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STUDENTS' DIGITAL COMPETENCE: A SCOPING REVIEW OF MEASURING INSTRUMENTS

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ABSTRACT

In today's society, digital competence is becoming increasingly relevant, as this competence is necessary to function on both a personal and professional level. Digital competence is essential for students, since it enables them to exist in a digitalised world. Over the last few decades, the concept of digital competence has been used more frequently (Spante et al., 2018), and now it is actively discussed, particularly in terms of policy documents (European Council, 2018; European Commission, 2014; European Commission 2021). During the discussions related to policy, the following questions have been raised: 1) what kind of skills and knowledge people should possess in a knowledge society, and 2) what should be taught to young students and how it has to be done (Ilomäki et al., 2016). The purpose of the present scoping review is to provide a comprehensive overview of relevant research regarding the instruments commonly used to measure digital competence of university students. Arksey and O'Malley's (2005) five-stage framework underpins the scoping review. Three databases were used to conduct a scoping literature review, including ERIC, ProQuest and EBSCO. The inclusion criteria were peer-reviewed publications written in English within the period from 2014 till 2020. Initially, 395 articles in total were selected; the full texts of 43 articles were assessed. Finally, only 13 out 395 articles that met the inclusion criteria were considered in the present research. This paper reports on three main categories: (1) definition of digital competence, (2) development and characteristics of an instrument measuring digital competence, and (3) key findings. The most commonly used framework found during this research was *The European Digital Competence Framework for Citizens 2.0.* (Vuorikari et al., 2016). A larger part of studies reports on a designed self-assessment questionnaire comprising of multiple-choice items and quantitative evaluation of the competence. The scoping review showed that the majority of the existing tests enable to assess students' digital information searching, communication and technical skills. The findings of previous studies indicate that students tend to overestimate their digital competence and lack knowledge of basic topics, the ones related to information and data literacy. Our findings point to the necessity to use different approaches for assessing digital competence on different levels.

Keywords: *assessment instrument, digital competence, digital literacy,scoping review, student.*

Introduction

In the past decade, digital competence has become a key concept in the discussions about the activities that individuals should be able to do and the goals that should be achieved when using digital technologies (European Council, 2018). In higher education institutions and universities there is currently a high number of students who certainly have not experienced a moment without the presence of digital technology in most, if not all, aspects of their life (Maderick et al., 2016). It was estimated that, in broad terms, 72 per cent of households in urban areas had access to the Internet at home in 2019, which is almost twice more than in rural areas, where only 38 per cent had access to the Internet (International Telecommunication Union, 2020). It implies that people, including students and educators, use different digital tools on the daily basis.

It has to be taken into account that during the COVID-19 crisis in spring 2020, various study courses and trainings were provided only in a digital environment, which was experienced for the first time by local students. Such condition has caused a need to focus on educators' and learners' digital competence. With the advent of digital technology, learning has been focused on processing the information received. Information and communication technology tools (ICT) have been used for various purposes, including searching, collecting and presenting information, communicating, collecting and processing data, simulating processes, as well as building new knowledge and creating products. A minimum set of digital skills is no longer enough to allow students to work effectively with digital tools, access the Internet or perform basic computer tasks (Buckingham, 2015). For this reason, enhancing digital competence is one of the priority objectives in education (European Commission, 2021, p. 6). Several different inventions have been applied to boost pupils' and students' motivation, so they could acquire the content of study courses more efficiently and qualitatively (Slavova & Garov, 2019).

Digital competence is one of the eight key competencies for lifelong learning defined by the European Council of European Union (European Council, 2018, p.10) as "Digital competence involves the confident, critical and responsible use of, and engagement with, digital technologies for learning, at work, and for participation in society". Digital competence includes eight categories: information and data literacy, communication and collaboration, media literacy, digital content creation, safety, intellectual property issues, problem-solving and critical thinking (European Council, 2018).

