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Adapting to crisis and unveiling the digital shift: a systematic literature review of digital competence in education related to COVID-19

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Nowadays, with technology penetrating into every aspect of our life, the ways to acquire knowledge has been greatly revolutionized. The outbreak of the Coronavirus (COVID-19) has accelerated digital informatization in education and the educational model has been transformed substantially. The demand for digital competence is at record high. The purpose of this study is to systematically explore digital competence in different national educational contexts during the COVID-19 pandemic (2019–2021), to provide academics with the current state of digital competence in education and main research trends in digital competence in education during this period, elucidate the impact of pandemic on digital competence, and explore the limitations in the implementation of digital competence in educational research. The results indicate that most research on digital competence in educational contexts related to COVID-19 focused on the current state of the digital competence of teachers and students, especially those in higher education and formal learning context. Still, with the situation compounded, the researchers furthered their study by investigating the factors that influenced digital competence in order to address educational challenges in a pandemic context. In addition, teachers and students were still not well equipped as for digital competence though their digital awareness and digital readiness in the teaching and learning process increased. It is recommended to promote and enhance digital competence training in order to improve students' achievement and the quality of education.

KEYWORDS

digital competence, education, systematic review, pandemic, digital transformation

1 Introduction

In a society full of information and knowledge, which is globalized and intercultural, digital technologies have been increasingly developed and integrated into the citizens' everyday life. People should be equipped to adapt quickly to a rapidly changing, multi-connected world. The European Commission (2021) and the Council of the European Union (2018) has identified digital competence as one of the eight key life skills in its recommendation on key competences for lifelong learning. In addition, technological developments and the penetration of technology have changed the way in which we obtain knowledge.

The outbreak of the COVID-19 pandemic has dealt a blow to several industries, as well as to education. The closures in response to COVID-19 have disrupted mainstream educational

activities in many countries, and there has been a paradigm shift in educational approaches due to health concerns (Schleicher, 2020). Several schools and institutions have moved from offline teaching, characterized by fixed hours and classrooms, to online teaching that is not limited by time and space and involves a deep integration of teaching in the classroom with new technologies, methods and content, with the aim of offering a safe and convenient study environment for their students. At the same time, various educational platforms and resources have been made available to educational institutions to meet their teaching needs (UNESCO, 2020a, 2020b). Although offline education is slowly returning to the limelight as the epidemic progresses, the evolution of online education has become a trend and is growing by leaps and bounds due to the impact of the epidemic (Li and Lalani, 2020) However, along with these changes, many technology-related and educational challenges have emerged.

The main subjects of 21st century education are digital natives, who were born at the time of the rapid development of technology, who use information and communication technologies to interact with others in their daily life, and digital immigrants, who have experienced the gradual penetration of technology into their lives, and have had to adapt to the new digital environment (Prensky, 2001; Iansiti and Richards, 2020). After being affected by the COVID-19 pandemic and given a shift in educational models, there is a growing social interest in digital competence. At this point, digital competence is the most up to date concept to describe technology related skills (Ilomäki et al., 2011).

The concept of digital competence has received much scholarly attention. Digital competence is defined as "the set of knowledge, skills, attitudes, abilities, strategies, and awareness that are required when using ICT and digital media to perform tasks; solve problems; communicate; manage information; collaborate; create and share content; and build knowledge effectively, efficiently, appropriately, critically, creatively, autonomously, flexibly, ethically, reflectively for work, leisure, participation, learning, and socializing" (Ferrari, 2012, p. 30), and it is widely understood as "the confident, critical and responsible use of, and engagement with, digital technologies for learning, at work, and for participation in society" (Council of the European Union, 2018, p. 10). The concept of digital competence has been debated in many ways. In the work of Calvani et al. (2012), digital competence was summarized at the technical, cognitive and ethical levels. Meanwhile, Janssen et al. (2013) indicated the dynamic and transversal characteristic of digital competence and considered it in terms of cognitive, attitudinal, and technical skills that help to alleviate the numerous problems and challenges of the knowledge society. Each of these frameworks interprets the understanding of digital competence from different perspectives. However, no framework-endorsed view could be claimed to contradict this overarching, comprehensive definition.

As an important element in the educational process, digital competence has been assessed and recognized in different ways and aspects in the educational context. In addition to investigating digital competence in the dimensions of knowledge, application and attitudes, the European Digital Competence Framework (Digomp), published in 2013, is widely known as a reference framework to support strategy and policy formulation and the development of digital competence (Zhao et al., 2021a). The version of DigComp has been updated to keep pace with the evolution and needs of society. In DigComp 2.0, 21 competencies were proposed and the list of five competency areas has been updated: (1) information and data literacy; (2) communication and collaboration; (3) digital content creation; (4) security; and (5) problem solving (Vuorikari et al., 2016). Eight proficiency levels and new examples of use were added in Digcomp 2.1 (Carretero Gómez et al., 2017). The DigComp 2.2 version was published following new and emerging topics and themes in the digital world with more examples (Vuorikari et al., 2022).

For teachers, having digital competence means they are going beyond the simple use of ICT tools to the successful integration of digital technology in their pedagogical practices. In 2017, the Digital Competence Framework for Educators (DigCompEdu) was launched, to provide educators with an understanding of what it means to be digitally competent and to assist them in developing the necessary skills to meet changing needs (Redecker, 2017). In order to provide a descriptive reference for the training purposes and for the assessment and certification process, enhancing teachers' and trainers' digital competence development, enabling their understanding of students' digital competence and facilitating changes in methodological approaches, the National Institute of Educational Technologies and Teacher Training (INTEF) in Spain published the Common Digital Competence Framework for Teachers (CDCFT) (INTEF, 2017). Moreover, technical knowledge that teachers are required to integrate into their teaching have been included in the Technological pedagogical content knowledge (TPACK) framework, which is divided into content, pedagogical and technological knowledge (Mishra and Koehler, 2006). Furthermore, the pandemic caused by COVID-19 has had a profound impact on education, highlighting the importance of improving teachers' professional and digital competence in both online and blended learning modes (Portillo and de la Serna, 2021).

For the rest of the education participants and a worldwide audience, the United Nations Educational, Scientific and Cultural Organization (UNESCO) established the Global Alliance to Monitor Learning (GAML) with the aim of improving learning achievements by supporting national learning assessment strategies and developing internationally comparable indicators and methodological tools (UNESCO & UIS, 2017). GAML has proposed a Global Framework of Reference on Digital Literacy Skills, which identifies relevant competencies on a global scale (Law et al., 2018). At the same time, various countries and institutions have implemented corresponding measures and programs to develop digital competence to meet the requirements of society. The European Union has published a Digital Education Action Plan (2021–2027), focusing on promoting a high-performance digital education ecosystem and enhancing digital skills and capacities for today's ongoing digital transformation (European Union, 2020). In line with the European Commission's digital policy for the new period, Spain has launched the Digital Spain Strategy 2025 plan which includes a series of measures, reforms and investments to facilitate the process of digital transformation (Government of Spain, 2020). In China, several reports, plans and blue papers have been published describing the progress made in the construction of Digital China, the number of users of online education in China, highlighting the regulation of online education and indicating the priorities for follow-up work (Cyberspace Administration of China, 2020; China Internet Network Information Center, 2021).

Over the last two decades, the notions of digital competence and digital literacy have been increasingly referred to and frequently discussed since they are closely linked. Not only are they referred to

in conjunction and used in support of each other, but in some studies, they are considered synonymous, despite their different origins and meanings (Iordache et al., 2017). First, digital competence is a notion that has been widely used to represent the knowledge, skills and complex abilities that people should have in a knowledge society (OECD, 2005; Ilomäki et al., 2011). Digital literacy was first presented by Gilster (1997) as "the ability to understand and use information in multiple formats from a wide range of sources when it is presented via computers" (p. 1), has a longer tradition and is connected to media literacy, information literacy, digital scholarship, learning skills, ICT literacy, career and identify management and communications and collaborations (JISC, 2014). In citing these concepts there are regional differences. Studies on digital competence are usually carried out in European countries outside the United Kingdom, while those on digital literacy are carried out in English-speaking countries (Spante et al., 2018). Regardless of the terminology chosen, these concepts embrace the idea that having a certain competence or literacy in a digital environment requires a combination of skills and attitudes (Durán et al., 2016).

Several reviews of digital competence have been conducted over the last decade. There are many reviews that specifically address digital competence in higher education (Esteve-Mon et al., 2020; Sánchez-Caballé et al., 2020; Zhao et al., 2021a). Some research has focused on primary and secondary education (Bojórquez-Roque et al., 2024; Su and Yang, 2024; Siddiq et al., 2016), while some reviewers have not limited themselves to which educational setting the research took place. The review conducted by Spante et al. (2018) presented the definition of digital competence and digital literacy and discussed the concept use of both notions. Sillat et al. (2021) explored an analysis of the existing proposals and conceptions of digital competence assessment processes and methods to support digital competence assessment. In the work of Pettersson (2018), it is highlighted how international research over the last decade has addressed digital competence in educational contexts in terms of policy, organizational infrastructure, strategic leadership, teachers and their teaching practices.

Moreover, in the 5 years following the pandemic, the influence of digital competence has continued to expand, not only in the field of education but also beyond. In addition to perspectives from students and teachers, the digital competence of leaders has also been highlighted (Opt Roodt et al., 2025). Concurrently, the gender dimension remains a prominent area of focus (Estanyol et al., 2023; Khoo et al., 2024). In the study of Kalogeratos et al. (2024), they have combined two of them, talking about gender and age as factors affecting the digital competence of elementary school principals. Guillén-Gámez et al. (2024) examined the impact of gender on university faculty in the workplace. Outside the education sector, digital competence is increasingly addressed in fields such as healthcare (Bachmann et al., 2024; Kulju et al., 2024; Ren et al., 2025) and economics (D'Ignazio et al., 2025). Indeed, both during and after the pandemic, these two domains have received significant attention, with considerable impacts and transformations. Furthermore, with the rapid development of artificial intelligence and the proliferation of digital tools, research on digital competence has adapted, increasingly linking it to the application of these tools. Nguyen (2024) has investigated the role of artificial intelligence in enhancing digital competence in education, while Adeshola and Adepoju (2024) has discussed the opportunities and challenges posed by ChatGPT in the educational context.

