Digital literacy in the university setting: A literature review of empirical studies between 2010 and 2021

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The impact of digital devices and the Internet has generated various changes at social, political, and economic levels, the repercussion of which is a great challenge characterized by the changing and globalized nature of today’s society. This demands the development of new skills and new learning models in relation to information and communication technologies. Universities must respond to these social demands in the training of their future professionals. This paper aims to analyze the empirical evidence provided by international studies in the last eleven years, related to the digital literacy of university students, including those pursuing degrees related to the field of education. Our findings highlight the fact that the digital literacy that is offered in universities to graduate/postgraduate students, in addition to treating digital literacy as a central theme, also focuses on perceived and developed self-efficacy. This is done by strengthening competencies related to digital writing and reading, the use of databases, the digital design of content and materials, and the skills to edit, publish or share them on the web, or applications aimed at treating digital literacy as emerging pedagogies and educational innovation. Secondly, we found studies related to digital competencies and use of the Internet, social networks, web, or the treatment of digital risks and their relationship with digital literacy. Thirdly, we found works that, in addition to focusing on digital literacy, also focused on different psychological constructs such as motivation, commitment, attitudes, or satisfaction.

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digital literacy, pre-service & teacher education, higher education, teachers’, transversal competences
Introduction

The concept of digital literacy (DL) appears for the first time in the works of Zurkowski (1974), for whom it is an ability to identify, locate, and examine information. However, despite its novelty, the conceptions it encompasses have been changing (Lim and Newby, 2021). Proof of this are the contributions of Gilster (1997) who combines the idea that DL is also closely linked to skills such as access, evaluation, and management of information used in learning processes. Digital learning is understood as the set of technical-procedural, cognitive, and socio-emotional skills necessary to live, learn, and work in a digital society (Eshet-Alkalai, 2012; European Commission, 2018). It is related to reading, writing, calculation skills, and effective use of technology in personal, social, and professional areas. It is also considered inseparable from the social and educational needs of the society in which we live (Larraz, 2013; Brata et al., 2022). Therefore, we refer to a concept that has several aspects including the technological aspect, the informative and multimedia aspect, and the communicative aspect. It involves a complete process and multiple literacies (Gisbert and Esteve, 2011; Lázaro, 2015; Valverde et al., 2022). It requires mastery of certain competencies related to the identification of training needs, access to information in digital environments, the use of ICT tools to manage information, interpretation, and representation of information, and the evaluation of information and the transmission of information (Covello and Lei, 2010; Walsh et al., 2022).

Digital literacy in university students

In recent years, society has undergone enormous changes with the digitalization of many of its spheres at the information level, the communication level, the level of knowledge acquisition, the level of the establishment of social relations, and even the level of leisure. Thus, our habits and means of accessing, managing, and transforming information have also changed (European Union, 2013; Cantabrana and Cervera, 2015; Allen et al., 2020; López-Meneses et al., 2018).

These developments have also had a great impact on the educational field, in which we have to rethink firstly what kind of students we are training in terms of the skills they need in today’s society, and secondly, whether we are training a profile of future teachers capable of training a student body that uses information and communication technologies as something inherent to their own personal and social development. In short, digital communication has changed practices related to literacy and has gained great relevance in the development of knowledge in the twenty-first century (Comisión Europea, 2012, 2013; European Commission, 2012; OECD, 2012; Unión Europea, 2013; Instituto Nacional de Tecnologías Educativas y Formación del Profesorado, 2017; Gudmundsdottir and Hatlevik, 2018; Pérez and Nagata, 2019; Fernández-de-la-Iglesia et al., 2020).

The European Commission (2013) indicates that initial teacher training (IDT) should integrate teachers’ digital literacy, betting on the pedagogical use of digital tools, enabling them to use them in an effective, appropriate, and contextualized manner. This teaching competence should be characterized by having a holistic, contextualized, performance-, function-, and development-oriented character. In short, it is about incorporating and adequately using ICT as a didactic resource (Cantabrana and Cervera, 2015; Castañeda et al., 2018; Tourón et al., 2018; Chow and Wong, 2020; Vodá et al., 2022).

In this sense, according to the work of Krumsvik (2009), the CDD (competencia digital docente de los profesores—digital competency training for teachers) is composed of four components: basic digital skills (Bawden, 2008), didactic competence with ICT (Koehler and Mishra, 2008; Gisbert and Esteve, 2011), learning strategies, and digital training or training.

While at the Spanish level, the Common Framework of Digital Teaching Competence of the National Institute of Educational Technologies and Teacher Training (INTEF, 2017) standardizes it in five areas: information and information literacy, communication and collaboration, digital content creation, security, and problem solving (López-Meneses et al., 2020). Recently, they have been consolidated as competencies that must be acquired by any university student, along with the knowledge, skills, and attitude that make up a digitally competent citizen (Recio et al., 2020; Indah et al., 2022).

Digital literacy in future teachers

Several efforts have been made to equip future teachers with these competencies through different standards and frameworks to the level of learning acquired (Fraser et al., 2013; INTEF, 2017; UNESCO, 2018). However, how to work these competencies in initial training is still a hotly debated topic, in which special attention is paid to the promotion of experiences of a pedagogical and innovative nature to transform teaching practices, involving the integration of technologies in the classroom, as stated in the Horizon Report 2019 for the Higher Education (Educause, 2019; Le et al., 2022).

Universities are in a moment of transformation, from a teacher-focused teaching model to a model based on active learning through the use of digital technologies, giving rise to a new type of education in which the use of digital devices is intrinsic (Area, 2018; Aarsand, 2019). If digital resources and devices are an inescapable part of current and future teaching practice, digital competency training for future teachers becomes extremely relevant, given that teachers need to acquire these competencies in their initial training to integrate them into their practices as future teachers. That is, the digital competence (DC) acquired during their initial training significantly predicts...
the integration of technologies in future teaching practice (Nikou and Aavakare, 2021), which could range from basic digital literacy to the integration of technologies in their daily teaching practice (Gisbert et al., 2016; Alanoglu et al., 2022). Several studies have defined the different indicators that make up DC (Siddiq et al., 2017; González et al., 2018; Rodríguez-García et al., 2019; Cabero-Almenara and Palacios-Rodríguez, 2020).

This calls for a new paradigm, in which future teachers must be digitally literate, in terms of the application of active methodologies, digital competencies, and the use of innovative strategies, styles, and approaches (Garcia-Martin and Garcia-Sanchez, 2017; Gómez-Garcia et al., 2021).

Currently, literacy workshops for future professionals are being carried out in a timely and precise manner from customized short training capsules to specific semester-long subjects in undergraduate or postgraduate studies. The training is focused on several specific aspects of digital literacy, but there is a lack of experience in imparting comprehensive digital training. In addition, there are just a few interactions with professional experts in such literacy (Ata and Yıldırım, 2019; Campbell and Kapp, 2020; Domingo-Coscolla et al., 2020; Tomczyk et al., 2020; Vinokurova et al., 2021).

The present study

For the present study, we based our approach on quality and current education, in which DC was postulated as a key element for the development of students. The educational system was tasked with preparing them for their full development and participation in society (OECD, 2011). For this reason, digital literacy is understood as an essential requirement for development in the society in which we live, based on the promotion of strategies related to searching, obtaining, processing, and communicating information. All these aspects have been consolidated as the dimensions of literacy in the twenty-first century (Piscitelli, 2009; Martin and Tyner, 2012). It is, therefore, necessary to understand the reality of this subject and to investigate how these practices are being developed in the context of work. And secondly, it is equally necessary to implement new interventions and lines of research that respond to this urgent need for literacy required by today’s society. Therefore, we posed the following research questions: What psychoeeducational and learning variables are key in digital literacy? What is the current situation internationally regarding digital literacy in all disciplines in pre-service teacher education? What are the differences in digital literacy requirements pre and post pandemic?

Objective

The objective of this study is to analyze the empirical evidence provided by international studies from 2010 to 2021 related to the digital literacy of university students, including those who are pursuing careers related to the educational field.

Relevant differences will be observed in the contributions in empirical evidence from international studies pre-post-pandemic, and drawn from diverse cultural backgrounds (Spanish-Latin, Portuguese, Finnish, etc.), gender, and personal digital resources.

Materials and methods

The systematic review is composed of four phases, following the model of Miller et al. (2016) and Scott et al. (2018).

PHASE 1: Search terms: In this phase, we developed a schematic of search terms from Web of Science and Scopus databases. We also accessed the databases to locate specific studies that were referenced in the publications that we found in the databases during our initial search. The schematic of terms and thematic axes that were used as a starting point for scanning both databases for anything related to the descriptor “digital” and the descriptor “literacy” is presented in Figure 1.

PHASE 2: Selection process based on inclusion and exclusion criteria. The following selection criteria were applied: year of publication between 2010 and 2021, availability of full text, and language of publication in English, Portuguese, or Spanish. Once the first results were obtained, they were selected based on title, abstract, and the use of standardized instruments in their methodology. We rejected the studies that used “ad hoc” instruments to measure digital competence.

In addition, the selection indicators provided by Cooper and Hedges (1994) and Cooper (2009) were used, such as peer-reviewed journals, referenced databases, and citation indexes.

PHASE 3: Analysis of methodological quality and indicators based on scientific evidence. Following Torgerson (2007) and Risko et al. (2008) and taking into consideration the MQQn (Risko et al., 2008), we used seven indicators to analyze the quality and effectiveness of the studies (Acosta and Garza, 2011). These were: alignment of theory, findings, reliability and validity, descriptive details of participants and the study, sample, and consistency of findings and conclusions with the data (Risko et al., 2008). Alternatively, evidence-based indicators were also used along with study effect sizes (Diaz and García, 2016; Canedo-García et al., 2017).

PHASE 4: Reliability and outcomes. Reliability was established for both the selection criteria and the coding criteria during each phase, to evidence the replicability of the results. In addition, the results entailed a qualitative analysis of the selected studies, the central arguments, and the evidence provided in a modulated way to address the research questions.

