulty in adopting the attitudes. The scale used was as follows: 1 - Extremely difficult, 2 - Partly difficult, 3 - I don't usually do this /I don't worry about it, 4 - Partly easy, 5 - Extremely easy. The last 17 sentences referred to the benefits of using the Internet for learning. For each of them, students had to tick the option that best reflected their response using the scale: Never/Rarely or 1 to 2 out of 10 times /Sometimes or 3 to 5 out of 10 times /Often or 6 to 8 out of 10 times/ (Almost) Always or 9 to 10 out of 10 times.

The first dimension, Information and Communication in Contemporary Times, was assessed through the examination of students' awareness of digital transformation and their ability to adapt to evolving info-communication technologies. The Sources, Research, and Selection of Information dimension involve the awareness of students' ability to identify credible sources and conduct effective online research. For the Comprehension, Organization, and Synthesis of Information dimension, the questionnaire included items to measure students' ability to process and integrate information from multiple sources. The Critical Evaluation of Information dimension focused on assessing analytical skills through items like "Distinguish between opinions and facts, recognising that values and beliefs are associated with information" or "Evaluate the correctness and veracity of the information".

The questionnaire also evaluated productive competencies through dimensions such as Production of Content and Intellectual Property, Copyright, and Plagiarism. Likert items for content production included "Choosing the best format for presenting information to best express an idea" or "Establishing links between dispersed information (such as the creation of hypertexts)". For ethical considerations, items like "Properly reference all sources of information used, such as images, videos and resources only available online" or "Use licences such as Creative Commons, GPL, MIT, Mozilla or others in order to use the information legally" tested students' understanding of copyright rules and plagiarism avoidance. The Communication dimension assessed both written and digital communication skills through items evaluating clarity, appropriateness for different audiences, and netiquette awareness. These productive and ethical dimensions reflect Borges' emphasis on responsible participation in digital information ecosystems.

Finally, the questionnaire addressed collaborative and metacognitive dimensions including Participation in Collaborative Media Environments, Privacy and Ethics in Communication, and Lifelong Learning and Metaliteracy. Items evaluated students' comfort with collaborative tools and their awareness of privacy concerns. The lifelong learning dimension assessed students' metacognitive awareness through items like "Recognise your weaknesses and potential in terms of information and communication

competencies, and strengthen them based on the results of this self-assessment". The Learning and Internet dimension of the questionnaire, and within the framework of the courses attended by the students, focused on self-perceived competencies in managing information, collaborating online, and leveraging the internet for problem-solving and creativity.

4 Discussion

The methodological work being carried out as part of this ongoing research emphasises the importance of a mixed approach to assessing digital and infocommunication skills in higher education, combining objective performance-based tests with self-assessment questionnaires. The digital literacy test, based on frameworks such as DigComp and the Portuguese QDRCD, sought to work with the varying levels of proficiency among students in key dimensions - Information Literacy, Communication and Citizenship, Content Creation, Security and Privacy, and Solution Development. The questionnaire, based on Borges' framework (2018), sought to emphasise the importance of students' self-perceived competencies.

The mixed-methods approach of this study seeks to respond to a critical gap in the literature by integrating theoretical and practical assessments, offering a more holistic evaluation than standardised tests or isolated self-reports. Compared to previous research, this work emphasises the need for specific adaptations of global frameworks to specific contexts in order to meet educational demands. However, the fact that the study is based on a single higher education context limits generalisability, suggesting the need for broader empirical validation in diverse institutions and cultures.

Future research should explore longitudinal designs to track competence development over time and investigate the role of pedagogical interventions in bridging identified gaps. Additionally, expanding the assessment to include qualitative methods, such as interviews or observational studies, could provide deeper insights into students' digital and info-communication practices. The evolving nature of digital technologies also necessitates periodic updates to assessment tools to reflect emerging competencies, such as AI literacy or data ethics. By addressing these gaps, future studies can further refine frameworks and methodologies, ensuring they remain relevant in rapidly changing educational and professional landscapes. This study advances the discourse on digital literacy and info-communication assessment while underscoring the imperative for continuous innovation in measurement tools and pedagogical strategies.

5 Conclusion

This study highlights the necessity of comprehensive and adaptable approaches to evaluating digital and info-communication competencies in higher education. By integrating performance-based assessments with self-report questionnaires, the research (and when the instruments are applied) provides a dual perspective on students' abilities, revealing both their practical skills and self-awareness in digital environments.

The study's blended methodology, rooted in established frameworks like DigComp and Borges' model, offers a replicable model for other institutions seeking to assess

and enhance digital competencies. More assertive and pragmatic conclusions can be drawn when evaluating the answers to the test and the questionnaire. However, we can already deduce that its broader applicability requires further validation across diverse educational and cultural contexts. Additionally, the rapid advancement of digital technologies demands continuous updates to assessment tools to include emerging areas such as artificial intelligence, data privacy, and digital well-being.

To ensure that higher education remains responsive to these changes, the following actions can be recommended:

- Institutional collaboration: universities should work together to standardize assessment tools while allowing for contextual adaptations, ensuring consistency and relevance across different settings;

- Curriculum enhancement: digital literacy and info-communication competencies should be embedded across disciplines, with a focus on fostering critical thinking, ethical reasoning, and adaptability in digital spaces;

- Lifelong learning initiatives: institutions should promote ongoing professional development for educators and students alike, preparing them to navigate and leverage new technologies effectively.

Ultimately, this study reinforces the pivotal role of higher education in equipping students with the digital and info-communication competencies needed for academic, professional, and civic success in an increasingly digital world. By adopting innovative assessment methods and prioritizing continuous learning, universities can better prepare graduates to thrive in a dynamic and technology-driven society.

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