All of these studies have added to the scholarly community's understanding of digital competence in education. However, after the impact of COVID-19, what is specifically happening in the field of education in terms of digital competence, its problems, development and research trend cannot be well identified.

Influenced and driven by this epidemic, the use of ICT to renew the vision of education and change the educational model has now become a major trend (Ali, 2020). However, inequalities and preexisting problems in education systems around the world have also intensified (Lorente et al., 2020). Therefore, it is extremely important to have an adequate level of digital competence and to allow for the effective use of ICT tools in education in the aftermath of the COVID-19 epidemic (Naresh, 2020). The emergence of the pandemic has impacted and changed the education sector in all aspects of teaching and learning, such as teaching models, pedagogical approaches, and educational targets, although it is now behind us, its emergence has had a profound impact on the development and consideration of education in its aftermath, and an understanding of the research that has been conducted in this particular period is necessary.

In this review, digital competence in education during the COVID-19 pandemic are systematically explored, providing an understanding of the influence of COVID-19 in digital competence, as well as knowing the current state of development of digital competence in education during this period and the main research trends, and outlining the limitations that have emerged in the current implementation of digital competence in educational research. The aim of this systematic review is to present an up-to-date (2019–2021) overview of digital competence in education in different educational contexts and in multiple countries. This review will concentrate on the following research questions:

1. What were the main study subjects, educational levels and educational contexts of digital competence studies in relation to COVID-19?
2. What were the major purposes, methodologies, outcomes and limitations of digital competence studies in educational contexts in relation to COVID-19?

2 Methods

A systematic review is the process of selection, identification and synthesis of previous studies in order to provide a comprehensive and reliable representation of the object under review (Gough et al., 2017). In this study, a systematic literature review was carried out with two research questions to present research on digital competence during the COVID-19 pandemic in education, aiming to provide an impartial synthesis and interpretation of the findings. After the research questions have been clearly defined. The databases selected for the search were identified, as well as the search strings, criteria for evaluation and selection of studies. To conclude we present the publications that were included at the end of the process.

This review was based on the guidelines for systematic literature reviews proposed by Kitchenham and Charters (2007) and García-Peñalvo (2017), following the SALSA (Search Assessment for

Synthesis and Analysis) framework proposed by Codina (2015). The first step is to identify the need for the review, define the research question, develop a review protocol, and evaluate the protocol. After defining the study based on the research questions and objectives, the selection criteria are developed and evaluated. The databases and search strings to be used are identified, as well as the criteria, and relevant content and data are searched and extracted from the scientific databases. The quality of the results is then assessed, and the data are collected, analyzed, and synthesized. This study followed the format of other conducted systematic reviews on the subject of educational technology and digital competence as well (Crompton and Burke, 2018; Zhao et al., 2021a).

2.1 Search strategy

First, the databases selected for this systematic literature review were the Web of Science (WoS) and Scopus, as they are the main database for multidisciplinary international academic literature (Aghaei Chadegani et al., 2013).

The search string for each selected source was defined by a search term concatenated by the Boolean AND/OR operator. The rationale behind the selection of keywords such as 'digital competence,' 'digital ability,' 'digital skill,' 'digital literacy,' 'covid,' 'corona,' and 'coronavirus' was to capture a broad range of relevant studies that explore the concept of digital competence in the context of the COVID-19 pandemic. The use of variations in the keywords, such as 'competence,' 'ability,' 'skills,' and 'literacy,' has ensured inclusivity of different terminologies that researchers might use when discussing the digital competence. The inclusion of terms like 'covid,' 'corona,' and 'coronavirus' narrowed the search to studies specifically addressing the impact or implications of the pandemic on digital competence. This keyword combination was chosen to make sure that the literature search would yield studies most directly related to the research questions concerning digital competence in relation to COVID-19. In addition, the use of Wildcards (*) was used in WoS and Scopus to include the singular and plural of each term. The terms were searched in the title, keywords and abstract of the paper.

The search strings per chosen electronic database in this systematic literature review were presented as follows:

- WoS: TS = (("digital competence*" OR "digital abilit*" OR "digital skill*" OR" digital literac*") AND ("covid" OR "corona" OR "coronavirus"))
- Scopus: TITLE-ABS-KEY (("digital competence*" OR "digital abilit*" OR "digital skill*" OR "digital literac*") AND ("covid" OR "corona" OR "coronavirus"))

2.2 Study selection

The process of data extraction was an iterative and gradual procedure, which was divided into several stages in that different activities were carried out. There were 422 articles in the initial search.

2.2.1 Inclusion and exclusion criteria

A set of inclusion and exclusion criteria was determined to select those relevant studies to answering the identified research questions (Table 1). A group of experts validated the inclusion and exclusion criteria, which consisted of eight university professors, two experts in statistics, three experts in linguistics and three experts in educational technology. In terms of research questions and research objectives, the selected articles were published in the context of the COVID-19 pandemic, which was from 2020. Furthermore, studies were not limited to the digital competence of teachers and students in education, as that of leadership and librarians also play an influential role in this innovation (Antonopoulou et al., 2021; Martzoukou, 2020; Rafiq et al., 2021). After applying the established search strings, the results obtained were checked for duplicates. Each study was then analyzed and evaluated on the basis of inclusion and exclusion criteria. In this review, we opted for original research articles, as they typically present independent, peer-reviewed experimental or survey data, offering direct and authentic research outcomes. This is to ensure the scientific integrity, rigor, and comprehensiveness of the review, thereby providing scholars and readers with more accurate and reliable research evidence.

The initial review of 422 studies resulted in the exclusion of 107 duplicate articles and 246 articles that did not comply with the inclusion criteria. The remaining 69 articles were further reviewed and assessed in depth against quality criteria to assure that the articles selected satisfied the inclusion and exclusion criteria and that the quality of the selected articles responded to the research questions.

2.2.2 Quality criteria

After selecting those papers that did not meet the exclusion criteria and matched all the inclusion criteria, every candidate paper

TABLE 1 Inclusion criteria and exclusion criteria.

Inclusion criteria
The research work is related to digital competence in the context of education.
The publication includes state of the art on digital competence and COVID-19.
Research papers are published during the COVID-19 pandemic.
The research papers are written in English.
The research papers have been published after being submitted to a peer review process.
The full version of the publication is available through the subscription of our institution or by the associations of which we are members.
The research follows the appropriate structure of a research according to the research method.

Exclusion criteria
The research work is not related to digital competence in the context of education.
The publication does not include state of the art on digital competence and COVID-19.
Research papers are not published during the COVID-19 pandemic.
The research papers are not written in English.
Research papers have been published without a peer review process.
The full version of the publication is not available through the subscription of our institution or by the associations of which we are members.
The research does not follow the appropriate structure of a research according to the research method.

was fully reviewed to determine whether it met quality standards. The quality criteria were primarily established based on the guidelines outlined by García-Peñalvo (2017), with additional adaptations made to align with the specific research questions and objectives of this systematic literature review. These criteria were then validated by a panel of eight university professionals, who reviewed and assessed each criterion for clarity, relevance, and pertinence. Based on their expertise, the panel provided recommendations for adjustments and refinements to ensure that the criteria effectively captured the key elements needed for evaluating study quality in the context of this review.

The quality criteria in this review were concerned with the state of art of digital competence and the COVID-19, research objectives, research methodologies, research instrument, research results, answers to the research questions, research conclusions, research limitations, and suggestions for future research directions and recommendations for developing digital competence in education in the aftermath of the pandemic. In the form of questions, the quality criteria were presented with coded elements (Table 2).

There were 69 articles reviewed and evaluated following the quality criteria questions. There were three options for each quality criteria relevant question and answers were coded as yes (1 point), no (0 point) and partial (0.5 point). A score would be assigned to the publication based on the content that corresponded to these quality criteria questions. As a dividing point for the selection of papers, those included in the final procedure had to have or exceed a value of 7.5 after answering these 10 quality criteria. Once the quality criteria were applied, 46 articles were removed. Finally, a total of 23 were selected and analyzed to answer the research questions.

A PRISMA flow was used to present this literature search and data extraction process (Figure 1) (Moher et al., 2009; Urrútia and Bonfill, 2010).

3 Results

This section is organized on the basis of stated research questions by analyzing the selected articles in order to propose answers to the research questions.

TABLE 2 Quality criteria.

Quality criteria
1. Does the research describe the state of art of digital competence and the COVID-19?
2. Are the research objectives or research questions clearly specified and described?
3. Is the study designed to achieve the objectives?
4. Is the instrument clearly described and design-based?
5. Is the sample and population of the study clearly described?
6. Are the research questions adequately answered?
7. Are the conclusions clearly described and based on the results?
8. Do the authors discuss the problems and limitations of the research?
9. Do the authors present future research directions?
10. Do the authors make any suggestions for developing digital competence in education in the aftermath of the pandemic?

3.1 What were the main study subjects, educational levels and educational contexts of digital competence studies in relation to COVID-19?

To understand the research trends on digital competence in education within the context and influence of the pandemic, the study subjects, educational levels and education contexts of studies on digital competence in education in relation to COVID-19 were explored.

3.1.1 Study subjects

In this review, a total of 23 publications were reviewed. First, the total sample size for each study type varied widely, from 17 (Beardsley et al., 2021) to 4,589 (Portillo et al., 2020) participants. Although the number of male and female students in each study varied, female participants across studies tended to be larger in number. There was only one publication with more male participants (Heidari et al., 2021), while one publication did not mention gender differences (Trubavina et al., 2021).

Of the 23 selected publications, the participants were mainly from Spain with 12 studies, participants in two publications came from China and there were two studies with participants from Indonesia. In addition, two publications selected samples from more than one country; Jang et al. (2021) conducted an empirical study on Korean and Finnish young people. And Betancourt-Odio et al. (2021) carried out a study with teachers from 15 countries.