Therefore, the procedure to be followed was documented and charted according to the PRISMA statement (Moher et al., 2009; Page et al., 2021) (see Figure 2). Likewise, an analysis was
undertaken of the key foci in the various studies to highlight the relevant findings and evidence they provided in this regard. The key focus of our work was: first, to analyze the documents related to the digital literacy of university students; second, to identify which variables affect digital literacy; and third, to undertake a comparative analysis between the different variables that were analyzed.

Results

All the selected studies had as samples university students who were pursuing some type of degree or postgraduate degree related to education, and therefore, studying to become future teachers. An intervention design was presented that corresponds to a pre-intervention, the intervention itself, and a post-intervention using techniques such as the activation of prior knowledge, instructions, emulation, and subsequent tests. We also found studies that had an experimental design assessing control groups and experimental groups (Kajee and Balfour, 2011; Kuhn, 2017; Pequeño et al., 2017; Sharp, 2018; Lerdpornkulrat et al., 2019).

In the case of those responsible for the intervention, practically in all cases, the teacher acts as such, with one or two of them taking the lead. Although the presence of specialized personnel should also be highlighted, as is the case of the work elaborated by Alfonzo and Batson (2014) and Elliott et al. (2018) in which a professional librarian also intervened. Or, in the work detailed by Ball (2019), where a consultant who is not a teacher but a professional expert in the use of digital devices and trained for such an occasion by a responsible brand (Apple) carried out the training at the center.

If we examine the constructs or competencies covered by the works selected in our search, we find that all of them, in addition to dealing with digital literacy, also focus on self-efficacy perceived and developed through digital literacy.
FIGURE 2
Flowchart of search results of empirical studies in databases applying the criteria of Moher et al. (2009) and Page et al. (2021).
The results of our study could be understood under different themes.

First, we found studies that referred to digital competence and other educational issues. Within them, we found a series of competencies that are emphasized such as digital writing and reading. Research developed from digital media, such as databases, web, or applications aimed at the treatment of digital literacy was noted as emerging pedagogies and educational innovation. The digital design of content and materials and the skills to edit, publish or share them, and competencies related to mathematics and its digital literacy, formed part of digital literacy.

Second, we found studies related to digital competence and the use and employment of the Internet, social networks, web 2.0, and the treatment of digital risks and their relationship with digital literacy.

Third, we found works that in addition to focusing on digital literacy, also focused on different psychological constructs such as motivation, commitment, attitudes, or satisfaction (Tables 1, 2).

Regarding instructional literature, we found a large number of results on mass training programs or courses in which digital literacy was the focus. Examples include a course offered in which students could sign up to, or modules taught during the teaching of a subject. We also found investigations on interventions that had been carried out through different subjects in the study program from where the sample was taken. In this case, the samples were taken on an ad hoc basis from a specific student body which the researcher intentionally decided based on a previous intervention experience with them (Ata and Yıldırım, 2019; Ball, 2019; Campbell and Kapp, 2020; Domingo-Coscolla et al., 2020; Tomczyk et al., 2020; Vinokurova et al., 2021).

In terms of material resources, all the studies used some type of documentation (digital or not) with instructions on the development of the activities, in which the students were provided with what to do and the steps to follow. In this case, the development scenario was both online and face-to-face, based on different activities given through workshops or seminars for their development.

It should also be noted that in those investigations in which the intervention itself required a specific application or program, the same was used, specifically, and even the intervention had a specific scenario since it was carried out in person in specialized laboratories where experts and specific material was available for this purpose. As an example of these specific materials, in our results, we found the use of the Photo Story 3, Dashboard, and Wikipedia, as well as the EMODO program or the SELI platform (Kajee and Balfour, 2011; Robertson et al., 2012; Ball, 2019; Hamutoglu et al., 2019; Tomczyk et al., 2020).

Regardless of the setting and the program or application employed, we can classify the duration of these interventions into two broad groups: those that had a duration of <1 semester, and those that had an intervention whose duration ranged from one semester to one academic year.

Regarding the instruments used, it should be noted that most of them used survey forms as an evaluation instrument, either by the researcher or by the students. In addition, it is usually used as a resource to collect information of a personal nature and about one's own experience throughout the intervention. We must also highlight the fact that in many of the results found, this form was used digitally or virtually, abandoning the old paper forms (Kajee and Balfour, 2011; Elliott et al., 2018; Ball, 2019; Lerdpornkulrat et al., 2019; Campbell and Kapp, 2020).

Regarding the use of questionnaires, scales or self-reports, we found several works that used participants’ digital literacy histories as instruments. Through them, the researcher could learn first-hand about the sample's personal experience of digital literacy, the previous knowledge they possess, the digital skills they had mastered, those they lack, or those they consider they should improve. It also included the sample's vision regarding the use and employment of digital resources in teaching practice (Kajee and Balfour, 2011; Robertson et al., 2012; Pequeño et al., 2017; Elliott et al., 2018).

In the case of scales, we found two papers that employed a Likert-scale elaborated ad hoc. We also found studies that employed standardized scales like the Information Literacy Assessment Scale for Education (ILAS-ED), the Digital Literacy Scale, or the E-Learning Attitudes Scale.

Some of the studies we reviewed used semi-structured interviews as a means of monitoring and providing feedback to the students Table 3; (Kajee and Balfour, 2011; Alfonso and Batson, 2014; Gill et al., 2015; Carl and Strydom, 2017; Elliott et al., 2018; Elphick, 2018; Ata and Yıldırım, 2019; Campbell and Kapp, 2020).

As for the sequence through which the different interventions were developed, we found two types—first, those that divided the contents in time, as is the case of the work of Kajee and Balfour (2011), who covered a first semester digital writing from online classes, self-instructions and face-to-face classes in a specific laboratory, and in a second semester was exposed to different digital research techniques, following the same methodology. In contrast, we spotted the second type, where the same technique was followed throughout the study, as is the case of Robertson et al. (2012). They applied digital stories as a tool for the development of the activity, but also the evaluation of the competency. In the research carried out by Lerdpornkulrat et al. (2019), it is apparent that with the use of the rubric, the teacher gave them an example of the work and asked them all to practice evaluating and grading this work. In this way, they could check if they understood how to use a rubric. They then used the rubric to self-assess their work. After receiving feedback, both groups of students revised and resubmitted their completed projects again.
| Research | Participants | Construct and competence | Instructional procedure | Instructional techniques | Instructional strategies |
|----------|--------------|--------------------------|-------------------------|-------------------------|------------------------|
| Alfonzo and Batson (2014) | N = 20 university doctoral students (future teachers) | Pre-post intervention | Intentional sampling | N Teachers = 2. A teacher and a librarian | Digital literacy/digital research/research software/digital databases/self-efficacy | Digital search—APA standards—applications | Activation of previous knowledge-scaffolding | Specific grants | Colloquium | Planning, Reinforcement | Review | Selection |
| Attar and Yildirim (2019) | N = 295 university students (future teachers) | Pre-post intervention | Intentional sampling | N Teachers = 1 | Digital literacy/internet/social media/perception/digital reading/digital writing/sel-efficacy | Training course | Activation of previous knowledge-scaffolding | Video | Colloquium | Planning, Reinforcement | Review | Selection |
| Ball (2019) | Do not specify | Pre-post intervention | Do not specify | Specialized personnel | Digital literacy/digital writing/digital material/creation/editing/media literacy/cybersecurity/self-efficacy | BA Writing and Publishing Program. Emphasis on writing, researching, evaluating, and reviewing articles in a digital environment | Activation of previous knowledge-scaffolding | Video | Colloquium | Planning, Reinforcement | Review | Selection |
| Botturi (2019) | N = 26 university students (future teachers) | Pre-post intervention | Intentional sampling | N Teachers = 1 | Digital literacy/access to information/digital content creation/content sharing/self-efficacy | Specific face-to-face program of 2 credits | Activation of previous knowledge-scaffolding | Video | Colloquium | Planning, Reinforcement | Review | Selection |
| Campbell and Kapp (2020) | N = 4 university students (future teachers) | Pre-post intervention | Do not specify | N Teachers = 1 | Digital literacy/self-efficacy/motivation | Training course | Activation of previous knowledge-scaffolding | Video | Colloquium | Planning, Reinforcement | Review | Selection |