In recent ten years there has been a growing interest in the assessment of digital competences and certification by various bodies, for example,

education administrations, European Community, etc. (Stopar & Bartol, 2019). Calvani working in collaboration with other colleagues managed to ascertain that the field of assessment of digital competence may be divided in different ways; the first is related to the possibility of obtaining information, that is, for a relatively short time; and the second may require repetition of observations over time to get more meaningful assessments of student involvement (Calvani et al., 2008).

The process of digital competence assessment is the complex one. Most of the examples of digital competence assessment that are reviewed in the *Global Education Report: Creating Sustainable Futures For All* (United Nations Educational, Scientific and Cultural Organization, 2016) involve computer-based performance assessments rather than assessments of knowledge about digital and ICT literacy.

In this scoping review, we are interested to summarizing and analysing the digital competence assessment tools explicitly used to assess students' digital skills.

Defining digital literacy and digital competence

Digital competence is essential for learning, work and active participation in a society. Over the past ten years the terms *Digital competence* and *Digital literacy* have become more widely used and more often discussed, especially in the field of policy documentation (European Commission, 2014; Eurydice, 2011). There have also been active discussions related to the types of skills and knowledge people need in a knowledge-based society, specifically what to teach and how to teach (Ilomäki et al., 2016).

The term *Digital literacy* was first introduced by Gilster as "the ability to understand and use information in multiple formats from a wide variety of sources when it is presented via computers" (1997, p. 6). Parvathamma and Pattar, in their turn, define digital literacy as the "ability to use ICT tools and internet access, manage, integrate, evaluate, create and communicate information to function in a knowledge society" (2013, p. 159).

Digital competence and digital literacy are often used synonymously (Krumsvik, 2008). Sometimes they are used to underpin each other, for instance as in Ferrari's report:

Digital Competence is the set of knowledge, skills, attitudes (thus including abilities, strategies, values, and awareness) that are required when using ICT and digital media to perform tasks; solve problems; communicate; manage information; collaborate; create and share content; as well as build knowledge effectively, efficiently, appropriately, critically, creatively, autonomously, flexibly, ethically, reflectively for work, leisure, participation, learning, socializing, consuming, and empowerment. (2012, p. 30)

The concept of digital competence is a multi-faceted moving target covering many areas and literacies and rapidly evolving as new technologies appear. This way, Calvani and colleagues define digital competence as:

> *Digital competence consists of exploring and facing new technological situations flexibly, selecting and critically evaluating data and information, exploiting technical potentials to represent and solve problems, and building shared and collaborative knowledge while fostering awareness of one's responsibilities and the respect of reciprocal rights/obligations.* (2008, p. 186)

Ferrari also highlights that the concept of digital competence is multifaceted, prone to continuous progress and rapid development, and is already influenced by the emergence of technology. According to Ferrari, to be digitally competent means to have the ability to understand media, to search and be critical about retrievable information, and to be able to communicate with others through a variety of digital tools and applications (Ferrari, 2012*)*.

Digital competence can be understood as the ability to use technology effectively to improve performance in all areas of daily life. Several researchers suggest that digital competence is not just an isolated skill to be developed, but a range of skills, abilities, and attitudes to be deployed across different areas and dimensions of knowledge (Ferrari et al., 2014; Vázquez-Cano, 2014).

Frameworks of digital competency

According to the *World Bank 2020 report Digital Skills: Frameworks and Programs*, one of the most comprehensive and widely used frameworks for general digital skills is the European Union's European Digital Competence Framework for Citizens (DigComp) (Bashir & Miyamoto, 2020). This framework has become a reference for strategical planning and development of digital competence initiatives at European and Member State levels. In 2013 the European Commission published the Digital Competence Framework (DigComp 1.0.). In June 2016 the European Commission Joint Research Center (JRC) published DigComp 2.0., updating the terminology and conceptual model (Vuorikari et al., 2016). In 2017 the Commission expanded it and published DigComp 2.1. which describes those competencies across eight proficiency levels, from foundation/beginner to highly specialized (Carretero et al., 2017). DigComp is subdivided into five areas and 21 competences, which include the notion of digital literacy (Ferrari, 2012).