Regarding the main study subject of digital competence studies in relation to the COVID-19, the majority of the research studies focused on faculty (48%). Apart from the concentration on teachers, there was an article that interviewed with headmasters. Although most publications explored digital competence from teachers' perspectives, we used the term "faculty" to encompass the participants of headmasters. It was followed by 43% (n = 11) of studies involving students. There were also two studies, which investigated young people in the context of education without limiting participants' learning background (Figure 2).

3.1.2 Educational levels

Figure 3 reveals that in terms of educational level, the majority of selected publications concerned higher education.

Classification based on the research subject, publications focusing on faculty mainly investigated university, secondary and primary school teachers, and two publications had teacher participants from various educational stages. Among publications involved in student studies, there were six publications, which paid attention to university students, one publication focused on postgraduate and doctoral students and the rest of the research studies investigated students from secondary, primary and high school.

3.1.3 Types of educational contexts

The educational contexts of 23 publications were analyzed (Figure 4). The majority of the research studies took place in a formal learning context. Four publications were performed in informal settings, and three publications were carried out in both formal and informal learning contexts. One study was conducted in a non-formal context.

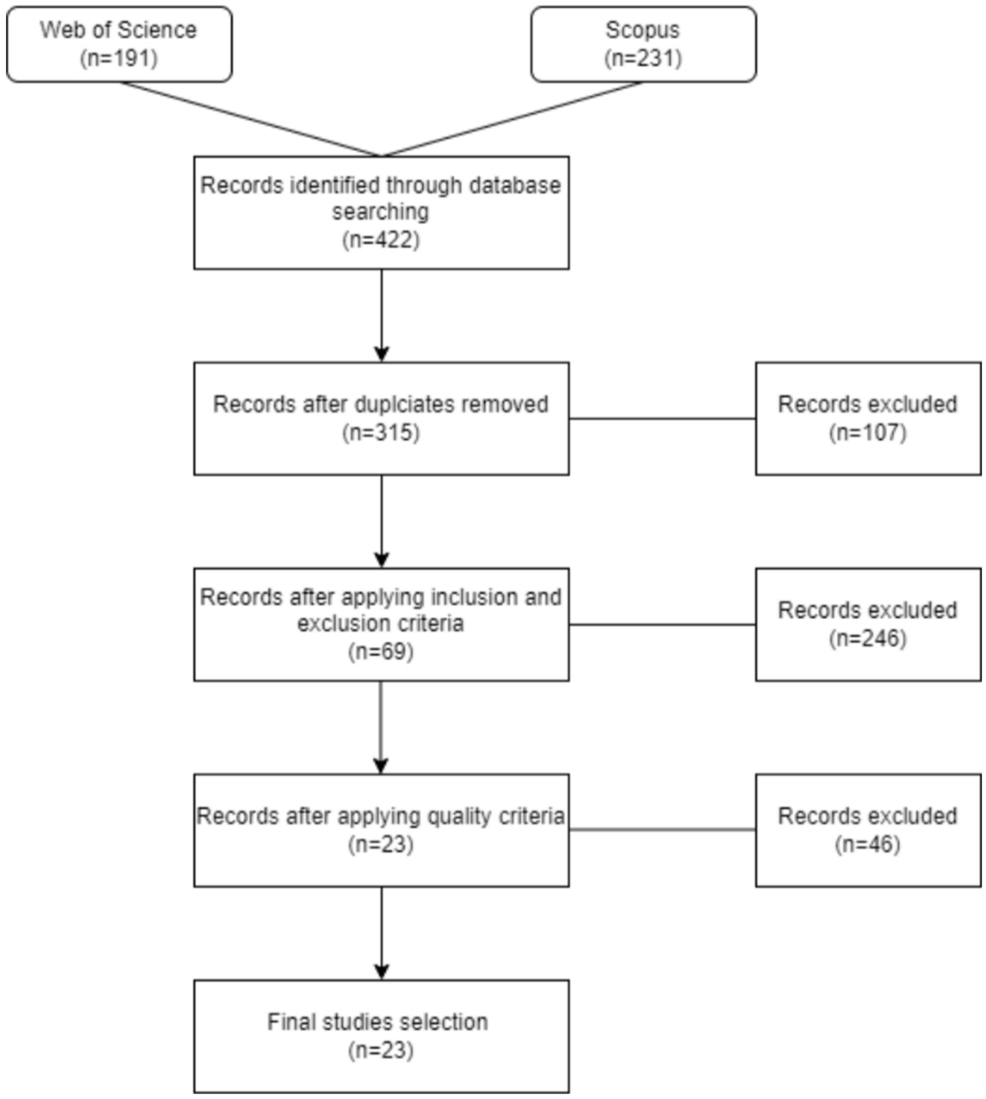

FIGURE 1
PRISMA flow: data extraction procedure.

3.2 What were the major purposes, methodologies, outcomes and limitations of digital competence studies in educational contexts in relation to COVID-19?

In order to understand the current status and progress of digital competence research in education during the COVID-19 pandemic, we investigated the research objectives, research methods, research findings and study limitations in order to collect relevant information.

3.2.1 Research purposes

Following an examination and analysis of the research purposes of the selected publications, a classification was made into the following categories: (1) Investigating participants' perception and their level of digital competence in the context of education. Studies in this category assessed participants' digital competence perception or their digital competence level in the education field. In this systematic literature review, participants in the field of education refer to teachers, students and headmasters. (2) Investigating factors that could affect digital competence. Studies in this category explored the factors that influence and contribute to differences in digital competence. (3) Investigating the impact of digital competence on participants' achievement. Studies in this category assessed the effectiveness of digital competence on participants' achievement, where here participants were considered as students. Figure 5 illustrates the results of the three categories.

Investigating participants' perception and their level of digital competence was the most reported of the research purposes, as 10 (43%) of the selected publications belonged to this category. There were eight publications that investigated teachers' perception of digital competence and two publications that focused on students' digital competence perception and level. Participants' perception were examined from a variety of perspectives. Some publications

evaluated participants' general perception of digital competence in the context of the COVID-19 pandemic. Others focused on specific types of perception. For example, Sales et al. (2020) explored social science faculty's perception of digital competence before and during the COVID-19 lockdown. And Betancourt-Odio et al. (2021) investigated teachers' self-perceptions on digital Competence for M-Learning.

There were nine publications that explored the factors that could impact digital competence. The impact caused by COVID-19 on the teachers' digital competence gained a lot of attention (Romero-Tena et al., 2021; Trubavina et al., 2021). And Rundel and Salemink (2021) conducted interviews with heads and teachers in German primary and secondary schools to explore what factors affect the development of digital competence in rural schools. After investigating university teachers' digital competence perception, Zhao et al. (2021b) explored the effects of gender and years of teaching experience on their digital competence. Regarding students, Luthfia et al. (2021) examined the relationship between digital literacy, online opportunities, and online risks among young people. Rodríguez-Moreno et al. (2021) investigated the impact of digital tools and social media on the university students' digital competence development during the pandemic. At the same time, Cabezas-González et al. (2021) targeted at examining the impact of online communication and the use of social networks on the level of digital competence in the area of communication. Moreover, Tran et al. (2020) identified the relationship between students' background and their digital competence. Hossein-Mohand et al. (2021) analyzed whether students' family and economic background could be influencing variables in using ICT for educational purposes as well.

Four of the selected publications assessed the effectiveness of digital competence on students' achievement. Sholikah and Harsono (2021) explored the impact of digital readiness on students' involvement in online education. Heidari et al. (2021) examined the impact of digital competence in digital informal learning contexts on student academic engagement during the COVID-19 pandemic. And the influence of university students' digital competence perception on their intention to use digital technology for learning purposes was discussed by Jang et al. (2021). In addition, Wang et al. (2021) not only analyzed the impact of digital competence on students' academic burnout and engagement in learning during the pandemic, but also focused on psychological aspects such as their psychological burden and mental effort.

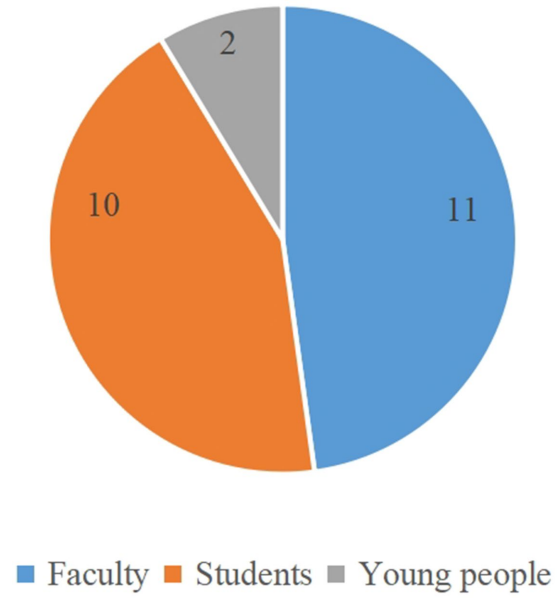

FIGURE 2
Results of the category of participants.

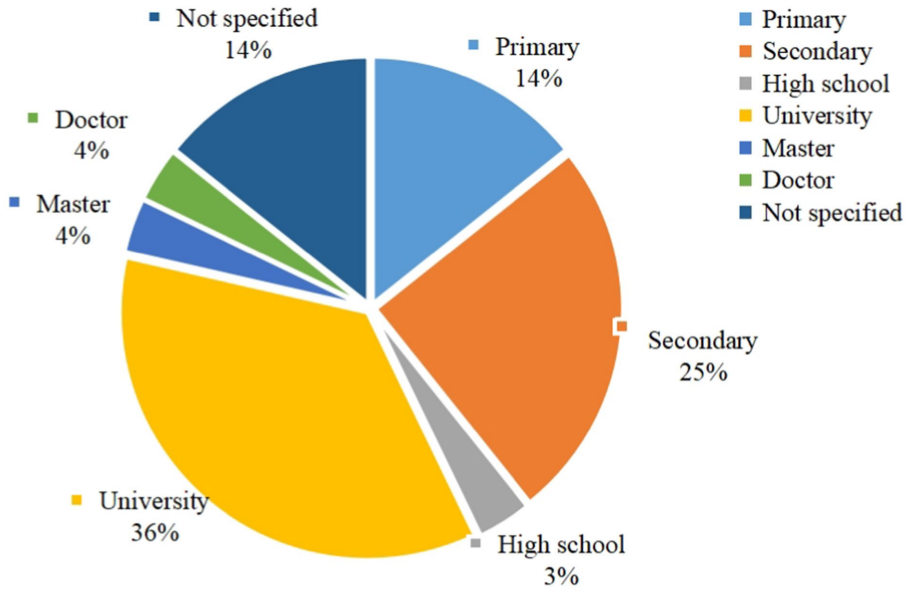

FIGURE 3
The educational level of the students or faculty involved in the selected publications.