(Continued)
| Research                      | Participants                                                                 | Construct and competence                                                                 | Instructional procedure                                                                 | Instructional techniques                                                                 | Instructional strategies                   |
|-------------------------------|-------------------------------------------------------------------------------|------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------|-------------------------------------------|
| Carl and Strydom (2017)       | N = 11 university students (future teachers)                                  | Digital literacy/E-portfolio/self-efficacy/motivation                                     | Digital content design—digital material design                                            | Activation of previous knowledge-scaffolding                                            | Colloquium Planning: Reinforcement Review  |
|                              | Do not specify                                                                | N Teachers = 1                                                                            | Self-instructions                                                                        | Collaborative/individual emulation                                                       | Selection                                 |
|                              | Pre-post intervention                                                         | Intentional sampling                                                                     | Visualization                                                                           |                                                                                          |                                           |
|                              | N Teachers = 11                                                               |                                           | Planned intervention                                                                     |                                                                                          |                                           |
|                              | Intentional sampling                                                          |                                           | Review                                                                                  |                                                                                          |                                           |
|                              | Support staff—library staff                                                   |                                           | Selection                                                                                |                                                                                          |                                           |
|                               | Do not specify                                                                |                                           |                                           |                                                                                          |                                           |
|                               | Pre-post intervention                                                         |                                           |                                           |                                                                                          |                                           |
|                               | N = 48 university students (future teachers)                                  |                                           |                                           |                                                                                          |                                           |
|                               | Do not specify                                                                |                                           |                                           |                                                                                          |                                           |
|                               | Pre-post intervention                                                         |                                           |                                           |                                                                                          |                                           |
|                               | N = 949 university students (future teachers)                                 |                                           |                                           |                                                                                          |                                           |
|                               | Do not specify                                                                |                                           |                                           |                                                                                          |                                           |
|                               | Pre-post intervention                                                         |                                           |                                           |                                                                                          |                                           |
| Research                  | Sample | Groups            | Design                  | Sampling and inclusion and exclusion criteria | Teachers | Construct and competence | Instructional procedure | Instructional techniques | Instructional strategies |
|---------------------------|--------|-------------------|-------------------------|-----------------------------------------------|----------|--------------------------|-------------------------|--------------------------|--------------------------|
| Gabriele et al. (2019)    | $N = 141$ university students (future teachers) | Do not specify | Pre-post intervention | Intentional sampling | Do not specify | Digital literacy/attitude/web 2.0/gamification/self-efficacy | Training course | Activation of previous knowledge-scaffolding | Colloquium Planning-Reinforcement Review Selection |
| Gill et al. (2015)        | $N = 11$ university students (future teachers) | Do not specify | Pre-post intervention | Intentional sampling | Do not specify | Digital literacy/pre-preparation/digital knowledge/self-efficacy | Application of practical knowledge from different subjects of the career | Activation of previous knowledge-scaffolding Self-instructions Collaborative/individual emulation | Specific grants Colloquium Planning-Reinforcement Review Selection |
| Hamutogluc (2019)         | $N = 47$ university students (future teachers) | Do not specify | Pre-post intervention | Intentional sampling | $N$ Teachers $= 1$ | Digital literacy/attitude/digital learning/self-efficacy/motivation | Training course once a week for 3 h per week | Activation of previous knowledge-scaffolding Self-instructions Collaborative/individual emulation | Colloquium Planning-Reinforcement Review Selection |
| Istenic et al. (2016)     | $N = 115$ university students (future teachers) | Do not specify | Pre-post intervention | Intentional sampling | Do not specify | Digital literacy/digital content design/digital mathematics/self-efficacy | Creation of digital stories—design of digital content—design of digital materials | Activation of previous knowledge-scaffolding Self-instructions Collaborative/individual emulation | Specific grants Colloquium Planning-Reinforcement Review Selection |
| Research | Participants | Construct and competence | Instructional procedure | Instructional techniques | Instructional strategies |
|----------|--------------|--------------------------|-------------------------|-------------------------|-------------------------|
| Kajee and Balfour (2011) | N = 20 university students (future teachers) | GE = 10 GC = 10 Pre-post intervention | Intentional sampling N Teachers = 1 | Academic Literacy/Digital Writing/Digital Research/Self-Efficacy | Activation of previous knowledge-scaffolding Self-instructions Collaborative/individual emulation Visualization Colloquium Planning-Reinforcement Review Selection |
| Kuhn (2017) | N = 20 university students (future teachers) | GE = 12 GE2 = 5 GC = 3 Pre-post intervention | Intentional sampling Do not specify | Digital literacy/attitude/digital skills/motivation/autonomy/ self-efficacy | Digital Practice and PLE Activation of previous knowledge-scaffolding Self-instructions Collaborative/individual emulation Visualization Colloquium Planning-Reinforcement Review Selection |
| Lerdpornkulrat et al. (2019) | N = 584 university students (future teachers) | GE = 321 GC = 263 Pre-post intervention | Intentional sampling N Teachers = 1 | Digital literacy/motivation/self-efficacy | Training course Activation of previous knowledge-scaffolding Self-instructions Collaborative/individual emulation Visualization Colloquium Planning-Reinforcement Review Selection |
| Paige et al. (2016) | N = 31 university students (future teachers) | Do not specify Pre-post intervention | Intentional sampling Do not specify | Digital literacy/digital content design/digital mathematics | Creation of digital stories—design of digital content—design of digital materials Activation of previous knowledge-scaffolding Self-instructions Collaborative/individual emulation Slowmation—digital narratives—round tables—interviews—oral evaluations Visualization Colloquium Planning-Reinforcement Review Selection |
| Pequito et al. (2017) | N = 54 university students (future teachers) | GE = 31 GC = 24 Pre-post intervention | Intentional sampling Do not specify | Digital literacy/digital narrative/self-efficacy | Application of practical knowledge from different subjects of the career Activation of previous knowledge-scaffolding Self-instructions Collaborative/individual emulation Visualization Colloquium Planning-Reinforcement Review Selection |

(Continued)
| Research | Participants | Construct and competence | Instructional procedure | Instructional techniques | Instructional strategies |
|----------|--------------|--------------------------|-------------------------|--------------------------|--------------------------|
|          |              |                          |                         |                          |                          |
| Robertson et al. (2012) | N = 150 university students (future teachers) | Do not specify | Pre-post intervention | Intentional sampling | N Teachers = 2 | Digital literacy/new pedagogies/multiliteracy/self-stories—thoughtful writing efficacy | Activation of previous knowledge-scaffolding Self-instructions Collaborative/individual emulation Planning-Reinforcement Review Selection Sharing |
| Sharp (2018) | N = 51 university students (future teachers) | GE = 20  GE2 = 20  GC = 11 | Pre-post intervention | Intentional sampling | Do not specify | Digital literacy/attitude/digital skills/motivation/autonomy/—wiki, —microblog self-efficacy | Activation of previous knowledge-scaffolding Self-instructions Collaborative/individual emulation Planning-Reinforcement Review Selection |
| Tomczyk et al. (2020) | N = 227 university students (future teachers) | Do not specify | Pre-post intervention | Intentional sampling | Do not specify | Digital literacy/digital inclusion/digital risks/digital content/self-efficacy | Activation of previous knowledge-scaffolding Self-instructions Collaborative/individual emulation Planning-Reinforcement Review Selection |
| Vinokurova et al. (2021) | Do not specify | Do not specify | Do not specify | Do not specify | Do not specify | Digital literacy/self-efficacy | Training course | Activation of previous knowledge-scaffolding Self-instructions Collaborative/individual emulation Planning-Reinforcement Review Selection |
| Research                  | Materials                                                                 | Instructor role          | Student role            | Student grouping | Implementation/Context | Program duration | Intervention results                                      | Comments                                   |
|---------------------------|---------------------------------------------------------------------------|--------------------------|-------------------------|------------------|------------------------|------------------|-----------------------------------------------------------|-------------------------------------------|
| Alfonzo and Batson (2014) | Texts/documents—specific computer applications—material with indications | Teacher—Researcher       | Developer of each activity | Small group      | Researcher/virtual     | For 4 days       | Greater use of digital tools than before training         | Has a sparse sample                      |
| Ata and Yildirim (2019)   | Does not specify                                                          | Teacher—Researcher       | Developer of each activity | Great group      | Researcher/face-to-face | An academic year | Increasing digital competence                            | It should apply more evaluation tools    |
| Ball (2019)               | Dashboard—training modules—Wikipedia guidelines and rules                 | Teacher—Researcher       | Developer of each activity | Small group      | Researcher/face-to-face | An academic year | Increasing digital competence                            | Does not indicate the method             |
| Botturi (2019)            | Texts/documents—specific computer applications—material with indications | Teacher—Researcher       | Developer of each activity | Great group      | Researcher             | 4 months         | Increasing digital competence                            | Has a sparse sample                      |
| Campbell and Kapp (2020)  | Texts/documents—specific computer applications—material with indications | Teacher—Researcher       | Developer of each activity | Great group      | Researcher/virtual     | 5 months         | Increasing digital competence                            | Has a sparse sample                      |
| Carl and Strydom (2017)   | Texts/documents—specific computer applications—material with indications | Teacher—Researcher       | Developer of each activity | Small group      | Researcher/virtual     | Do not specify    | Great interest and motivation on the part of the participants | Does not use standardized instruments |
| Domingo-Cosciolla et al.  (2020) | Texts/documents—specific computer applications—material with indications | Teacher—Researcher       | Developer of each activity | Great group      | Researcher             | Do not specify    | Increasing digital competence                            | Has a sparse sample/does not indicate duration |
| Elliott et al. (2018)     | Weekly Lectures-seminars-online resources library                        | Teacher—Researcher       | Developer of each activity | Small group      | Researcher/face-to-face | An academic year | Increased digital expertise and dominance                 | Has a sparse sample                      |
| Elphick (2018)            | Conferences and seminars                                                 | Teacher—Researcher       | Developer of each activity | Great group      | Researcher/face-to-face | One semester      | Increased digital expertise and dominance                 | Does not use standardized instruments   |