From 2013 till now DigComp has been used extensively in the context of employment, education, as well as training and lifelong learning. The changes between the version of DigComp published between 2013 and 2017

reflect certain developments such as an increased perception of "digital content" and "digital technologies," and include relevant updates regarding EU legislation, for example, *The EU General Data Protection Regulation.*

Method

A scoping review refers to the process of mapping or summarising the existing literature to understand the range of the field (Davis et al., 2009). A scoping study tends to present broader themes to which various types of study may be applicable and is less likely to seek to assess the quality of the studies included (Arksey & O'Malley, 2005). To illustrate the search results of the study and to provide an overview of the inclusion and exclusion criteria, a scope review method was used; it is based on the framework of Arksey and O'Malley (2005). The method consists of five steps: "1) Identifying the research question; 2) Identifying relevant studies; 3) Study selection; 4) Charting the data; 5) Collating, summarizing, and reporting the results" (Arksey and O'Malley, 2005, p.22). A scoping review of studies, enabling us to describe instruments with the aim to assess digital competence, was conducted. A detailed description of inclusion and exclusion criteria is given in Table 1.

Table 1. Inclusion and exclusion criteria

Criteria	**Included**	**Excluded**
Time frame	2014–2020	Before 2014 and after 2020
Publication type	Online peer-reviewed articles	Policy documents, books, reports
Focus	Studies with a primary focus on assessment or self- assessment of digital competence	Articles focusing on other aspects
Language	English	Other languages
Target population	Articles focusing on university students and digital competence assessment	Articles focusing on pupils, other population (seniors, special needs, adults)

Eligibility criteria for final databases selection for this scoping review were the topic of interest, type of the article, and the accessibility of the databases.

Finally, scientific databases ERIC (Educational Resources Information Centre), ProQuest, EBSCO were included in this review of the scope literature. The research search was performed using only the following keywords: *digital literacy, digital competence, digital competence assessment, assessing digital competence, student and assessment instrument.*

Results

The search generated 395 articles. All titles were analysed using the set inclusion criteria; 220 articles were excluded (Figure 1).