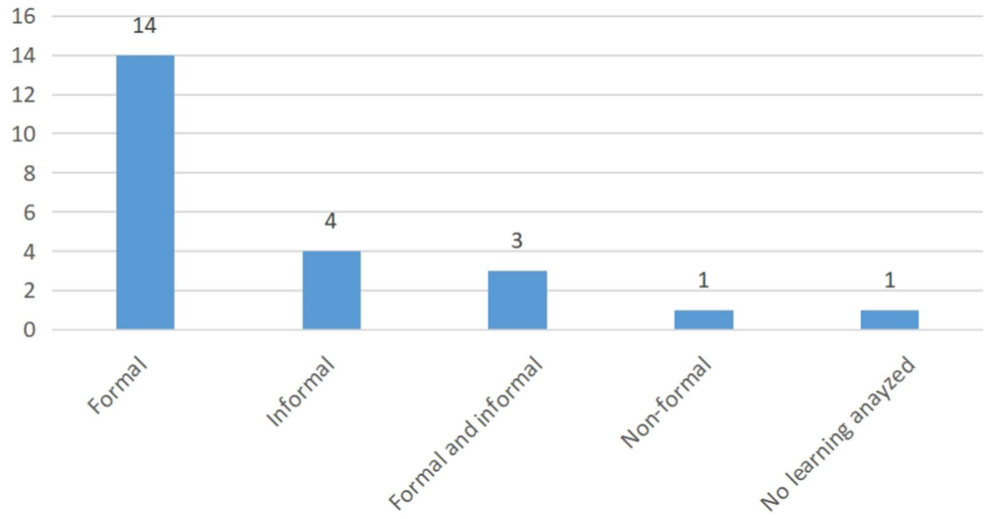

FIGURE 4
Educational contexts.

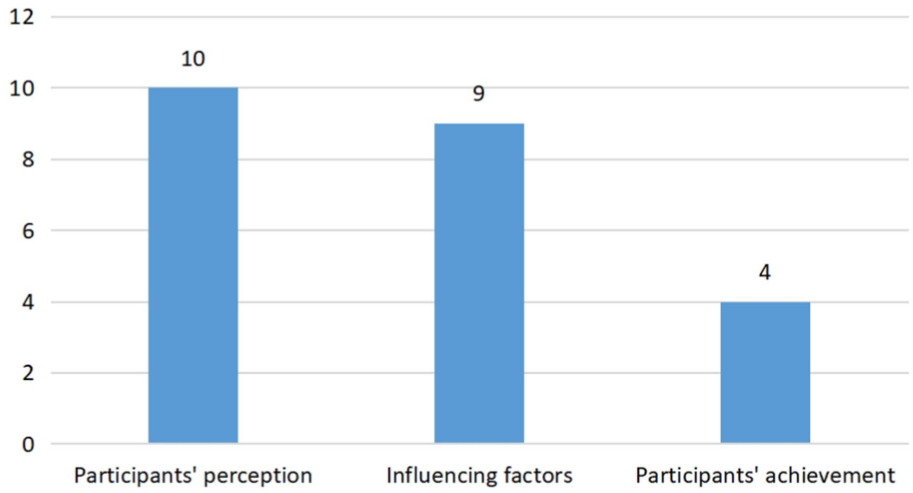

FIGURE 5
Research purposes.

3.2.2 Research methods

An examination of the research methods used in these selected publications is presented in Table 3. The majority of the selected studies followed a quantitative approach to conduct the research, and the data was collected from a questionnaire. Three research studies were carried out through mixed methods. There were two studies that used qualitative methodology by conducting interviews. And two studies followed the guidelines for partial least squares structural equation modeling (PLS-SEM) (Hair et al., 2021).

TABLE 3 Research methodology.

Research methods	Number of studies
Quantitative methodology	16
Mixed methods	3
Qualitative methodology	2
PLS-SEM	2

3.2.3 Research outcomes

The 23 publications selected for this review were analyzed. The research outcomes were later presented according to the classification of the research purpose.

Research outcomes from publications investigating faculty's and students' digital competence perception and level were analyzed. With regard to teachers, teachers felt that their awareness and competence in using digital tools for teaching and learning had increased as a result of the impact of the epidemic (Beardsley et al., 2021). Most

teachers in the sample demonstrated basic-intermediate level in some areas of digital competence, but they felt less confident when the complexity of the task increased. For example, teachers perceived their digital competence to be more focused on information and data literacy, such as searching, analyzing and selecting educational resources (Betancourt-Odio et al., 2021; Cabero-Almenara et al., 2021; Perifanou et al., 2021). Teachers rated themselves positively in terms of digital competence in communication and collaboration, security and problem solving, however, teachers did not feel very competent when they needed to use specific tools or create digital content (Portillo et al., 2020; Sánchez-Cruzado et al., 2021; Zhao et al., 2021b). As for students, their digital competence perception varied in some aspects in different countries in the face of a global lockdown situation (Tejedor et al., 2020). In general, students thought themselves as digitally competent although there is still a need for them to improve in terms of didactic, curricular, and methodological aspects, as well as in planning, organization, and management of digital technological resources and spaces (Schina et al., 2020). From the teacher's perspective, students were noted to master technological tools and use mobile devices extensively, but they lacked the ability to evaluate, critically use and communicate information (Sales et al., 2020). In addition, the necessity of training for faculty and students was highlighted on the basis of their digital competence perception (Rodríguez-Muñiz et al., 2021; Schina et al., 2020).

Among the publications that focused on analyzing the factors influencing digital competence, participants' socio-demographic characteristics such as age, gender, teaching experience, previous training in ICT, economic status, and academic level were presented. Moreover, the integration of ICT equipment, financial issues, the use of ICT tools and its motivation, parents' educational background, experience of implementing distance education in the educational process before the quarantine, and the pandemic situation caused by COVID-19 were listed as well. For teachers, it was indicated that male teachers showed a higher digital competence self-perception in several areas, and teachers with less teaching experience perceived themselves as more digitally competent (Zhao et al., 2021b). Similar gender differences were observed among students by Romero-Tena et al. (2021). On the basis of their findings, Trubavina et al. (2021) stated that differentiated learning was required depending on the teachers' age, teaching experience, previous training for developing digital competence and experience of implementing distance learning in educational process before the quarantine and their inner motivation. Rundel and Salemink (2021), from the rural school perspective, indicated that the integration of ICT equipment, financial issues and parents' digital competence could be influencing factors on digital competence. Similarly, for those students who were in a better financial situation and had parents with higher levels of education, their digital literacy perception was more positive (Tran et al., 2020). Luthfia et al. (2021) also confirmed that youth's monthly expenses, age, and education levels were important factors for digital literacy, and digital literacy had a positive effect on online opportunities. And the use of ICT for the educational purposes and students' digital competence was influenced positively by their perceptions of its usefulness for their academic performance and learning, their educational level was also related to the time they spent on the Internet (Hossein-Mohand et al., 2021). Regarding the use of ICT tools, the use of virtual tools to develop teamwork and Youtube for communication was deemed to have a positive impact on students' digital competence, while previous ICT training and dedicated time to use ICT tools could contribute to some dimensions of digital competence (Rodríguez-Moreno et al., 2021). However, Cabezas-González et al. (2021) pointed out the negative impact of the use of online communication and social networks on students' digital competence levels. And in the context of the COVID-19, Romero-Tena et al. (2021) noted that the pandemic situation had a negative impact on students' self-perceptions of their digital skills.

In regard to the four publications exploring the impact of digital competence on students' achievement, three of them confirmed a positive and significant association between digital competence and students' academic engagement. And it was demonstrated that individual digital competence could facilitate the use of digital technology for learning purposes (Jang et al., 2021). Heidari et al. (2021) showed that digital competence had a positive correlation with students' academic engagement and their digital informal learning by examining the mediating role of digital informal learning between digital competence and academic engagement. In addition to noting that digital competence showed the greatest positive impact on students engagement, the psychological well-being of university students during the COVID-19 pandemic was noted, indicating that digital competence did not directly affect academic burnout, indirectly through its alleviating effect on mental load and mental effort (Wang et al., 2021). Moreover, the positive impact of digital competence on students' involvement in university was explored in the context of distance learning using mobile learning, and how it was affected by the pandemic (Jang et al., 2021).

3.2.4 Research limitations

Types of limitations of the investigations are presented in Table 4. It was noted that the sample size was the most common limitation that appeared in the 23 publications selected ($n = 10$). And the implementation of the data collection method was identified as a frequent research limitation in the articles ($n = 9$). This was followed by the formulation of research aims and objectives ($n = 8$). Six publications indicated methodological limitation in their research, indicating the weakness of the research method. Besides, self-reported data ($n = 3$) and lack of data ($n = 1$) were also mentioned in the research limitations. There were 11 publications with more than one research limitation, while five selected publications did not mention any research limitations.

4 Conclusion and discussion

This systematic literature review examined publications from the emergence of the COVID-19 pandemic to the present that have been published in the WoS and Scopus databases on digital competence in education in the context of the pandemic. It provides an overview of current research on digital competence in pandemic-influenced educational models, concerning the main study subjects, the educational levels and educational contexts in which the research has emerged, and the major purpose, methodologies, outcomes and limitations of the research. In this systematic literature review, a total of 23 publications were analyzed. It presents the current status and trends of COVID-19-related digital competence research in education since the emergence of the pandemic and its huge impact on the field of education.