(Continued)
| Research | Materials | Instructor role | Student role | Student grouping | Implementation/Context | Program duration | Intervention results | Comments |
|----------|-----------|----------------|--------------|-----------------|------------------------|------------------|---------------------|----------|
| Gabriele et al. (2019) | Power point presentations—introductory videos of the software—brochures—applications created ad hoc | Teacher—Researcher | Developer of each activity | Great group | Researcher/face-to-face | 10 months | Increasing digital competence | Has a sparse sample |
| Gill et al. (2015) | Texts/documents—specific computer applications—material with indications | Teacher—Researcher | Developer of each activity | Small group | Researcher/virtual | For 3 years | Practical knowledge of the application of ICT as a learning tool | Has a sparse sample |
| Hamutoglu et al. (2019) | Texts/documents—EDMODO | Teacher—Researcher | Developer of each activity | Great group | Researcher/face-to-face | 5 weeks | Increasing digital competence | Has a sparse sample |
| Istenic et al. (2016) | Texts/documents—specific computer applications—material with indications | Teacher—Researcher | Developer of each activity | Small group | Researcher/virtual | An educational technology course in the academic year 2011–2012 | Creation of digital content for the teaching of mathematics | Does not use standardized instruments |
| Kajee and Balfour (2011) | Texts/documents—computer applications—Laboratory with computers—standalone server—printer through 40 workstations | Teacher—Researcher | Developer of each activity through 40 workstations | Small group/face-to-face | Researcher Specific laboratory | Two semesters of 14 weeks duration | GE improvements greater than GC | Has a sparse sample |
| Kuhn (2017) | Texts/documents—specific computer applications—material with indications | Teacher—Researcher | Developer of each activity | Small group | Researcher/virtual | An academic year | GE1 and GE2 improvements greater than GC | Has a sparse sample |
| Lerdpornkulrat et al. (2019) | Power point presentations—introductory videos of the software—brochures | Teacher—Researcher | Developer of each activity | Small group | Researcher/face-to-face | 13 sessions | Increased self-efficacy in relation to standards and expectations | It should apply more evaluation tools |
| Research | Materials | Instructor role | Student role | Student grouping | Implementation/Context | Program duration | Intervention results | Comments |
|----------|-----------|----------------|--------------|------------------|-----------------------|-----------------|---------------------|----------|
| Paige et al. (2016) | Texts/documents—specific computer applications—material with indications | Teacher—Researcher | Developer of each activity | Small group | Researcher/virtual | Do not specify | Creation of digital content for the teaching of mathematics | Does not use standardized instruments |
| Pequeño et al. (2017) | Texts/documents—specific computer applications—material with indications | Teacher—Researcher | Developer of each activity | Small group | Researcher/virtual | An academic year | GE improvements greater than GC | Has a sparse sample |
| Robertson et al. (2012) | Texts/documents—computer applications—Photo Story 3 program | Teacher—Researcher | Developer of each activity | Small group | Researcher/virtual | For 3 years: 10 months | New learning and means of expression | Has a sparse sample |
| Sharp (2018) | Texts/documents—specific computer applications—material with indications | Teacher—Researcher | Developer of each activity | Small group | Researcher/face-to-face | Two semesters | GE1 and GE2 improvements greater than GC | Has a sparse sample |
| Tomczyk et al. (2020) | Texts/documents—SELI platform | Teacher—Researcher | Developer of each activity | Great group | Researcher/virtual | Do not specify | Increasing digital competence | Does not indicate the process |
| Vinokurova et al. (2021) | Texts/documents—specific computer applications—material with indications | Teacher—Researcher | Developer of each activity | Great group | Researcher/virtual | Do not specify | Increasing digital competence | Omits data for possible replicability |
TABLE 3  Assessment intervention in the reviewed studies.

| Research                         | Timetable for the implementation of each instrument | Direct comments                                                                 | Task-specific performance | Overall task performance |
|----------------------------------|----------------------------------------------------|--------------------------------------------------------------------------------|----------------------------|--------------------------|
| Alfonso and Batson (2014)         | Pre-evaluation, post-evaluation and follow-up evaluation using Qual-trics software | Comparison and improvement of the results obtained through the Qual-trics software | Learning the ZOTERO platform at the end of the invention | Mastery of digital bibliographic research and ZOTERO |
| Ata and Yildirim (2019)           | During the intervention                            | Does not specify                                                                | Does not specify          | Carecen of digital skills to find, evaluate, create, and communicate |
| Ball (2019)                      | During the intervention                            | Tests throughout the development of the subject through portfolios               | Feedback of the results of the questionnaires at the end of each module that showed improvements | Progressive mastery of digital skills |
| Botturi (2019)                   | Before and after the intervention                 | Agree with the participants on the contents and the evaluation                   | Yields are analyzed practice and evolution | Limited space in the curriculum |
| Campbell and Kapp (2020)         | Before and after the intervention                 | Learning models and tasks to apply in the classroom                              | Inclusion of digital competences in curriculum design and monitoring of their development | Differences between resources in centers and in households |
| Carl and Strydom (2017)          | Before and after the intervention                 | Assessment through direct observation and class visits                           | Digital learning as part of teacher training | Digital writing support required |
| Domingo-Coscolla et al. (2020)   | Before and after the intervention                 | Documentary analysis. Discussion groups and finally questionnaires               | Digital literacy and content creation | Not all aspects of CDD are measured |
| Elliott et al. (2018)            | Before and after the intervention                 | Through the delivery of weekly activities                                        | Increased capacity to identify, select and apply digital reading | A single discipline with a smaller number of staff and students |
| Elphick (2018)                   | Before and after the intervention                 | Performance is measured through direct observation and scales                    | Increasing the dominance of digital competence with iPads | It must be applied in educational practice and not only at the laboratory level |
| Gabriele et al. (2019)           | Before and after the intervention                 | Feedback on your programming experience and skills from questionnaires           | Medium-high level of CT skills, combining design and programming skills | Not all students developed these skills |
| Gill et al. (2015)               | Before and after the intervention                 | 3 stages of ICT teaching capacity development in which each phase is evaluated   | Practice itself as a learning tool | Minimal development where there is no real use of ICT for learning and teaching |
| Hamutoglu et al. (2019)          | Before and after the intervention                 | Before and after the introduction by standardized instruments                   | Increased attitudes and skills | Only through EDMODO |
| Istenic et al. (2016)            | Before and after the intervention                 | Describes the statement design framework and evaluation criteria for solving mathematical and digital problems | Their conceptions changed during the course of passive recipients to active producers of media content. | Control group without intervention |
| Kajee and Balfour (2011)         | Before and after the intervention                 | Evaluates the results by semesters from accounts or observations                | Increasing digital capacity | Large differences in terms of resources |
| Kuhn (2017)                      | Before and after the intervention                 | Evaluate performance through student presentations                              | Improving your digital skills and abilities | Scarcity of digital tools |
| Lerdpornkultrat et al. (2019)    | Before and after the intervention                 | Formative assessment and feedback                                               | Increased ability to search, evaluate, process and communicate information | Only the students of the experimental group participated in a formalized activity in the classroom |
| Paige et al. (2016)              | Before and after the intervention                 | Development of conceptual and semiotic understandings.                           | Increasing digital literacy in content creation | It is only done with one app |
| Pequeño et al. (2017)            | Before and after the intervention                 | Narrative research with digital ethnography,                                    | Technological and social mediation | Focused solely on one degree |

(Continued)
In the investigation by Elliott et al. (2018), the intervention was structured in work modules with the following sequence of sessions: they were introduced in the first session with opportunities for group discussions and questions. Essential module reading was provided in weekly online study units and module workshops integrated academic reading and writing activities, such as paraphrasing and referencing, with module content.

In the study by Ball (2019), in the first year, the students took modules on publishing history, culture, markets, and media. In the second year, the intervention was based on their publishing skills, reading for writing development, and grammar and general literacy.

Hamutoglu et al. (2019) organized their intervention in different weeks, such that during the first week of the 14-week semester, the instructor oriented the students for the course and administered pre-tests. In the following week, students were provided with a session on the Edmodo platform and orientation training on the course content.

In the work of Gabriele et al. (2019), the experimental research plan (i.e., activities to be performed, methodology to be adopted) was established over 4 months followed by the organization of the reading material (power point presentations, introductory videos of the software, handouts, ad hoc created applications as examples).

We also found interventions that had very short time durations, but provide daily detail of the contents and interventions. Similarly, Alfonzo and Batson (2014) dedicate 1 day to the search and orientation in digital resources, 1 day to the APA standards, and 3 days to develop and use a specific application.

In the research by Istenic et al. (2016), the intervention was based on six different types of tasks related to a variety of mathematical problems, including problems with redundant data, problems with multiple solutions, problems with multiple paths to the solution, problems with no solution, mathematical problems in logic, and problems with insufficient information.

In some interventions, the sequence through which they are developed is the very development of the subject of the degree course from which they are implemented, as is the case of the work of Gill et al. (2015).

In the work of Carl and Strydom (2017), students were first familiarized with the devices and then introduced to electronic portfolios, which helped them to create blogs that serve as platforms for electronic portfolios, and guided them on how to collect artifacts and how to reflect and share content.

In one work we found narrative was used as a technique so that the students could later present their work, analyze it in groups, rework it and present it again to their classmates. Kuhn (2017), Pequeño et al. (2017), and Elphick (2018) followed this model.

Adopting a novel consultative approach, Botturi (2019) co-designed the intervention with his students in two steps: they were surveyed 4 weeks before the start of the course and asked to choose between two options: an overview of different topics/methods/experiences, or an in-depth exploration of one or two topics/methods/experiences. All respondents indicated a preference for the first option and provided indications of the topics they wished to cover (see Tables 4, 5).

The limitations of our search are listed in Table 6. At the theoretical level, we encountered studies that were not very...
| Research                      | Questionnaires-self-reports-rating scales-semantic differential | Wallet physical/virtual | Interviews-Reports | Evaluation of the effects of the intervention | Satisfaction | Comments-Individual-Group |
|-------------------------------|----------------------------------------------------------------|--------------------------|--------------------|-----------------------------------------------|---------------|---------------------------|
| Alfonzo and Batson (2014)     | Information literacy assessment scale for education (ILAS-ED)  | Observations on student work | Does not specify  | Post-evaluation of the competencies from the qualtrics software | Learning and satisfaction for participating students | Significant effects on previous methods of instruction |
| Ata and Yildirim (2019)       | Digital literacy scale                                           | Does not specify         | The final evaluation confirms the mastery of digital competences | Attitudinal, cognitive and are predictors of digital literacy | Domain alto and positive perceptions of digital literacy |
| Ball (2019)                  | Article editing of at least 1,500 words of additional content to the article-500-word report detailing the choice of edits made and the approach used | Edited portfolio         | 1,090 edits in 124 articles, creating six new articles | High capacity for digital editing and publication of content | Mastery and monitoring of competencies after the training course |
| Botturi (2019)               | Ad hoc elaborate Likert scale                                   | Does not specify         | Follow-up interviews | Greater digital self-efficacy                | Critical assessment of obstacles to implementing DML | Ability to integrate DML |
| Campbell and Kapp (2020)     | Questionnaires that provide background on participants' biographies, perceptions, and experiences with technology | Reflections - justification of their use of technology - narratives of the difficulties experienced | Video recording, semi-structured focus group interview | Increasing understanding of digital learning possibilities | Complementary tool and means to participate and not as an intentional remedy | Digital non-competition is a barrier today |
| Carl and Strydom (2017)      | Ad hoc elaborate Likert scale                                   | Individual and virtual   | Recorded interviews: reflection, training, professional development, and social dimensions of the e-portfolio | Integration of electronic portfolios as tools for reflection | High institutional expectations | Digital growth and development through the use of digital portfolios |
| Domingo-Coscolla et al. (2020) | Ad hoc elaborate Likert scale                                  | Does not specify         | Focus groups       | Promoting digital literacy and digital content creation | Insufficient CDD proficiency | Three institutional actions on CDD to be considered in university curricula |