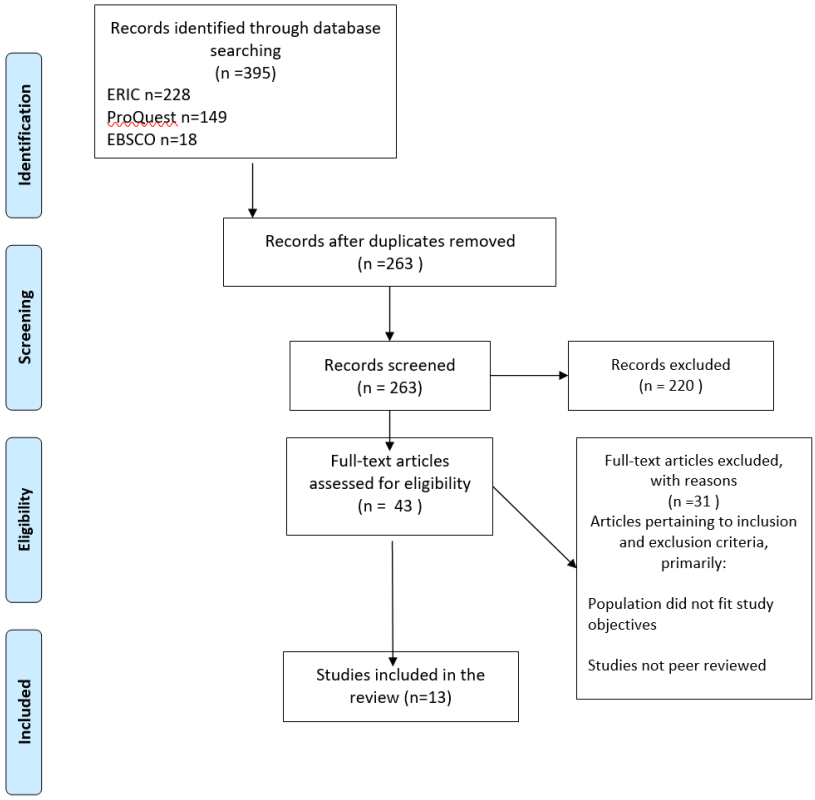

Figure 1. Flow diagramme for the scoping review search

The full texts of 43 articles were assessed. In the process of manual screening 30 of these articles were excluded, and 13 articles that met the inclusion criteria were included in the research (see Table 2). The exclusion on the studies was for two reasons: irrelevance of study objectives and absence of peer review.

Among the reviewed articles, 2 of them were from Spain, two – from Italy, and others – from Argentina, Chine, Chile, Colombia, Ecuador, Greece, Ireland, Japan, Peru, Poland, Slovakia, Ukraine and Venezuela. Eight of the total 13 articles reported were published within the last two years. This indicates that the research interest for digital competence assessment has increased.

Table 2. Frameworks for Digital Competence

Country	Author (Year)	Theoretical / Conceptual Framework
Argentina, Colombia, Peru, and Venezuela	Crawford-Visbal et al. (2020)	European Framework of Digital Competence 2.0., 2016
Italy	Sciumbata (2020)	European Framework of Digital Competence Framework 2.0., 2016
Ukraine	Kuzminska et al. (2019)	European Framework of Digital Competence 2.1., 2017
Spain, Italy, Ecuador	Tejedor et al. (2020)	Digital Competence Framework for Educators, 2017
Greece, Ireland, Scotland	Martzoukou et al. (2020)	European Framework of Digital Competence 2.1., 2017 Digital capability framework (JISC)
China	He and Chang (2014)	iDCA (instant digital competence assessment) instrument framework (Calvani et al., 2008, 2012)
Spain	Vázquez-Cano et al. (2017)[1]; Gutiérrez Porlán and Sánchez Serrano (2016)[2]; Esteve-Mon et al. (2020)[3]; Guzmán-Simón et al. (2017)[4]	[1] "University Students' Basic Digital Competences 2.0" (COBADI) [2] European Framework of Digital Competence 1.0. for citizens, 2013 [3] INCOTIC: Inventory of Competencies in Information and Communication Technologies INCOTIC questionnaire [4] New Literacy Studies approach (Barton & Hamilton, 1998; Baynham, 1995; Gee, 1990; Street, 1995)
Japan	Cote and Milliner (2016)	Digital literacy questionnaire adapted from a seminal survey created by Son et al. (2011)
Poland, Slovakia	Hajduová et al. (2020)	Authors develop an assessment instrument
Chile and Uruguay	Silva et al. (2019)	Digital competence indicators and dimensions proposed by Lázaro and Gisbert (2015)

To identify the range of the study, article summaries with regard to the year of publication, country, purpose of the study, sample/participants, theoretical/conceptual framework, assessment instrument and key findings were provided (see Table 3).

Three types of data collection methods were identified, namely, self-assessment, performance-based assessment and test-type assessment. The digital competence framework consisting of six assessment instruments was based on DigComp assessment methodology, thus, it includes multiple-choice items. In the study by Tejedor and colleagues (2020) the design of the questionnaire was based on the Digital Competence Framework for Educators (DigCompEdu) (Redecker & Punie, 2017). DigCompEdu is directed towards educators at all levels of education, from early childhood to higher and adult education, including general and vocational education and training, special needs education as well as non-formal learning contexts. In this scoping review, we also identified other digital competence assessment conceptual frameworks (see Table 2).