In addressing the first research question, which inquires about the main study subjects, educational levels, and educational contexts of digital competence studies in relation to COVID-19, the research

TABLE 4 Types of limitations of the selected investigations.

Publications	Type of limitations
Beardsley et al. (2021)	Sample size; implementation of data collection method.
Betancourt-Odio et al. (2021)	Not mentioned.
Cabero-Almenara et al. (2021)	Sample size; methodology limitation.
Cabezas-González et al. (2021)	Implementation of data collection method.
Hossein-Mohand et al. (2021)	Sample size; implementation of data collection method; formulation of research aims and objectives; methodology limitation.
Heidari et al. (2021)	Sample size; self-reported data; formulation of research aims and objectives; methodology limitation.
Jang et al. (2021)	Sample size; implementation of data collection method; formulation of research aims and objectives.
Luthfia et al. (2021)	Sample size; implementation of data collection method; formulation of research aims and objectives.
Perifanou et al. (2021)	Self-reported data.
Portillo et al. (2020)	Not mentioned.
Rodríguez-Muñiz et al. (2021)	Implementation of data collection method; formulation of research aims and objectives.
Romero-Tena et al. (2021)	Not mentioned.
Rodríguez-Moreno et al. (2021)	Methodology limitation.
Rundel and Salemink (2021)	Not mentioned.
Sales et al. (2020)	Methodology limitation.
Schina et al. (2020)	Sample size; lack of data; formulation of research aims and objectives
Sholikah and Harsono (2021)	Sample size; implementation of data collection method; formulation of research aims and objectives.
Sánchez-Cruzado et al. (2021)	Methodology limitation.
Tejedor et al. (2020)	Sample size.
Tran et al. (2020)	Implementation of data collection method.
Trubavina et al. (2021)	Not mentioned.
Wang et al. (2021)	Methodology limitation; implementation of data collection method.
Zhao et al. (2021b)	Sample size; self-reported data; formulation of research aims and objectives

purposes of 23 selected publications were initially reviewed and analyzed. It should be noted that the sample size varied in these studies. In addition, selected publications related to digital competence and the pandemic in the education field paid more attention to faculty, followed by students. Most studies continue to focus on higher education and formal settings. Prior to the pandemic, digital competence research in educational contexts focused on teacher development (Kalimullina et al., 2021; Pettersson, 2018). In the post-epidemic era, educational challenges are still being discussed, with the focus remaining consistently on teachers, and mentions of a lack of teacher competence (Anam et al., 2025). The general crisis caused by the pandemic confronted participants in the educational process with an entirely new situation. Educators as the main leader in the teaching and learning process, have experienced the need to rethink their roles and educational tasks (Huber and Helm, 2020; Rodríguez-Triana et al., 2020). Teachers are not only expected to fulfil the basic teaching requirements, but also to acquire certain digital skills to face the challenges of distance learning and so-called emergency remote teaching, as are students (Carretero Gómez et al., 2021; Portillo et al., 2020).With regard to education level and educational context of digital competence studies in relation to COVID-19, authors in the selected publications mainly concentrated their work in the higher education and formal learning context. The impact of COVID-19 has not only resulted in recurring periods of temporary physical closure of schools and higher education institutions and an accelerated shift in teaching models, but its economic impact will indirectly affect the employment of higher education students and the financial support of higher education institutions, in other words, the innovation base of education and the composition of the future labor market (Cao et al., 2020; Farnell et al., 2021).

To address the research question, "What were the major purposes, methodologies, outcomes, and limitations of digital competence studies in educational contexts in relation to COVID-19?," we first reviewed and analyzed the research purposes of 23 selected publications. It is noted that most research on digital competence in the educational context related to COVID-19 focused on the current state of digital competence of faculty and students. In the wake of the pandemic, the current state of digital competence of faculty and students in different pedagogical models has led to concerns (Dias-Trindade et al., 2021; Eri et al., 2021; Lobo and Dhuri, 2021; Martzoukou et al., 2021). The exploration and the investigation of digital competence is no longer in its infancy-nine publications investigated factors that could affect digital competence and four of them explored the impact of digital competence on participants' achievement. Following the penetration of COVID-19 into education, the academic community became more concerned with what factors could influence digital competencies and explored the relationship between digital competence and students' achievement as a way of addressing the challenges of education in the context of the pandemic and ensuring the quality of education (Adedoyin and Soykan, 2020). Since such transformations were prompted by the crisis in a significant way, educational institutions, teachers and students were not necessarily well prepared (Ewing and Cooper, 2021).

In terms of the methodology employed for research, it is notable that most selected articles were conducted in the form of questionnaires, following a quantitative methodology. This tendency or preference for quantitative methods was also observed by Perdomo et al. (2020).

Concerning the research outcomes, they were analyzed as they presented an update on the situation and the most recent progress made after the emergence of COVID-19. First, faculty and students' digital competence are still at a basic-intermediate level, although they now have an enhanced digital awareness and digital readiness in the teaching and learning process. These results are consistent with the conclusions drawn by Jogezai et al. (2023) in their study on digital competence in the post COVID-19. Some of them perceived themselves at a good level in certain areas; however, many of them continue to feel inadequate in different areas due to the characteristics of the roles of teachers and students in education. Some faculty considered their digital competences in the area of information and data literacy, communication and collaboration, safety and problem solving to be positive, while they felt overwhelmed when tasks became complex. This corresponds with the results obtained by Zhao et al. (2021a) describing digital competence in higher education from 2015 to 2021 (before the COVID-19 pandemic). Students were skilled in the use of ICT tools and used them extensively, but when these skills reached the pedagogical level, they were not sufficiently able to evaluate and critique resources and information. This is consistent with the early observations of the Sánchez-Caballé et al. (2020) studies, which stated that students' use of digital tools did not automatically make them digitally competent. Also, the importance of training in ICT and digital competence have been emphasized, along with the analysis from Fernández-Batanero et al. (2021) of the literature on digital pedagogical competence in the decade prior to the emergence of the pandemic. In contrast to what was found during the pandemic by Zheng et al. (2020), that there was the negative impact of the COVID-19 pandemic on students' self-perception of digital competence. As mentioned by many studies, various gender divides and barriers in the digital transformation process had been revealed (Iivari et al., 2020; Onyema et al., 2020). Several factors that could affect digital competence were also listed and presented. Moreover, a positive relationship between digital competence and students' achievement was found, which was confirmed by several studies in different educational contexts as well (Kim et al., 2019; Mehrvarz et al., 2021). Studies have shown that teachers and students have gradually adapted to an increasingly digitalized learning environment (Khlaif et al., 2021; Siddiq et al., 2024). However, there are still significant differences in the competence of teachers and students in these areas across educational institutions and educational environments where online or blended learning is taking place (Howard et al., 2021). Educational institutions across the globe are continuously adapting and updating educational policies and curricula to incorporate digital competence and 21st-century skills as part of compulsory national education, while the worldwide trends in education report proposed by Organization for Economic Co-operation and Development (OECD) notes the need for teachers to be prepared to demonstrate greater expertise in using advanced technology during the post-epidemic era (OECD, 2023). Therefore, there is a need for research to compare the various situations. With an in-depth analysis of teachers' and students' digital competence, this review provided valuable guidance for the development of educational institutions' strategies and curricula. Institutions should design personalized and tiered training programs based on the actual needs of teachers and students, particularly in areas such as creating digital content and handling complex tasks, to enhance their overall digital competence. These points are also proposed and emphasized by the selected articles (Sánchez-Cruzado et al., 2021; Zhao et al., 2021b). Additionally, these research findings highlighted the gender divide and technological barriers encountered during the digital transformation process. Educational policies and curricula must address these challenges, especially in the post-pandemic era, where the digital transformation of education will have significant implications for both quality and equity. Therefore, educational institutions must continue to prioritize the development of long-term, sustainable strategies for digital competence to guarantee equal opportunities for digital empowerment for both students and teachers (Hossein-Mohand et al., 2021; Schina et al., 2020).

Regarding the research limitations identified in the selected publications, the most common limitations encountered were the sample size, the implementation of data collection method and the formulation of research aims and objectives. Future research is recommended to consider the sample size and diversity of the participants in the study, to avoid employing a single research method and to specify research aims and objectives to improve the level of focus of the study.

5 Limitations

This systematic literature review provides the academic community, in the context of the COVID-19 pandemic, a description of the current state of digital competence of faculty and students, an exploration of the factors influencing the development of digital competence and the impact of the pandemic on digital competence in education, as well as an observation on research trends in this subject. This is not without limitations. First, there were only two data bases included for selecting publications, even though WoS and Scopus are the two bibliographic databases that are generally considered to be the most comprehensive sources of data (Zhu and Liu, 2020). Further review it is recommended that the database search be expanded. In addition, since only original articles were selected for this review, literature such as policy reports, institutional research, and government documents could be given consideration in the future, providing us with different perspectives and a more in-depth understanding of how digital competence is being developed and measured in practice. Secondly, the language of the publications was limited to English, despite the inclusion of English or non-English speaking subjects, but some articles on digital competence in education and related to COVID-19 published in other languages were not included. It was also suggested that considering multilingual studies in future reviews that would provide a more balanced perspective. Third, in order to specify the scope of the publications, terms related to the COVID-19 were added in the search string. Other articles on the subject published during the pandemic but without explicit COVID-19-related terms in the title, keywords or abstract might have been omitted.

6 Identified gaps and future research recommendation

This systematic literature review identified several gaps in the research and proposed recommendations for any future research on developing digital competence in education in a pandemic context. Firstly, most studies concentrated on faculty and students' digital competence development. With the effects of the pandemic, digital technology accelerated and penetrated more widely and deeply into education. It is crucial to consider other roles involved in the education process as well. Moreover, instead of focusing at the university and secondary educational levels, participants from the Master degree level could be taken into account in the future studies as the number of postgraduate students is gradually increasing. Furthermore, most of the studies were carried out in a formal educational context. The pandemic brought a widespread and immediate impact on education, and forced institutions to make an urgent transition to emergency distance learning, in which lessons were taught beyond the classroom (OECD, 2021a, 2021b). Exploring digital competence in the informal educational context would contribute to a better understanding of digital competence during the pandemic.