(Continued)
| Research | Questionnaires-self-reports-rating scales-semantic differential | Wallet physical/virtual | Interviews-Reports | Evaluation of the effects of the intervention | Satisfaction | Comments-Individual-Group |
|----------|---------------------------------------------------------------|-------------------------|------------------|---------------------------------|----------------|---------------------------|
| Elliott et al. (2018) | Essay of 3,000 words on the theories of learning—group oral presentation | Portfolio of 3,000 words. The portfolio was divided into three sections that required students to relate different phases of their personal education experiences to theory. | Semi-structured questionnaires, mainly quantitative, at the beginning and end of the academic year | Difficulties as part of the process | Students’ expectations of achievement as the course progressed | Scaffolding strategies with a positive effect on digital self-efficacy |
| Elphick (2018) | Free text surveys—ad hoc elaborate Likert scale | Does not specify | Semi-structured interview with small groups | Correlations between classrooms rich in technology and digital self-efficacy practical applicability of the intervention | The use of iPads has a positive impact on digital behaviors and perceptions about digital skills | Digital competence as a key skill in teachers |
| Gabriele et al. (2019) | Ad hoc elaborate Likert scale | Does not specify | Tests to check the level of abstraction, parallelism, logistics, synchronization, and control | Elaboration of digital material from games with Scratch Software | | Increased knowledge and digital skills |
| Gill et al. (2015) | Interviews developed in 6 phases | Does not specify | Interviews developed in 6 phases | Development is proportionate to opportunities to observe and/or use ICT for learning | Classroom experience enables and accelerates the development of digital literacy | The development of digital literacy as a key challenge for future donors |
| Hamutoglu et al. (2019) | E-Learning attitudes scale—digital literacy scale | Does not specify | Does not specify | Relevant results in terms of avoidance | The trend is one of the most significant predictors of digital literacy skills. | Effectiveness of treatment on participants’ attitudes toward e-learning platforms |
| Istenic et al. (2016) | Performance analysis—analysis of written reflections—pre- and post-test scores-reflections of the participants | Does not specify | Does not specify | Increases in digital pedagogical competences | Instructional approach with digital storytelling and multi-mode design to facilitate learning | Transfer of ICT competencies and their integration into teaching |
| Kajee and Balfour (2011) | Digital literacy stories of the participants (collected at the beginning of the semester) | Remarks of student work—access and sufficiency | Semi-structured interviews | Digital practice as valuable and social knowledge | Influence of the social context | Digital literacy as a contribution and influence to learning |

(Continued)
| Research | Questionnaires-self-reports-rating scales-semantic differential | Wallet physical/virtual | Interviews-Reports Evaluation of the effects of the intervention | Satisfaction | Comments-Individual-Group |
|----------|---------------------------------------------------------------|-------------------------|---------------------------------------------------------------|--------------|--------------------------|
| Kuhn (2017) | *Ad hoc* elaborate likert scale | Does not specify | Focus groups | Obtaining new literacies from digital practice | Need for support and guidance in these contents | Redesign of the PLE of the students. |
| Lerdpornkulrat et al. (2019) | Questionnaires developed *ad hoc*—standardized questionnaires | Rubric | Does not specify | Developing self-efficacy related to digital literacy | Increase in self-efficacy in information literacy | The rubric as an appropriate tool to measure learning outcomes related to information literacy |
| Paige et al. (2016) | *Ad hoc* elaborate Likert scale | Does not specify | Does not specify | experiences and reflections of the PST on Slowmation as an educational tool | Modeling of best practice evaluation tools. | Digital literacy skills development |
| Pequeño et al. (2017) | Transmedia narratives | Does not specify | Comments and recommendations made in the group work | Transmedia education as a process of technological mediation and social | Digital skills that students incorporate into internships design, analysis, production, and dissemination of transmedia content | Creation and dissemination of transmedia content |
| Robertson et al. (2012) | Personal digital story | Remarks of student work—journal of researcher’s reflections | Does not specify | Digital stories as an appropriate tool for evaluation and reflection | Multi-literacy | Evidence of transformative pedagogy |
| Sharp (2018) | *Ad hoc* elaborate likert scale | Does not specify | Does not specify | Increasing prevalence of digital learning environments | Greater involvement in digital practices | Collaborative digital literacy practices |
| Tomczyk et al. (2020) | *Ad hoc* elaborate likert scale | Does not specify | Does not specify | Need for more training | Need for more studies to identify digital gaps | Achievement Learning Autonomy Adaptation |
| Vinokurova et al. (2021) | Does not specify | Does not specify | Does not specify | Educational paradigm shift in terms of the content of education | Digital transformation | Increased opportunities for teachers to offer and disseminate ICTs if they have good digital literacy |
| Research                | Pertinence | Meetings                  | Feedback                                                                 |
|-------------------------|------------|---------------------------|--------------------------------------------------------------------------|
| Alfonzo and Batson      | Horizontal | Does not specify          | Feedback to the student at the end of the course                         |
| (2014)                  | relevance   |                           | Does not specify                                                         | Pre-post-follow-up evaluation | Agreement between observers collecting data | The duration of the workshops is short |
| Ata and Yildirim         | Horizontal | Does not specify          | Feedback to students after the completion of each phase                  |
| (2019)                  | relevance   |                           | Reliability                                                              | Pre-post-intervention evaluation | A single researcher                         | Does not indicate the process or sessions |
| Ball (2019)             | Horizontal | Does not specify          | Feedback to students after each module                                   |
|                         | relevance   |                           | Consistency                                                              | Pre-post-intervention evaluation | A single researcher                         | Does not use standardized instruments |
| Botturi (2019)          | Horizontal | Does not specify          | Continuous feedback to students on each task                             |
|                         | relevance   |                           | Consistency                                                              | Pre-post-intervention evaluation | A single researcher                         | Does not use records such as interviews or portfolios |
| Campbell and Kapp       | Horizontal | Does not specify          | Feedback at the end of the intervention                                   |
| (2020)                  | relevance   |                           | Does not specify                                                         | Pre-post-intervention evaluation | A single researcher                         | Does not specify the duration |
| Carl and Strydom        | Horizontal | Does not specify          | Feedback to students at the end of the course                            |
| (2017)                  | relevance   |                           | Does not specify                                                         | Pre-post-intervention evaluation | A single researcher                         | Does not indicate the process or sessions |
| Domingo-Coscolla et al. | Horizontal | Does not specify          | Feedback to students at the end of the intervention                      |
| (2020)                  | relevance   |                           | Reliability                                                              | Pre-post-intervention evaluation | Agreement between observers collecting data | Does not use records such as interviews or portfolios |
| Elliott et al. (2019)   | Horizontal | Does not specify          | Feedback to students after each session                                  |
|                         | relevance   |                           | Reliability                                                              | Pre-post-intervention evaluation | Agreement between observers collecting data | Does not use standardized instruments |
| Elphick (2018)          | Horizontal | Does not specify          | Feedback to students after each session                                  |
|                         | relevance   |                           | Consistency                                                              | Pre-post-intervention evaluation | A single researcher                         | Does not use standardized instruments |
| Gabriele et al. (2019)  | Horizontal | Does not specify          | Feedback on your programming experience and skills from questionnaires   |
|                         | relevance   |                           | Reliability                                                              | Pre-post-intervention evaluation | Does not specify                            | Does not use records such as interviews or portfolios |
| Gill et al. (2015)      | Horizontal | Does not specify          | Feedback to students in each subject                                     |
|                         | relevance   |                           | Reliability                                                              | Pre-post-follow-up evaluation | Do not specify                              | Does not apply any self-assessment scale |
| Hamutoglu et al.        | Horizontal | Does not specify          | Feedback to students with the scores of each standardized instrument     |
| (2019)                  | relevance   |                           | Reliability                                                              | Pre-post-intervention evaluation | A single researcher                         | Does not use records such as interviews or portfolios |
| Istenic et al. (2016)   | Horizontal | Does not specify          | Feedback to students after completing each task (6)                     |
|                         | relevance   |                           | Reliability                                                              | Pre-post-intervention evaluation | Do not specify                              | Does not apply any self-assessment scale |