Four assessment instruments used a questionnaire based on a Likert – type scale of digital competence, which represents different levels of skills. In one of the studies by Crawford-Visbal and colleagues (2020) qualitative communication methods were used: focus groups and semi-structured interviews were conducted to measure progress in digital competencies. In the study by Sciumbata (2020), participants answered the survey that consisted of four sections, including preliminary questions, two self-assessment parts and a section containing multiple-choice questions to test the actual knowledge of the participants. In their study, Gutiérrez Porlán and Sánchez Serrano (2016), basing on DigComp 1.0. methodology at the core of which there are statements divided into five blocks, two questionnaires were distributed to students, namely, a questionnaire onself-perception and on digital competence. The second questionnaire on digital competence was an adaption of the first one, since it included the following statement: "Task X has helped improve my competence in area X." that helped to get more profound understanding of the issues on the basis of students' responses (Gutiérrez Porlán & Sánchez Serrano, 2016, p. 53)

Most of the tools consisted of several dimensions, categories, or areas of digital competence (see Table 3).

Table 3. Characteristics of included students' digital competence assessment instruments

Author (Year) & Title	Theoretical/ Conceptual Framework	Study purpose/ Context & Focus	Participants Sample	Methods	Key findings
Crawford-Visbal et al. (2020) Assessment of Digital Competences in Communication Students across four Latin American Universities	DigComp 2.0., 2016 Dimensions: 1) Information & data literacy; 2) Communication & collaboration; 3) Digital content creation	To assess how Communication students of the four universities in Latin America are developing their digital competencies.	157 freshmen (new students); sophomores (students between fourth and fifth semester) Seniors (close to graduation)	Questionnaire Focus group Semi-structured interviews	Students presented relatively low competence levels, especially in terms of Data and Information Literacy and Digital Content Creation competencies.
Sciumbata (2020) Students of humanities and digital skills: a survey on Italian university students	DigComp 2.0., 2016 Dimensions: 1) Information & data literacy; 2) Communication & collaboration; 3) Digital content creation; 4) Safety; 5) Problem solving	To assess how students perceive their level of digital skills and whether there is a discrepancy between their self-assessed level and their actual knowledge	270 students, born after 1993 234 female, 27 men	Questionnaire of four sections: preliminary questions two self-assessment parts multiple-choice questions based on the DigComp 2.0. The survey was distributed through social media (47 Facebook groups)	Students tend to overestimate their digital skills and lack knowledge of a fundamental topic. The most problematic area is the information-related one. Although most respondents declared themselves as independent users, they seem to lack understanding in the safety area.
Kuzminska et al. (2019) Study of Digital Competence of Students and Teachers in Ukraine	DigComp 2.1., 2017 Dimensions: 1) Information & data literacy; 2) Communication & collaboration;	The purpose of this study is to define how well education participants (teachers and	Employees, teachers, and students of higher education in various fields.	1. Sample survey; 2.Case Study (practical example); 3.Comparative study	The teachers and students have an above-average level of usage of digital tools and communications. The level of competency of professional usage of IT is

	3) Digital content creation; 4) Safety; 5) Problem-solving	students) are prepared to use their educational environment as a space for using and improving their digital competencies.			much higher for students than for teachers. No difference in gender, age, and availability of technical means were defined. The level of competencies does not depend on the way that the skills were obtained.
Tejedor et al. (2020) Digital Literacy and Higher Education during Covid19 Lockdown: Spain, Italy, and Ecuador	Digital Competence Framework for Educators, 2017 Dimensions: 1) Teacher`s professional engagement and collaboration; 2) Digital learning and sources; 3) Teaching and teachers guidance and skills; 4) Supporting students	To determine how higher education in three different countries faced a global lockdown situation in ensuring digital literacy development.	376 students aged between 18 and 40 years old	Questionnaire with an exploratory-correlation scope. The instrument was designed using Google Forms.	Students felt they were not sufficiently supported enough during lockdown; Digital skills and competencies should be reinforced in teachers as a critical point in a new learning scenario.
Martzoukou et al. (2020) A study of higher education students' self-perceived digital competencies for learning and everyday life online participation	DigComp 2.1., 2017; Dimensions: 1) Information & data literacy; 2) Communication & collaboration; 3) Digital content creation; 4) Safety; 5) Problem solving	To explore how students in higher education self-assess their digital competence	61 postgraduate students; 97 undergraduate students	Questionnaire-based on five-point Likert-type.	Students' self-assessment of digital competencies was lacking in a number of areas (information literacy, digital creation, digital research, and digital identity management. Students' digital competencies were found to be linked to previous experiences within the everyday life digital