Second, the majority of studies have investigated participants' perceptions and levels of digital competence through self-reported data, which may not reflect their true level of digital competence. It is recommended that future research designs and applications incorporate objective assessments of digital competence, such as practical digital task tests, which can more accurately reflect actual skills and knowledge and examine the actual state of their digital competence. Many studies have explored factors that could affect digital competence, and the positive impact of digital competence on students' academic achievement has been demonstrated. Combined with the results of this review, which shows that teachers and students are at a basic-intermediate level of digital competence, the question of how to improve the digital competence of teachers and students in a pandemic situation, and what effective pedagogical approaches should be engaged and followed to ensure quality education, are issues that need to be explored in depth.

Third, based on the findings of this review, there were a number of publications that employed only one research method and pointed out the limitations of research on data. It is suggested that in future studies, mixed methods of collecting quantitative and qualitative data be applied in order to have a more comprehensive understanding of the topic and to consider a representative research sample.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Author contributions

YZ: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Resources, Software, Validation, Visualization, Writing – original draft, Writing – review & editing. MS-G: Data curation, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Writing – review & editing. AP-L: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Resources, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. RS: Conceptualization, Funding acquisition, Investigation, Methodology, Project administration, Resources, Supervision, Validation, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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References

Adedoyin, O. B., and Soykan, E. (2020). COVID-19 pandemic and online learning: the challenges and opportunities. *Interact. Learn. Environ.* 31, 863–875. doi: 10.1080/10494820.2020.1813180

Adeshola, I., and Adepoju, A. P. (2024). The opportunities and challenges of ChatGPT in education. Interactive Learning. *Environments*. 32, 6159–6172.

Aghaei Chadegani, A., Salehi, H., Yunus, M., Farhadi, H., Fooladi, M., Farhadi, M., et al. (2013). A comparison between two main academic literature collections: web of science and Scopus databases. *Asian Soc. Sci.* 9, 18–26. doi: 10.5539/ass.v9n5p18

Ali, W. (2020). Online and remote learning in higher education institutes: a necessity in light of COVID-19 pandemic. *High. Educ. Stud.* 10, 16–25. doi: 10.5539/hes.v10n3p16

Anam, R. S., Sukardi, R. R., Handayani, M., Anantanukulwong, R., and Jajuri, T. (2025). Prospective primary school teachers' understanding of model representation: the case of static electricity. *IJIS Educ.* 7, 125–143. doi: 10.29300/ijisedu.v7i1.5009

Antonopoulou, H., Halkiopoulos, C., Barlou, O., and Beligiannis, G. N. (2021). Transformational leadership and digital skills in higher education institutes: during the COVID-19 pandemic. *Emerg. Sci. J.* 5, 1–15. doi: 10.28991/esj-2021-01252

Bachmann, N., Rose, R., Maul, V., and Hölzle, K. (2024). What makes for future entrepreneurs? The role of digital competencies for entrepreneurial intention. *J. Bus. Res.* 174:114481. doi: 10.1016/j.jbusres.2023.114481

Beardsley, M., Albó, L., Aragón, P., and Hernández-Leo, D. (2021). Emergency education effects on teacher abilities and motivation to use digital technologies. *Br. J. Educ. Technol.* 52, 1455–1477. doi: 10.1111/bjet.13101

Betancourt-Odio, M. A., Sartor-Harada, A., Ulloa-Guerra, O., and Azevedo-Gomes, J. (2021). Self-perceptions on digital competences for m-learning and education sustainability: a study with teachers from different countries. *Sustain. For.* 13:343. doi: 10.4025/actascitechnol.v43i1.5638

Bojórquez-Roque, M. S., Garcia-Cabot, A., Garcia-Lopez, E., and Oliva-Córdova, L. M. (2024). Digital competence learning ecosystem in higher education: A mapping and systematic review of the literature. *IEEE Access* 12, 87596–87614. doi: 10.1109/ACCESS.2024.3416906

Cabero-Almenara, J., Barroso-Osuna, J., Gutiérrez-Castillo, J. J., and Palacios-Rodríguez, A. (2021). The teaching digital competence of health sciences teachers. A study at Andalusian universities (Spain). *Int. J. Environ. Res. Public Health* 18:2552. doi: 10.3390/ijerph18052552

Cabezas-González, M., Casillas-Martín, S., and Muñoz-Repiso, A. G. V. (2021). Basic education students' digital competence in the area of communication: the influence of online communication and the use of social networks. *Sustain. For.* 13:4442. doi: 10.3390/su13084442

Calvani, A., Fini, A., Ranieri, M., and Picci, P. (2012). Are young generations in secondary school digitally competent? A study on Italian teenagers. *Comput. Educ.* 58, 797–807. doi: 10.1016/j.compedu.2011.10.004

Cao, W., Fang, Z., Hou, G., Han, M., Xu, X., Dong, J., et al. (2020). The psychological impact of the COVID-19 epidemic on college students in China. *Psychiatry Res.* 287:112934. doi: 10.1016/j.psychres.2020.112934

Carretero Gómez, S., Napierala, J., Bessios, A., Mägi, E., Pugacewicz, A., Ranieri, M., et al. (2021). What did we learn from school-ing practices during the COVID- 19 lockdown. Luxembourg: Publications Office of the European Union.

Carretero Gómez, S., Vuorikari, R., and Punie, Y. (2017). DigComp 2.1: The digital competence framework for citizens with eight proficiency levels and examples of use. Luxembourg: Publications Office of the European Union.

China Internet Network Information Center. (2021). The 48th China statistical report on internet development. Available online at: http://n2.sinaimg.cn/finance/a2d36afe/20210827/FuJian1.pdf (Accessed December 28, 2023).

Codina, L. (2015). No lo llame Análisis Bibliográfico, llámelo Revisión Sistematizada. Y cómo llevarla a cabo con garantías: Systematized Reviews + SALSA Framework. Available online at: https://www.lluiscodina.com/revision-sistematica-salsa-framework/ (Accessed December 05, 2023).

Council of the European Union (2018). Council recommendation of 22 may 2018 on key competences for lifelong learning (2018/C 189/01). *Offic. J. Eur. Union. C* 189, 1–13.

Crompton, H., and Burke, D. (2018). The use of mobile learning in higher education: a systematic review. *Comput. Educ.* 123, 53–64. doi: 10.1016/j.compedu.2018.04.007

Cyberspace Administration of China. (2020). Digital China development report 2020. Available online at: http://www.cac.gov.cn/2021-06/28/c_1626464503226700.htm (Accessed January 02, 2024).

D'Ignazio, A., Finaldi Russo, P., and Stacchini, M. (2025). Micro-entrepreneurs' financial and digital competences during the pandemic in Italy. *Ital. Econ. J.*, 1–37. doi: 10.1007/s40797-024-00306-1

Dias-Trindade, S., Moreira, J. A., and Ferreira, A. G. (2021). Evaluation of the teachers' digital competences in primary and secondary education in Portugal with digcompedu checkin in pandemic times. *Acta Scientiarum Technol.* doi: 10.4025/actascitechnol.v43i1.56383

Durán, M., Gutiérrez, I., and Prendes, M. P. (2016). Análisis conceptual de modelos de competencia digital del profesorado universitario. *RELATEC* 15, 97–114. doi: 10.17398/1695-288X.15.1.97

Eri, R., Gudimetla, P., Star, S., Rowlands, J., and Girgla, A. (2021). Digital resilience in higher education in response to COVID-19 pandemic: student perceptions from Asia and Australia. *J. Univ. Teach. Learn. Pract.* 18, 108–134. doi: 10.53761/1.18.5.7

Estanyol, E., Montaña, M., Fernández-de-Castro, P., Aranda, D., and Mohammadi, L. (2023). Digital competence among young people in Spain: a gender divide analysis. *Comunicar* 31, 113–123. doi: 10.3916/C74-2023-09

Esteve-Mon, F. M., Llopis-Nebot, M. A., and Adell-Segura, J. (2020). Digital teaching competence of university teachers: a systematic review of the literature. *IEEE Revista Iberoamericana Tecnol. Aprendizaje* 15, 399–406. doi: 10.1109/RITA.2020.3033225

European Commission. (2021). Digital competence framework for citizens. Available online at: https://ec.europa.eu/jrc/en/digcomp (Accessed October 19, 2023).

European Union. (2020). Digital education action plan, 2021-2027. Available online at: Retrieved from https://ec.europa.eu/education/education-in-the-eu/digital-education-action-plan_en (Accessed November 28, 2023).

Ewing, L. A., and Cooper, H. B. (2021). Technology-enabled remote learning during COVID-19: perspectives of Australian teachers, students and parents. *Technol. Pedagog. Educ.* 30, 41–57. doi: 10.1080/1475939X.2020.1868562

Farnell, T., Skledar Matijevic, A., and Šcukanec Schmidt, N. (2021). The impact of COVID-19 on higher education: A review of emerging evidence. Analytical Report. European Commission.

Fernández-Batanero, J. M., Román-Graván, P., Montenegro-Rueda, M., López-Meneses, E., and Fernández-Cerero, J. (2021). Digital teaching competence in higher education: a systematic review. *Educ. Sci.* 11:689. doi: 10.3390/educsci11110689

Ferrari, A. (2012). Digital competence in practice: an analysis of frameworks. Available online at: https://pdfs.semanticscholar.org/851f/ebe72df176a16ad6e26b00ff5df35520da34.pdf (Accessed September 12, 2023).

García-Peñalvo, F. J. (2017). Mapeos sistemáticos de literatura, revisiones sistemáticas de literatura y benchmarking de programas formativos. Available online at: https://repositorio.grial.eu/bitstream/grial/1056/3/Mapping.pdf (Accessed August 07, 2023).