(Continued)
| Research                     | Pertinence            | Meetings                                      | Feedback                                      | Reliability and validity assessment | Maintenance and generalization | Other controls                                      | Feedback                                                                 |
|------------------------------|-----------------------|-----------------------------------------------|-----------------------------------------------|-------------------------------------|-------------------------------|-------------------------------------------------|--------------------------------------------------------------------------|
| Kajee and Balfour (2011)     | Horizontal relevance  | Does not specify                             | Student feedback at the end of each semester  | Does not specify                    | Pre-post-intervention evaluation | A single researcher                          | Only applicable within the university and within the laboratory itself  |
| Kuhn (2017)                  | Horizontal relevance  | Does not specify                             | Continuous feedback after each student presentation | Vaquidez                          | Pre-post-follow-up evaluation | Do not specify                           | Does not use standardized instruments                              |
| Lerdpornkulrat et al. (2019) | Horizontal relevance  | Does not specify                             | Feedback from the researcher and self-assessment | Reliability Consistency Validity Exploratory factor analysis | Pre-post-intervention evaluation | A single researcher                          | Does not use records such as interviews or portfolios                     |
| Paige et al. (2016)          | Horizontal relevance  | Does not specify                             | Feedback after the intervention               | Validity                            | Pre-post-intervention evaluation | Do not specify                           | Does not specify the duration                                               |
| Pequeño et al. (2017)        | Horizontal relevance  | Does not specify                             | Feedback after the intervention               | Consistency Validity                | Pre-post-intervention evaluation | Do not specify                           | Does not use standardized instruments                              |
| Robertson et al. (2012)      | Horizontal relevance  | Does not specify                             | Continuous feedback from their own experiences | Does not specify                    | Pre-post-follow-up evaluation | Agreement between observers collecting data | Does not apply any self-assessment scale                                |
| Sharp (2018)                 | Horizontal relevance  | Does not specify                             | Feedback after the intervention               | Consistency Exploratory factor analysis | Pre-post-intervention evaluation | Do not specify                           | Does not use standardized instruments                              |
| Tomczyk et al. (2020)        | Horizontal relevance  | Does not specify                             | Feedback after the intervention               | Reliability Consistency Validity Exploratory factor analysis | Pre-post-intervention evaluation | Do not specify                           | Does not use records such as interviews or portfolios                     |
| Vinokurova et al. (2021)     | Horizontal relevance  | Does not specify                             | Feedback from students through their own experience | Validity                            | Pre-post-follow-up evaluation | Do not specify                           | Does not indicate the process or sessions                                |

Indicators and controls used in the instructional intervention in the empirical studies reviewed II.
current, missing research questions or hypotheses, or even missing objectives. At the statistical level, we found several studies had a small or unrepresentative sample.

Analyzing the interventions themselves, we identified a few limitations, especially in those studies that neither indicates the tasks, record the entire process, or lack key information to replicate the intervention. In some studies, key information relating to the person carrying out the intervention was missing, particularly on whether they had the specific training for this purpose. Another limitation that was identified was that very few evaluation strategies were in place to evaluate the interventions (see Table 7).

Similarly, gaps were found regarding ethical controls, where in some studies the main limitation was that ethical controls were non-existent or not specified (Robertson et al., 2012; Istenic et al., 2016; Kuhn, 2017; Elphick, 2018; Ata and Yıldırım, 2019; Tomczyk et al., 2020).

Figure 3 shows the evolution over the years of the samples used in each of the studies from 2011 to 2020.

Figure 4 shows the evolution over the years of the controls used in each of the studies from 2011 to 2021.

Discussion

This work aimed to analyze the empirical evidence found in international studies between 2011 to 2021 related to the digital literacy of university students, including those pursuing degrees in education. This objective has been met.

Regarding the first focus related to literacy, this paper highlighted the fact that studies from the West are the most prevalent in this field (Çoklar et al., 2017; Ata and Yıldırım, 2019; Hamutoglu et al., 2019; Sujarwo et al., 2022), which correspond to cross-sectional studies, mostly employing instruments such as “the Digital Literacy Scale” developed by Ng (2012), and “the information literacy self-efficacy scale (ILS)” developed by Kurbanoğlu et al. (2006). Regarding the level of mastery, the results showed an upper intermediate level of competence in information and digital literacy, communication, and collaboration, but a low intermediate level in terms of digital content creation, particularly in the creation and dissemination of multimedia content using different tools (López-Meneses et al., 2020; Moreno et al., 2020).

Regarding the second focus, digital literacy in university students, this study reviewed the various contributions of other works and found the presence of a competent group in this field, which makes efficient use of both the Internet and digital media (Çoklar et al., 2016; Ata and Yıldırım, 2019; Lim and Newby, 2021). However, differences were also found in this collective relating to gender, where women were more competent than men in digital literacy, information literacy, technological literacy, and communicative literacy (Hamutoglu et al., 2019; López-Meneses et al., 2020; Navarro, 2020). However, on the other hand, we also found studies that revealed particular gender gaps where men showed a higher propensity for DL, while women outperform men in the overall digital literacy test (Ata and Yıldırım, 2019). Ata and Yıldırım (2019) also found differences in DL between students where university students studying science or mathematics-related majors had higher levels of digital literacy than students majoring in social sciences or psychology fields (Ata and Yıldırım, 2019; Chow and Wong, 2020).

And as for the third focus, digital literacy in future teachers, we found a dual use of digital literacy, in its social and leisure aspect (searching or maintaining friendships through social networks, sharing digital content, downloading content, or playing online games), and in its academic aspect (searching in search engines, working through online documents, organizing or synthesizing information from different processors, using computer programs to make presentations, edit images or content, or create audiovisual content (López-Meneses et al., 2020).

The main contribution of this review lies in its comparison between pre/post-pandemic studies, which show a great increase in the use of technologies in the educational world (across the curriculum), and research work focused on measuring the competencies of these devices (Baber et al., 2022). These new investigations have not only followed the line of previous ones but focused on the measurement of digital literacy and its influence on it by variables such as the degree of origin, gender, age, or being a digital native or immigrant (Castañeda-Peña et al., 2015; Çoklar et al., 2016; Castañeda et al., 2018; Ata and Yıldırım, 2019; Gür et al., 2019; Hamutoglu et al., 2019; Lerdpornkulrat et al., 2019; González et al., 2020; Navarro, 2020; De Sixte et al., 2021). But there has been an expansion of the topics and variables that are studied in conjunction with digital literacy, among which we find as a novelty, the study of psycho-educational variables such as academic motivation (Chow and Wong, 2020), self-efficacy and motivation (Lerdpornkulrat et al., 2019), effort expectations (Nikou and Aavakare, 2021), and self-concept as a student and as a teacher (Yeşilyurt et al., 2016). The importance attached to the educational field, the identification of different roles or behaviors within the concept of digital literacy that is delimited, or even the types of uses within the concept of digital literacy (López-Meneses et al., 2020; Moreno et al., 2020; Navarro, 2020; Lim and Newby, 2021) are new trends.

Therefore, we can affirm that in this study the research predictions are fulfilled, in that the results found show relevant differences from international studies pre-post pandemic; and by different cultural backgrounds (Spanish Latin, Portuguese, Finnish...), gender, and personal digital resources. In terms of applications for educational practice, these results do not indicate that university students are competent in terms of digital literacy, although they demonstrate some competencies like online information search, information evaluation, information processing, information communication, and
TABLE 6 Limitations of the instructional interventions described in the empirical studies reviewed.

| Research          | Background limitations | Limitations on participants | Limitations of the instrument | Program limitations | Limitations of results | Discussion on limitations and conclusions | General limitations | Comments                                      |
|-------------------|------------------------|-----------------------------|-------------------------------|---------------------|------------------------|------------------------------------------|---------------------|-----------------------------------------------|
| Alfonzo and Batson (2014) | The research question is missing | Reduced sample Non-representative sample | Non-validity and reliability of instruments with their own data | Non-grouping | No graphs or tables They do not analyze each variable Not analyzing generalization effects | Does not indicate reliability and validity assessment | No ethical controls (informed acceptance to participate, confidentiality...) | Sample must be larger |
| Ata and Yıldırım (2019) | The research question is missing | Lack of inclusion and exclusion criteria | No tasks Do not record the entire process | Non-grouping | They do not analyze each variable | They do not compare with previous current studies | No ethical controls (informed acceptance to participate, confidentiality...) | Few evaluation strategies |
| Ball (2019) | The research question is missing | No method | Non-validity and reliability of instruments with their own data Instruments unknown and not provided for in the Annex | Non-grouping | No graphs or tables They do not analyze each variable | They do not compare with previous current studies | No ethical controls (informed acceptance to participate, confidentiality...) | Does not indicate the sample |
| Botturi (2019) | The research question is missing | Reduced sample Non-representative sample | Non-validity and reliability of instruments with their own data Instruments unknown and not provided for in the Annex | Non-grouping | They do not analyze each variable | They do not compare with previous current studies | No ethical controls (informed acceptance to participate, confidentiality...) | Few evaluation strategies |
| Campbell and Kapp (2020) | The research question is missing | Lack of inclusion and exclusion criteria | No tasks Do not record the entire process | Non-grouping | They do not analyze each variable | Does not indicate reliability and validity assessment | No ethical controls (informed acceptance to participate, confidentiality...) | Sample must be larger |
| Carl and Strydom (2017) | The research question is missing | Reduced sample Non-representative sample | Non-validity and reliability of instruments with their own data Instruments unknown and not provided for in the Annex | Non-grouping | No graphs or tables They do not analyze each variable Not analyzing generalization effects | Does not indicate reliability and validity assessment | No ethical controls (informed acceptance to participate, confidentiality...) | Sample must be larger |
## TABLE 6 (Continued)

| Research                  | Background limitations | Limitations on participants | Limitations of the instrument | Program limitations | Limitations of results | Discussion on limitations and conclusions | General limitations | Comments |
|---------------------------|------------------------|-----------------------------|--------------------------------|---------------------|------------------------|------------------------------------------|---------------------|----------|
| Domingo-Coscolla et al.   | The research question is missing | Reduced sample Non-representative sample | Non-validity and reliability of instruments with their own data Instruments unknown and not provided for in the Annex | Non-grouping | They do not analyze each variable | They do not compare with previous current studies | No ethical controls (informed acceptance to participate, confidentiality...) | Sample must be larger |
| (2020)                    |                        |                             |                                |                     |                        |                                          |                     |          |
| Elliott et al. (2018)     | The research question is missing | Lack of inclusion and exclusion criteria Reduced sample Non-representative sample | Non-validity and reliability of instruments with their own data Instruments unknown and not provided for in the Annex | Non-grouping | No graphs or tables They do not analyze each variable | They do not compare with previous current studies | No ethical controls (informed acceptance to participate, confidentiality...) | Sample must be larger |
| Elphick (2018)            | The research question is missing | Lack of inclusion and exclusion criteria | Non-validity and reliability of instruments with their own data Instruments unknown and not provided for in the Annex | No number of sessions | They do not analyze each variable | They do not compare with previous current studies | No ethical controls (informed acceptance to participate, confidentiality...) | The application of standardized chords and instruments is lacking. Few evaluation strategies |
| Gabriele et al. (2019)    | Obsolete fonts         | Reduced sample Non-representative sample | Non-validity and reliability of instruments with their own data Instruments unknown and not provided for in the Annex | Non-grouping | Only the publication is compared | They do not compare with previous current studies | No ethical controls (informed acceptance to participate, confidentiality...) | Sample must be larger |
| Gill et al. (2015)        | The research question is missing | Reduced sample Non-representative sample | Non-validity and reliability of instruments with their own data | Non-grouping | No graphs or tables They do not analyze each variable Not analyzing generalization effects | They do not compare with previous current studies | No ethical controls (informed acceptance to participate, confidentiality...) | Sample must be larger |