	Digital capability framework (JISC), 2012; 1) ICT proficiency; 2) Digital creation, problem-solving, and innovation; 3) Digital communication and participation; 4) Digital learning and development; 5) Digital identity and wellbeing				environment. The more the self-perceived digital competence levels of students were based on dealing with everyday life digital tasks, the more likely they were to develop high self-perceived digital competence in other digital areas related to their education.
He and Chang (2014) Digital informal learning among Chinese university students: the effects of digital competence and personal factors	iDCA Dimensions: 1) Technological (visual literacy, troubleshooting, understanding Technical Concepts) 2) Cognitive Skills (Organizing and connecting textual and visual data, Organizing structured data, Information Research) 3) Ethical Knowledge (Staying safe online, respect for others)	To investigate the interactions and effects of digital competence, personal innovativeness, and attitudes to digital competence tend to get involved in digital informal learning more. informal learning on digital informal learning behaviors among university students	235 university students;	Questionnaire Digital Competence Scale based on the iDCA; Digital informal learning scale	University students' digital competence has a positive association with students' digital informal learning, while students with a higher level of digital competence tend to get involved in digital informal learning more.

Vázquez-Cano et al. (2017) Differences in basic digital competencies between male and female university students of Social Sciences in Spain	The "University Students' Basic Digital Competences 2.0" (COBADI – registered at the Spanish Patent and Trademark Office, http://cort.as/gNom) Modules: 1)Competences in the use of ICT for the search and treatment of information 2)Interpersonal competencies in the use of ICT at university; 3)Virtual and social communication tools at university	The study aims to determine whether, through the Bayes factor method, we can attribute significant differences in basic digital competencies to first-year male and female university students studying Social Sciences courses, specifically Social Education, Social Work, and Pedagogy Spain.	923 students	2.0 COBADI® questionnaire IT contains 23 items divided into three modules. All items formed off on a 1–4 point Likert scale	Men have greater perceived competence in digital cartography and online presentations, whereas women prefer to request personal tutorials to resolve doubts about technology and have greater perceived competence in corporate emailing. There is also evidence the men have greater perceived competence in developing "online presentations" than women do
Cote and Milliner (2016) Japanese university student self-assessment and digital literacy test results	Digital literacy questionnaire adapted from a seminal survey created by Son et al. (2011).	To assess freshmen students' digital literacy?	112 freshmen student	Digital literacy questionnaire adapted from a seminal survey created by Son et al. (2011)	Almost all students had very low self-assessment of their digital skills, and respondents returned inferior results in the digital literacy test. Although smartphone ownership and personal computer ownership are at 100%, students do not appear to be using these devices in any depth.

Gutiérrez Porlán and Sánchez Serrano (2016) Evaluation and development of digital competence in future primary school teachers at the University of Murcia	DigComp1.0., 2013 Dimensions: 1) Information; 2) Communication; 3) Content creation; 4) Safety; 5) Problem-solving	To ascertain the perception of first-year Primary Education degree students about their own digital competence before and after taking the ITC subject.	134 students	Questionnaire on self-perception of digital competence	Students mainly consider themselves to be competent in aspects related to information, communication, and problem-solving. Students rate their competence quite highly in the most basic and general elements (level 1), but this falls as the level of complexity increases (levels 2 and 3) The tasks used in this experience were rated very positively by the student, with all the tasks helping to improve their digital competence to a large degree.
Hajduová et al. (2020) Digital competencies of Polish and Slovak Students – Comparative Analysis in the Light of Empirical Research	Study authors develop an assessment instrument: Dimensions: 1) IT competencies (33 variables) 2) Information competencies (11 variables)	To analyse the perception of digital competencies by Polish and Slovak students.	343 students, 172 from Poland and 171 from Slovakia	Questionnaire	Students cope better with basic tasks describing digital competencies than with more challenging tasks. Polish students demonstrate higher competencies than Slovak ones in all surveyed areas.
Silva et al. (2019) Teacher's digital competence among final year Pedagogy students in Chile and Uruguay	Teacher's digital Competence (TDC) indicators and dimensions proposed by Lázaro &Gisbert (2015) Dimensions:	To assess the level of TDC in a sample of students from Chile and Uruguay. To determine	568 students	Test-type assessment instrument The responses were scored according to their level of precision: 1, 0.75,	The distribution of students with a low level of D4 is significantly higher than that of students with intermediate competency. A high percentage, 39,3%, of