Gilster, P. (1997). Digital Literacy. New York, NY: John Wiley & Sons, Inc.

Gough, D., Oliver, S., and Thomas, J. (2017). An introduction to systematic reviews. London: Sage.

Government of Spain. (2020). 2025 digital Spain plan. Available online at: https://portal.mineco.gob.es/en-us/ministerio/estrategias/Pages/00_Espana_Digital_2025.aspx (Accessed November 12, 2023).

Guillén-Gámez, F. D., Gómez-García, M., and Ruiz-Palmero, J. (2024). Digital competence in research work: predictors that have an impact on it according to the type of university and gender of the higher education teacher: digital competence in research work: predictors that have an impact on it according to the type of university and gender of the higher education teacher. *Revista Medios Educ.* 69, 7–34. doi: 10.12795/pixelbit.99992

Hair, J. F., Hult, G. T. M., Ringle, C. M., and Sarstedt, M. (2021). A primer on partial least squares structural equation modeling (PLS-SEM). Thousand Oaks, CA: Sage publications.

Heidari, E., Mehrvarz, M., Marzooghi, R., and Stoyanov, S. (2021). The role of digital informal learning in the relationship between students' digital competence and academic engagement during the COVID-19 pandemic. *J. Comput. Assist. Learn.* 37, 1154–1166. doi: 10.1111/jcal.12553

Hossein-Mohand, H., Gómez-García, M., Trujillo-Torres, J. M., Hossein-Mohand, H., and Boumadan-Hamed, M. (2021). Uses and resources of technologies by mathematics students prior to COVID-19. *Sustain. For.* 13:1630. doi: 10.3390/su13041630

Howard, S. K., Tondeur, J., Siddiq, F., and Scherer, R. (2021). Ready, set, go! Profiling teachers' readiness for online teaching in secondary education. *Technol. Pedagog. Educ.* 30, 141–158. doi: 10.1080/1475939X.2020.1839543

Huber, S. G., and Helm, C. (2020). COVID-19 and schooling: evaluation, assessment and accountability in times of crises—reacting quickly to explore key issues for policy, practice and research with the school barometer. *Educ. Assess. Eval. Account.* 32, 237–270. doi: 10.1007/s11092-020-09322-y

Iansiti, M., and Richards, G. (2020). Coronavirus is widening the corporate digital divide. Available online at: https://hbr.org/2020/03/coronavirus-is-widening-the-corporate-digital-divide (Accessed January 03, 2024).

Iivari, N., Sharma, S., and Ventä-Olkkonen, L. (2020). Digital transformation of everyday life–how COVID-19 pandemic transformed the basic education of the young generation and why information management research should care? *Int. J. Inf. Manag.* 55:102183. doi: 10.1016/j.ijinfomgt.2020.102183

Ilomäki, L., Kantosalo, A., and Lakkala, M. (2011). What is digital competence? In linked portal. Brussels: European Schoolnet.

INTEF. (2017). Common digital competence framework for teachers. Available online at: https://aprende.intef.es/sites/default/files/2018-05/2017_1024-Common-Digital-Competence-Framework-For-Teachers.pdf (Accessed September 26, 2023).

Iordache, C., Mariën, I., and Baelden, D. (2017). Developing digital skills and competences: a quick- scan analysis of 13 digital literacy models. *Italian J. Sociol. Educ.* 9, 6–30. doi: 10.14658/pupj-ijse-2017-1-2

Jang, M., Aavakare, M., Nikou, S., and Kim, S. (2021). The impact of literacy on intention to use digital technology for learning: a comparative study of Korea and Finland. *Telecommun. Policy* 45:102154. doi: 10.1016/j.telpol.2021.102154

Janssen, J., Stoyanov, S., Ferrari, A., Punie, Y., Pannekeet, K., and Sloep, P. (2013). Experts' views on digital competence: commonalities and differences. *Comput. Educ.* 68, 473–481. doi: 10.1016/j.compedu.2013.06.008

JISC. (2014). Developing digital literacies: Provides ideas and resources to inspire the strategic development of digital literacies - those capabilities which support living, learning and working in a digital society. JISC. Available online at: https://www.jisc.ac.uk/full-guide/developing-digital-literacies (Accessed September 07, 2023).

Jogezai, N. A., Koroleva, D., and Baloch, F. A. (2023). Teachers' digital competence in the post COVID-19 era: the effects of digital nativeness, and digital leadership capital. Contemporary. *Educ. Technol.* 15:ep466. doi: 10.30935/cedtech/13620

Kalimullina, O., Tarman, B., and Stepanova, I. (2021). Education in the context of digitalization and culture: evolution of the Teacher's role, pre-pandemic overview. *J. Ethnic Cult. Stud.* 8, 226–238. doi: 10.29333/ejecs/629

Kalogeratos, G., Lourida, K., Anastasopoulou, E., Tsogka, D., and Pierrakeas, C. (2024). "Gender and age as factors affecting the digital skills of primary school principals" in INTED2024 proceedings (Valencia: IATED), 1643–1651.

Khlaif, Z. N., Salha, S., Affouneh, S., Rashed, H., and ElKimishy, L. A. (2021). The Covid-19 epidemic: teachers' responses to school closure in developing countries. *Technol. Pedagog. Educ.* 30, 95–109. doi: 10.1080/1475939X.2020.1851752

Khoo, C., Yang, E. C. L., Tan, R. Y. Y., Alonso-Vazquez, M., Ricaurte-Quijano, C., Pécot, M., et al. (2024). Opportunities and challenges of digital competencies for women tourism entrepreneurs in Latin America: a gendered perspective. *J. Sustain. Tour.* 32, 519–539. doi: 10.1080/09669582.2023.2189622

Kim, H. J., Hong, A. J., and Song, H. D. (2019). The roles of academic engagement and digital readiness in students' achievements in university e-learning environments. *Int. J. Educ. Technol. High. Educ.* 16, 1–18. doi: 10.1186/s41239-019-0152-3

Kitchenham, B., and Charters, S. (2007). Guidelines for performing systematic literature reviews in software engineering. Available online at: https://userpages.uni-koblenz.de/~laemmel/esecourse/slides/slr.pdf (Accessed September 11, 2023).

Kulju, E., Jarva, E., Oikarinen, A., Hammarén, M., Kanste, O., and Mikkonen, K. (2024). Educational interventions and their effects on healthcare professionals' digital competence development: a systematic review. *Int. J. Med. Inform.* 185:105396. doi: 10.1016/j.ijmedinf.2024.105396

Law, N., Woo, D., de la Torre, J., and Wong, G. (2018). A global framework of reference on digital literacy skills for indicator 4.4.2. Unesco Institute for Statistics. Available online at: http://uis.unesco.org/sites/default/files/documents/ip51-global-framework-reference-digital-literacy-skills-2018-en.pdf (Accessed November 01, 2023).

Li, C., and Lalani, F. (2020). The COVID-19 pandemic has changed education forever. This is how. In World economic forum (Vol. 29). Available online at: https://www.weforum.org/agenda/2020/04/coronavirus-education-global-covid19-online-digital-learning/ (Accessed February 01, 2024).

Lobo, J., and Dhuri, K. R. (2021). Positive impact of Covid-19 pandemic in enhancing digital literacy skills among library professionals: a study. *Libr. Philos. Pract.*, 1–18.

Lorente, L. M. L., Arrabal, A. A., and Pulido-Montes, C. (2020). The right to education and ict during covid-19: an international perspective. *Sustain. For.* 12:9091. doi: 10.3390/su12219091

Luthfia, A., Wibowo, D., Widyakusumastuti, M. A., and Angeline, M. (2021). The role of digital literacy on online opportunity and online risk in Indonesian youth. *Asian J. Public Opin. Res.* 9, 142–160. doi: 10.15206/ajpor.2021.9.2.142

Martzoukou, K. (2020). Academic libraries in COVID-19: A renewed mission for digital literacy: Library Management.

Martzoukou, K., Kostagiolas, P., Lavranos, C., Lauterbach, T., and Fulton, C. (2021). A study of university law students' self-perceived digital competences. *J. Librariansh. Inf. Sci.* 54:09610006211048004.

Mehrvarz, M., Heidari, E., Farrokhnia, M., and Noroozi, O. (2021). The mediating role of digital informal learning in the relationship between students' digital competence and their academic performance. *Comput. Educ.* 167:104184. doi: 10.1016/j.compedu.2021.104184

Mishra, P., and Koehler, M. J. (2006). Technological pedagogical content knowledge: a framework for teacher knowledge. *Teach. Coll. Rec.* 108, 1017–1054. doi: 10.1111/j.1467-9620.2006.00684.x

Moher, D., Liberati, A., Tetzlaff, J., and Altman, D. G.Prisma Group (2009). Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *PLoS Med.* 6:e1000097.

Naresh, R. (2020). Education after COVID-19 crisis based on ICT tools. *Purakala* 31, 464–468. doi: 10.1186/s41239-0170070-1

Nguyen, T. H. C. (2024). Exploring the role of artificial intelligence-powered facilitator in enhancing digital competencies of primary school teachers. *Eur. J. Educ. Res.* 13, 219–231. doi: 10.12973/eu-jer.13.1.219

OECD. (2005). The definition and selection of key competencies. Executive summary. Available online at: http://www.oecd.org/dataoecd/47/61/35070367.pdf (Accessed December 11, 2023).

OECD (2021a). The state of global education: 18 months into the pandemic. Paris: OECD Publishing.

OECD (2021b). The state of higher education: one year in to the COVID-19 pandemic. Paris: OECD Publishing.

OECD (2023). Education at a glance 2023: OECD indicators. Paris: OECD Publishing.