(Continued)
| Research                        | Background limitations                                                                 | Limitations on participants | Limitations of the instrument                                                                 | Program limitations | Limitations of results                                                                 | Discussion on limitations and conclusions | General limitations                                                                                     | Comments |
|--------------------------------|----------------------------------------------------------------------------------------|------------------------------|------------------------------------------------------------------------------------------------|---------------------|----------------------------------------------------------------------------------------|------------------------------------------|--------------------------------------------------------------------------------------------------------|----------|
| Hamutoglu et al. (2019)        | The research question is missing                                                        | Lack of inclusion and exclusion criteria | No tasks                                                                                     | Non-grouping        | Only the publication is compared                                                         | The answer to the research question is not indicated | No ethical controls (informed acceptance to participate, confidentiality...) | Few evaluation strategies |
| Istenic et al. (2016)          | The research question is missing                                                        | Lack of inclusion and exclusion criteria | Non-validity and reliability of instruments with their own data Instruments unknown and not provided for in the Annex | Non-grouping        | No graphs or tables They do not analyze each variable Not analyzing generalization effects | They do not compare with previous current studies | No ethical controls (informed acceptance to participate, confidentiality...) | The application of standardized chords and instruments is lacking. Few evaluation strategies |
| Kajee and Balfour (2011)       | Obsolete fonts                                                                          | Reduced sample Non-representative sample | Non-validity and reliability of instruments with their own data Instruments unknown and not provided for in the Annex | Not who implemented | No graphs or tables They do not analyze each variable Not analyzing generalization effects | Does not indicate Reliability and Validity Assessment | Key information to replicate the intervention is missing | Sample must be larger |
| Kuhn (2017)                    | The research question is missing                                                        | Reduced sample Non-representative sample | Non-validity and reliability of instruments with their own data Instruments unknown and not provided for in the Annex | No number of sessions Not who implemented | No graphs or tables They do not analyze each variable | They do not compare with previous current studies | No ethical controls (informed acceptance to participate, confidentiality...) | Sample must be larger |
| Lerdpornkulrit et al. (2019)   | Missing assumptions or forecasts                                                        | Lack of inclusion and exclusion criteria | No tasks Do not record the entire process                                                    | Does not indicate instruction procedure | No practical and theoretical applications | No explicit limitations | No ethical controls (informed acceptance to participate, confidentiality...) | Does not use the wallet |
| Paige et al. (2016)            | The research question is missing                                                        | Reduced sample Non-representative sample | Non-validity and reliability of instruments with their own data Instruments unknown and not provided for in the Annex | Non-grouping        | No graphs or tables They do not analyze each variable Not analyzing generalization effects | They do not compare with previous current studies | No ethical controls (informed acceptance to participate, confidentiality...) | Sample must be larger |
| Research                | Background limitations | Limitations on participants | Limitations of the instrument | Program limitations | Limitations of results | Discussion on limitations and conclusions | General limitations | Comments                          |
|-------------------------|------------------------|------------------------------|--------------------------------|---------------------|------------------------|------------------------------------------|---------------------|-----------------------------------|
| Pequeño et al. (2017)   | The research question is missing | Reduced sample               | Non-validity and reliability of instruments with their own data | No number of sessions Not who implemented | No graphs or tables They do not analyze each variable | They do not compare with previous current studies | No ethical controls (informed acceptance to participate, confidentiality...) | Sample must be larger |
|                        | Missing assumptions or forecasts | Non-representative sample    | Instruments unknown and not provided for in the Annex |                      |                        |                                          |                     |                                   |
|                        | Missing targets         |                              |                                |                     |                        |                                          |                     |                                   |
| Robertson et al. (2012) | Obsolete fonts          | Reduced sample               | Non-validity and reliability of instruments with their own data | Not who implemented | No graphs or tables They do not analyze each variable | Does not indicate Reliability and Validity Assessment | It's not an experimental intervention study, it's just a pre-post group Key information to replicate the intervention is missing No ethical controls (informed acceptance to participate, confidentiality...) | The application of standardized chords and instruments is lacking. Few evaluation strategies |
|                        | The research question is missing | Non-representative sample    | Instruments unknown and not provided for in the Annex |                      |                        |                                          |                     |                                   |
|                        | Missing assumptions or forecasts |                              |                                |                     |                        |                                          |                     |                                   |
|                        | Missing targets         |                              |                                |                     |                        |                                          |                     |                                   |
| Sharp (2018)            | The research question is missing | Lack of inclusion and exclusion criteria | Non-validity and reliability of instruments with their own data | No number of sessions Not who implemented | No graphs or tables They do not analyze each variable | They do not compare with previous current studies | Key information to replicate the intervention is missing | The application of standardized chords and instruments is lacking. Few evaluation strategies |
|                        | Missing assumptions or forecasts |                              |                                |                     |                        |                                          |                     |                                   |
|                        | Missing targets         |                              |                                |                     |                        |                                          |                     |                                   |
| Tomczyk et al. (2020)   | Missing research question Missing assumptions or forecasts | Lack of inclusion and exclusion criteria | Non-grouping | No tasks Do not record the entire process | Non-grouping | They do not analyze each variable | They do not compare with previous current studies | No ethical controls (informed acceptance to participate, confidentiality...) | Few evaluation strategies |
|                        |                           |                              |                                |                     |                        |                                          |                     |                                   |
| Vinokurova et al. (2021)| The research question is missing | Lack of inclusion and exclusion criteria | Non-grouping | No tasks Do not record the entire process | Non-grouping | They do not analyze each variable | They do not compare with previous current studies | No ethical controls (informed acceptance to participate, confidentiality...) | Does not indicate the procedure or the participants or the sessions |
| Research            | Moment       | Comparison of the control group | Sequence of instruction | Previous written protocol | Comparable instructor training | File                                                               | Uniform and standard application |
|---------------------|--------------|---------------------------------|-------------------------|----------------------------|-------------------------------|----------------------------------------------------------------------|----------------------------------|
| Alfonzo and Batson  | Pre          | Evaluate the group in general    | 3 workshops: Library Orientation, APA style, ZOTERO          | Day 1: Library orientation, APA style. Day 2, 3, and 4: ZOTERO | Does not specify              | Pre-evaluation, post-evaluation, and follow-up evaluation using Qualtrics software | Equal application of the program to all students: same duration, sequence, tasks, and context |
| (2014)              | During       |                                 |                         |                            |                               |                                                                      |                                  |
|                     | Expose       |                                 |                         |                            |                               |                                                                      |                                  |
|                     | Follow       |                                 |                         |                            |                               |                                                                      |                                  |
| Ata and Yıldırım     | During       | Evaluate the group in general    | Does not specify        | Does not specify           | Does not specify              | Does not specify                                                     | Equal application of the program to all students: same duration, sequence, tasks, and context |
| (2019)              | Expose       |                                 |                         |                            |                               |                                                                      |                                  |
|                     | Follow       |                                 |                         |                            |                               |                                                                      |                                  |
| Ball                | During       | Evaluate the group in general    | Modules of history and editorial culture, markets, and media. Editorial Skills Module, Reading for Writing, and Grammar Development and General Literacy | Does not specify           | Does not specify              | Portfolios and weekly blog                                            | Equal application of the program to all students: same duration, sequence, tasks, and context |
| (2019)              | Expose       |                                 |                         |                            |                               |                                                                      |                                  |
|                     | Follow       |                                 |                         |                            |                               |                                                                      |                                  |
| Botturi             | During       | Evaluate the group in general    | Agreed with students that provided instructions on the topics they wished to cover | Does not specify           | Does not specify              | Balance                                                              | Equal application of the program to all students: same duration, sequence, tasks, and context |
| (2019)              | Expose       |                                 |                         |                            |                               |                                                                      |                                  |
|                     | Follow       |                                 |                         |                            |                               |                                                                      |                                  |
| Campbell and Kapp   | During       | Evaluate the group in general    | Does not specify        | Does not specify           | Does not specify              | Questionnaires, portfolio, and interviews                           | Equal application of the program to all students: same duration, sequence, tasks, and context |
| (2020)              | Expose       |                                 |                         |                            |                               |                                                                      |                                  |
|                     | Follow       |                                 |                         |                            |                               |                                                                      |                                  |
| Carl and Strydom    | Pre          | They evaluate the group in general although I am divided into two subgroups | Stages: familiarization, indexing, graphing and cartography, and interpretation | Familiarization - blo-share | Does not specify              | Recorded interviews - portfolio                                      | Equal application of the program to all students: same duration, sequence, tasks, and context |
| (2017)              | During       |                                 |                         |                            |                               |                                                                      |                                  |
|                     | Expose       |                                 |                         |                            |                               |                                                                      |                                  |
|                     | Follow       |                                 |                         |                            |                               |                                                                      |                                  |
| Domingo-Coscolla et | During       | Evaluate the group in general    | Does not specify        | Does not specify           | Does not specify              | Scales and focus groups                                              | Equal application of the program to all students: same duration, sequence, tasks, and context |
| al. (2020)          | Expose       |                                 |                         |                            |                               |                                                                      |                                  |
|                     | Follow       |                                 |                         |                            |                               |                                                                      |                                  |