	1) Curriculum, didactics, and methodology (D1); 2) Planning, Organizing and Managing Digital Technology Resources (D2); 3) Ethical, legal, and security aspects (D3); 4) Personal and professional development	the relationship between the level of TDC and the factors of gender and educational status.		0.5, 0.25 points. The assessment instrument was made up of the four top-rated questions by experts. The instrument was composed of 40 questions, distributed in four dimensions.	male students, reach advanced digital competencies in D2 compared to female students.
Guzmán-Simón et al. (2017) Undergraduate students' perspectives on digital competence and academic literacy in a Spanish University	The instrument was created from the New Literacy Studies approach (Barton & Hamilton, 1998; Baynham, 1995; Gee, 1990; Street, 1995); Dimensions: 1) personal literacy (reading), 2) personal literacy (writing), 3) cultural consumption, 4) library culture 5) undergraduate academic literacy.	To determine characteristics of digital competence of undergraduate students in one Spanish University. To assess literacy practices of students and which practices they use to develop digital competence at university.	786 students	Self-report questionnaire The items were assessed with a Likert scale from 1 (never) to 6 (always). It consisted of 39 questions (146 items) clustered in five dimensions: personal literacy (reading), emotional literacy (writing), cultural consumption, library culture, and undergraduate academic literacy.	The study indicates a wide gap between digital competence developed in informal learning contexts and its scarcity in university literacy practices (formal learning settings). Spanish University academic practices do not incorporate ICT and information literacy processes as a part of student's academic literacy.

Esteve-Mon et al. (2020) Digital Competence and Computational Thinking of Student Teachers	INCOTIC: The Inventory of Competencies in Information and Communication Technologies *(González-Martínez, Esteve, Larraz, Espuny & Gisbert, 2018)* Dimensions: 1) Availability of ICT resources, 2) Use of ICT resources, 3) Digital competence (informational dimension, technological, multimedia and communicative, 4) Attitudes towards ICT, Expectations of the use of ICT in education	To determine the relationship between computational thinking and digital competence.	248 university students	INCOTIC questionnaire of self-perception of the digital competence 20 items distributed from the four literacy areas: informational, technological, multimedia, and communicative, with a 5-points in a Likert-type format. TPC: The Computational Thinking Test (32 questions of previous knowledge of a programming language)	According to the results, most students perceive themselves as having medium to high level of digital competence. Students with a more significant perception of their digital competence obtain a higher score in computational thinking.

In some studies, the issues related to validity and reliability in terms of digital competence assessment instruments use were examined (Table 4).

Table 4. Validity and Reliability of Digital Competence assessment

Author (Year)	**Validity**	**Reliability**
Crawford-Visbl et al. (2020)	No information	No information
Sciumbata (2020)	No information	No information
Kuzminska et al. (2019)	No information	Cronbach's alpha
Martzoukou et al. (2020)	No information	Cronbach's alpha
He and Chang (2014)	Confirmatory factor analysis and partial least squares modelling	Cronbach's alpha
Tejedor et al. (2020)	No information	Cronbach's alpha
Esteve-Mon et al. (2020)	No information	No information
Guzmán-Simón et al. (2017)	Principal component analysis (PCA)	Cronbach's alpha
Gutiérrez Porlán and Sánchez Serrano (2016)	No information	No information
Vázquez-Cano et al. (2017)	No information	Cronbach's alpha Guttman's
Cote and Milliner (2016)	No information	No information
Hajduova et al. (2020)	No information	Cronbach's alpha
Silva et al. (2019)	Expert judgment (nine experts in the field of higher education linked to ITT)	Cronbach's alpha

Cronbach's alpha was the most frequently used reliability coefficient. It was noted that four instruments reported neither validity nor reliability tests. Only three tools reported both validity and reliability tests.