Onyema, E. M., Eucheria, N. C., Obafemi, F. A., Sen, S., Atonye, F. G., Sharma, A., et al. (2020). Impact of coronavirus pandemic on education. *J. Educ. Pract.* 11, 108–121. doi: 10.7176/JEP/11-13-12

Opt Roodt, H., Bracht, E. M., van Dick, R., and Hernandez Bark, A. S. (2025). Navigating through the digital workplace: measuring leader digital competence. *J. Bus. Psychol.* 40, 179–205. doi: 10.1007/s10869-024-09947-6

Perdomo, B., González-Martínez, O. A., and Barrutia Barreto, I. (2020). Digital competences in faculties: a systematic review. *EDMETIC* 9, 92–115. doi: 10.21071/edmetic.v9i2.12796

Perifanou, M., Economides, A. A., and Tzafilkou, K. (2021). Teachers' digital skills readiness during COVID-19 pandemic. *Int. J. Emerg. Technol. Learn.* 16:238. doi: 10.3991/ijet.v16i08.21011

Pettersson, F. (2018). On the issues of digital competence in educational contexts–a review of literature. *Educ. Inf. Technol.* 23, 1005–1021. doi: 10.1007/s10639-017-9649-3

Portillo, J., and de la Serna, A. L. (2021). An international perspective for 'improving teacher professional development for online and blended learning: a systematic meta-aggregative review'. *Educ. Technol. Res. Dev.* 69, 25–28. doi: 10.1007/s11423-020-09851-9

Portillo, J., Garay, U., Tejada, E., and Bilbao, N. (2020). Self-perception of the digital competence of educators during the COVID-19 pandemic: a cross-analysis of different educational stages. *Sustain. For.* 12:10128. doi: 10.3390/su122310128

Prensky, M. (2001). Digital natives, digital immigrants part 2: do they really think differently? *Horizon* 9, 1–6. doi: 10.1108/10748120110424816

Rafiq, M., Batool, S. H., Ali, A. F., and Ullah, M. (2021). University libraries response to COVID-19 pandemic: a developing country perspective. *J. Acad. Librariansh.* 47:102280. doi: 10.1016/j.acalib.2020.102280

Redecker, C. (2017). European framework for the digital competence of educators: DigCompEdu. Luxembourg: Publications Office of the European Union.

Ren, S. S., Xu, W. Z., Chen, Z., and Chen, J. J. (2025). Digital competency among pediatric healthcare workers and students: a questionnaire survey. *World J. Pediatr.* 21, 1–7. doi: 10.1007/s12519-024-00866-3

Rodríguez-Moreno, J., Ortiz-Colón, A. M., Cordón-Pozo, E., and Agreda-Montoro, M. (2021). The influence of digital tools and social networks on the digital competence of university students during COVID-19 pandemic. *Int. J. Environ. Res. Public Health* 18:2835. doi: 10.3390/ijerph18062835

Rodríguez-Muñiz, L. J., Burón, D., Aguilar-González, Á., and Muñiz-Rodríguez, L. (2021). Secondary mathematics teachers' perception of their readiness for emergency remote teaching during the COVID-19 pandemic: a case study. *Educ. Sci.* 11:228. doi: 10.3390/educsci11050228

Rodríguez-Triana, M. J., Prieto, L. P., Ley, T., de Jong, T., and Gillet, D. (2020). Social practices in teacher knowledge creation and innovation adoption: a large-scale study in an online instructional design community for inquiry learning. *Int. J. Comput.-Support. Collab. Learn.* 15, 445–467. doi: 10.1007/s11412-020-09331-5

Romero-Tena, R., Llorente-Cejudo, C., Puig-Gutiérrez, M., and Barragán-Sánchez, R. (2021). The pandemic and changes in the self-perception of teacher digital competences of infant grade students: a cross sectional study. *Int. J. Environ. Res. Public Health* 18:4756. doi: 10.3390/ijerph18094756

Rundel, C., and Salemink, K. (2021). Bridging digital inequalities in rural schools in Germany: a geographical lottery? *Educ. Sci.* 11:181. doi: 10.3390/educsci11040181

Sales, D., Cuevas-Cerveró, A., and Gómez-Hernández, J. A. (2020). Perspectives on the information and digital competence of social sciences students and faculty before and during lockdown due to Covid-19. *Profes. Inform.* 29, 1–20. doi: 10.3145/epi.2020.jul.23

Sánchez-Caballé, A., Gisbert-Cervera, M., and Esteve-Mon, F. (2020). The digital competence of university students: a systematic literature review. *Aloma* 38, 63–74. doi: 10.51698/aloma.2020.38.1.63-74

Sánchez-Cruzado, C., Santiago Campión, R., and Sánchez-Compaña, M. (2021). Teacher digital literacy: the indisputable challenge after COVID-19. *Sustain. For.* 13:1858. doi: 10.3390/su13041858

Schina, D., Esteve-González, V., Usart, M., Lázaro-Cantabrana, J. L., and Gisbert, M. (2020). The integration of sustainable development goals in educational robotics: a teacher education experience. *Sustain. For.* 12:10085. doi: 10.3390/su122310085

Schleicher, A. (2020). The impact of COVID-19 on education insights from education at a glance 2020. Available online at: https://www.oecd.org/education/the-impact-ofcovid-19-on-education-insights-education-at-a-glance-2020.pdf (Accessed December 21, 2023).

Sholikah, M. A., and Harsono, D. (2021). Enhancing student involvement based on adoption Mobile learning innovation as interactive multimedia. *Int. J. Interact. Mobile Technol.* 15, 101–118 doi: 10.3991/ijim.v15i08.19777

Siddiq, F., Hatlevik, O. E., Olsen, R. V., Throndsen, I., and Scherer, R. (2016). Taking a future perspective by learning from the past–a systematic review of assessment instruments that aim to measure primary and secondary school students' ICT literacy. *Educ. Res. Rev.* 19, 58–84. doi: 10.1016/j.edurev.2016.05.002

Siddiq, F., Olofsson, A. D., Lindberg, J. O., and Tomczyk, L. (2024). What will be the new normal? Digital competence and 21st-century skills: critical and emergent issues in education. *Educ. Inf. Technol.* 29, 7697–7705. doi: 10.1007/s10639-023-12067-y

Sillat, L. H., Tammets, K., and Laanpere, M. (2021). Digital competence assessment methods in higher education: a systematic literature review. *Educ. Sci.* 11:402. doi: 10.3390/educsci11080402

Spante, M., Hashemi, S. S., Lundin, M., and Algers, A. (2018). Digital competence and digital literacy in higher education research: systematic review of concept use. *Cogent Educ.* 5:1519143. doi: 10.1080/2331186X.2018.1519143

Su, J., and Yang, W. (2024). Digital competence in early childhood education: a systematic review. *Educ. Inf. Technol.* 29, 4885–4933. doi: 10.1007/s10639-023-11972-6

Tejedor, S., Cervi, L., Pérez-Escoda, A., and Jumbo, F. T. (2020). Digital literacy and higher education during COVID-19 lockdown: Spain, Italy, and Ecuador. *Publica* 8:48. doi: 10.3390/publications8040048

Tran, T., Ho, M. T., Pham, T. H., Nguyen, M. H., Nguyen, K. L. P., Vuong, T. T., et al. (2020). How digital natives learn and thrive in the digital age: evidence from an emerging economy. *Sustain. For.* 12:3819. doi: 10.3390/su12093819

Trubavina, I., Dotsenko, S., Naboka, O., Chaikovskyi, M., and Meshko, H. (2021). Developing digital competence of teachers of humanitarian disciplines in the conditions of COVID-19 quarantine measures. *J. Phys. Conf. Ser.* 1840:012052. doi: 10.1088/1742-6596/1840/1/012052

UNESCO. (2020a). Distance learning solutions. Available online at: https://en.unesco.org/covid19/educationresponse/solutions (Accessed December 29, 2023).

UNESCO. (2020b). National learning platforms and tools. Available online at: https://en.unesco.org/covid19/educationresponse/nationalresponses#WESTERN%20EUROPE%20&%20NORTH%20AMERICA (Accessed January 24, 2024).

UNESCO & UIS. (2017). Global alliance to monitor learning (GAML): concept paper. Available online at: http://gaml.uis.unesco.org/wp-content/uploads/sites/2/2018/10/gaml-concept_paper-2017-en2_0.pdf (Accessed November 27, 2023).

Urrútia, G., and Bonfill, X. (2010). Declaración PRISMA: una propuesta para mejorar la publicación de revisiones sistemáticas y metaanálisis. *Med. Clin.* 135, 507–511. doi: 10.1016/j.medcli.2010.01.015

Vuorikari, R., Kluzer, S., and Punie, Y. (2022). DigComp 2.2, the digital competence framework for citizens: With new examples of knowledge, skills and attitudes. Luxembourg: Publications Office of the European Union.

Vuorikari, R., Punie, Y., Gomez, S. C., and Van Den Brande, G. (2016). DigComp 2.0: the digital competence framework for citizens. Update phase 1: the conceptual reference model (no. JRC101254). Joint Research Centre (Seville site). Available online at: https://publications.jrc.ec.europa.eu/repository/handle/JRC101254 (Accessed August 09, 2023).

Wang, X., Zhang, R., Wang, Z., and Li, T. (2021). How does digital competence preserve university students' psychological well-being during the pandemic? An investigation from self-determined theory. *Front. Psychol.* 12:1252. doi: 10.3389/fpsyg.2021.652594

Zhao, Y., Pinto-Llorente, A. M., and Sánchez Gómez, M. C. (2021a). Digital competence in higher education research: a systematic literature review. *Comput. Educ.* 168, 104212–104214. doi: 10.1016/j.compedu.2021.104212

Zhao, Y., Pinto-Llorente, A. M., Sánchez Gómez, M. C., and Zhao, L. (2021b). The impact of gender and years of teaching experience on college teachers' digital competence: an empirical study on teachers in Gansu agricultural university. *Sustain. For.* 13:4163. doi: 10.3390/su13084163

Zheng, F., Khan, N. A., and Hussain, S. (2020). The COVID 19 pandemic and digital higher education: exploring the impact of proactive personality on social capital through internet self-efficacy and online interaction quality. *Child Youth Serv. Rev.* 119:105694. doi: 10.1016/j.childyouth.2020.105694

Zhu, J., and Liu, W. (2020). A tale of two databases: the use of web of science and Scopus in academic papers. *Scientometrics* 123, 321–335. doi: 10.1007/s11192-020-03387-8