Discussion

A scoping review was undertaken to describe digital competence assessment instruments to measure students' digital competence. The scoping review showed that most of the existing tests assess students' digital information searching communication and technical skills. In the review, most of the instruments were composed of several competence areas: information and data literacy, communication and collaboration, digital content creation, safety and problem-solving. The majority of the studies report on a designed self-assessment questionnaire comprising

multiple-choice items and evaluation of digital competence. The present research helped to establish that the most commonly used framework was appeared to be the European DigComp framework for Citizens 2.0. (Vuorikari et al., 2016).

As part of the scoping review, the main key findings of the included studies were analysed. Some studies show that students tend to overestimate their digital competence and lack knowledge of fundamental topics (Gutiérrez Porlán & Sánchez Serrano 2016; Sciumbata, 2020). The study conducted by Martzoukou and colleagues (2020) indicates that the development of digital competence is linked with their previous experiences in the digital environment in everyday life. For example, according to the research in Argentina, Colombia, Peru, and Venezuela, despite the high levels of digital literacy in communication and collaboration, students' competence in information and data literacy and digital content creation remained low (Crawford-Visbl et al., 2020).

In several research it was also found that men had higher levels of digital competence than women (He & Milliner 2014; Crawford-Visbal et al., 2020). The results obtained by Esteve-Mon and colleagues (2020) show that digital competence is closely related to digital problem-solving (computational thinking), that is, students with higher digital competence scores had also higher digital problem – solving competency.

The study conducted by He and Milliner (2014) indicate that university students' digital competence has a positive association with students' digital informal learning, while students with a higher level of digital competence tend to get more involved in informal digital learning. Sciumbata (2020) established that 270 students participating had an excellent opinion of their digital skills most of them consider themselves to be good users and independent users in three out of five DigComp areas. However, when tested, significant gaps in their knowledge in all the areas were identified.

Our approach was not without limitations. First of all, the selection process, the inclusion, and exclusion criteria have influenced the outcomes of this scoping review. The exclusion of non-English studies further limits potentially relevant studies, which contain important and valuable information. This scoping review did not conduct a quality appraisal process of the research included. This may have influenced the interpretation of the research results. It is significant to note that, our search included three multidisciplinary databases, namely, ERIC, ProQuest, EBSCO). For further exploration of the issue, it is recommended to enlarge the number of databases by including other databases (i. e. Scopus, Web of Science). This scoping review could serve as the groundwork for a stricter systematic review.

Conclusions

Nowadays, digital competence is gaining importance and represents a critical factor in every aspect of our lives. We have provided an overview of literature on digital competence assessment instruments in the field of higher education. The conclusion of our review is that research conducted at universities and colleges does not have a developed systematic approach to researching and assessing students' digital competencies. Several studies (Gutiérrez Porlán & Sánchez Serrano 2016; Kuzminska et al., 2019) included in the report included such research participants in which students took part in short online study courses to acquire and improve digital skills, as a result of which students' existing digital skills were not systematically assessed, and students' existing digital skills were not taken into account. Some higher education institutions, such as National University of La Plata in Argentina, University of the Coast in Colombia, San Ignacio de Loyola University in Peru, Cecilio and Acosta Catholic University in Venezuela), conducted research on students' digital competences and focused mainly on the skills related to digital technologies, for example, which ICT and digital media that students use and integrate into the study process. The results obtained in the scoping review are significant in order to better assess students' future digital competences. Further research has to be focused specifically on high-validity digital competence assessment tools.

The digital competence assessment tools included in the review could be helpful for both universities and education policymakers for the development of digital competence assessment tools in higher education.

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