(Continued)
| Research                           | Moment | Comparison of the control group | Sequence of instruction                                                                 | Previous written protocol                                                                 | Comparable instructor training                                                                 | File                                                                 | Uniform and standard application                                                                 |
|-----------------------------------|--------|---------------------------------|----------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|----------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------|
| Elliott et al. (2018)             | During | Evaluate the group in general   | Sessions with opportunities for group discussions and questions. Module essential reading was provided in weekly online study units | Does not specify                                                                          | Broader university support from support staff specializing in academic skills in the “learning development team” and library staff. | Questionnaires, essays, and portfolio                                                                 | Equal application of the program to all students: same duration, sequence, tasks, and context |
| Elphick (2018)                    | During | Evaluate the group in general   | Conferences and seminars—direct observation—scales—interviews                            | Does not specify                                                                          | Training sessions facilitated by an Apple professional Authorized Development Coach            | Narratives—presentations—classroom observations—comments and feedback—audiovisual recordings | Equal application of the program to all students: same duration, sequence, tasks, and context |
| Gabriele et al. (2019)            | During | Evaluate the group in general   | 1. Experimental research plan 2. The reading material was organized (power point presentations, introductory videos of the software, brochures, applications created ad hoc as examples) | Does not specify                                                                          | Does not specify                                                                          | Scales and individual tests                                                                 | Equal application of the program to all students: same duration, sequence, tasks, and context |
| Gill et al. (2015)                | Pre    | Evaluate the group in general   | Of the different subjects related to ICT in the career                                     | Of the different subjects related to ICT in the career                                        | Does not specify                                                                          | Interviews                                                                                     | Equal application of the program to all students: same duration, sequence, context tasks             |
| Hamutoglu et al. (2019)           | During | Evaluate the group in general   | Preliminary tests of the first week. In the following week session on the Edmodo platform and an orientation training on the content of the course | Does not specify                                                                          | Does not specify                                                                          | Two standardized scales                                                                                      | Equal application of the program to all students: same duration, sequence, context tasks              |
| Istenic et al. (2016)             | Pre    | Evaluate the group in general   | Six tasks                                                                                | Students completed the pre-test before the start of the study and the subsequent test 15 days later. | Does not specify                                                                          | Digital Literacy Stories—Pre and Post-Assessment                                                    | Equal application of the program to all students: same duration, sequence, context tasks              |
| Kajee and Balfour (2011)          | Pre    | Evaluation of the intervention group and another equivalent control group to verify differential efficacy | Semester 1: Digital Writing Semester 2: Digital Research                                  | Does not specify                                                                          | Does not specify                                                                          | Digital literacy stories—semi-structured interviews—observations—access and sufficiency surveys—journal of researchers’ reflections | Equal application of the program to all students: same duration, sequence, context tasks              |
| Research                  | Moment | Comparison of the control group | Sequence of instruction | Previous written protocol | Comparable instructor training | File                                                                 | Uniform and standard application |
|--------------------------|--------|---------------------------------|-------------------------|---------------------------|------------------------------|----------------------------------------------------------------------|----------------------------------|
| Kuhn (2017)              | During | Evaluation of the intervention group and another equivalent control group to verify differential efficacy | Scales—exhibition—discussion groups | Does not specify | Does not specify | Narratives—exhibitions—classroom observations—comments and feedback—audiovisual recordings | Equal application of the program to all students: same duration, sequence, context tasks |
| Lerdpornkulrat et al. (2019) | During | Only the GC participates in a formalized face-to-face activity based on the use of the course rubric as a self-assessment tool | Through the rubric they were able to self-evaluate their own work After receiving feedback, both groups of students reviewed and resubmitted their feedback Complete projects again | Does not specify | Does not specify | Questionnaires developed ad hoc—standardized questionnaires | only the students of the experimental group participated in a formalized activity in the classroom |
| Paige et al. (2016)      | Pre    | Evaluate the group in general | Slowmation, vivas, digital narratives, roundtables, interviews and oral assessments | Slow | Does not specify | Pre- and post- intervention test—Scale | Equal application of the program to all students: same duration, sequence, context tasks |
| Paqueño et al. (2017)    | During | Evaluation of the intervention group and another equivalent control group to verify differential efficacy | Narrative—characteristics—exhibition—analysis—reworking—exhibition and possibilities | Digital ethnography for examine relations with technologies and the media and how they mediate in the configuration of subjectivities | Does not specify | Narratives—exhibitions—classroom observations—comments and feedback—audiovisual recordings | Equal application of the program to all students: same duration, sequence, context tasks |
| Robertson et al. (2012) | Pre    | Evaluate the group in general | Digital stories. After the presentation, you are asked to write a written reflection describing your experience | Content analysis and categorization | Does not specify | Digital literacy stories of the—observations—journal of researcher’s reflections | Equal application of the program to all students: same duration, sequence, context tasks |

(Continued)
| Research            | Moment       | Comparison of the control group | Sequence of instruction | Previous written protocol | Comparable instructor training | File | Uniform and standard application |
|---------------------|--------------|---------------------------------|-------------------------|---------------------------|-------------------------------|------|----------------------------------|
| Sharp (2018)        | During       | Evaluation of the intervention group | Does not specify        | Does not specify          | Does not specify              | Scales | Equal application of the program to all students: same duration, sequence, context tasks |
|                     | Expose       | and another equivalent control group to verify differential efficacy |                        |                           |                               |       |                                  |
|                     | Follow       |                                 |                        |                           |                               |       |                                  |
| Tomczyk et al. (2020)| During      | Evaluate the group in general   | Unspecified             | Does not specify          | Does not specify              | Scale | Equal application of the program to all students: same duration, sequence, context tasks |
|                     | Expose       |                                 |                        |                           |                               |       |                                  |
|                     | Follow       |                                 |                        |                           |                               |       |                                  |
| Vinokurova et al. (2021)| During    | Evaluate the group in general | Does not specify        | Does not specify          | Does not specify              | Scale | Equal application of the program to all students: same duration, sequence, context tasks |
|                     | Expose       |                                 |                        |                           |                               |       |                                  |
|                     | Follow       |                                 |                        |                           |                               |       |                                  |

Indicators and controls used in the instructional intervention in the empirical studies reviewed.
dissemination skills (Çoklar et al., 2016; Lerdpornkulrat et al., 2019). Therefore, there is the risk of training an incomplete student body in digital competence. For complete and comprehensive digital literacy for university students, especially future teachers, there is an urgent need to invest in digital literacy programs. This will ensure that the comprehensive digital competence of students corresponds to the use and employment of the Internet and digital devices in their teaching tasks (Gisbert et al., 2016), and be a guarantee of their integration into teaching practice (Aslan and Zhu, 2016; Nikou and Aavakare, 2021).

As for the limitations of this work, they are closely related to the seven indicators for analyzing study quality and effectiveness (Acosta and Garza, 2011), which are: alignment of theory, findings, reliability and validity, descriptive details of participants, and the study, sample, and consistency of findings and conclusions with the data (Risko et al., 2008). Along with evidence-based indicators, and effect sizes of studies (Díaz and García, 2016; Canedo-García et al., 2017). So future lines of research or work, should take into account overcoming these limitations, and embrace them in the face of their development.

The number of studies found in the systematic review is comparable to what is usual in this type of study and even higher. For example, in the exemplary systematic review by Scott et al. (2018), they identified only 29 studies that met the quality criteria, reviewing 50 years of studies published in the US, and of these, only four were quantitative. In the study by Borgi et al. (2020), they only found ten studies that fit the criteria in a very good analysis. Other systematic reviews go along the same lines, and in the same journal and section Frontiers in Psychology. For example, Dickson and Schubert (2020) and Liu et al. (2022) found only six studies in a review of great interest; the study by Nguyen et al. (2021) identified 18 eligible articles; Shou et al. (2022) with 12 studies included; or Tarchi et al. (2021), Huang (2022) found seven studies for quantitative analysis and eight for indirect evidence; Coxen et al. (2021) with 21 articles...
included in the focal analyzes of the systematic review. The number of studies to be representative is not defined by the number but by the existence of such studies. In a systematic review, all studies are reviewed, thus the population of published studies that fit the indicated criteria. With these studies, it was possible to do an analysis of objective indicators in a general comparison between studies; assessing the instruments used; examining the characteristics of the interventions such as strategies, instructional procedure, and psychological variables considered; comparing the fidelity controls of the treatments, which guarantees their rigor and their application in the terms prescribed by the empirical validation of the interventions; and reviewing the limitations of the studies and their contributions by years. These contributions were based on objective data from the studies and have been represented in tables and figures. In addition, a qualitative analysis is provided that highlights the value of intervention studies in relation to digital competence, and the key psychological variables that have been used. It is true that the studies published since 2010 were used, and that there could have been more studies before, but considering the evolution of this type of focus in relation to digital competence and the psychological variables involved, it is evident that the most interesting thing is to consider the recent years which is when its need and use has been generalized throughout the population.

Conclusions

In general, the results show that university students are digitally literate and make efficient use of both the Internet and digital media. In this sense, we found an intermediate or higher level in skills related to communication and collaboration, such as through different chat rooms, platforms, and communication applications. But an intermediate-low level in terms of digital content creation, especially in the creation and dissemination of multimedia content. So, this should be one of the future competencies to increase in this group. Although there are differences according to gender, age, or degree of origin.

We have to invest in comprehensive digital literacy programs for teachers in initial training, which appears implicit in the training plans of their official studies. Digital literacy needs to be a part of the official curriculum, and be developed rather quickly as a separate subject but in an interdisciplinary manner throughout their training. In this way, they become digitally literate people capable of creating and generating digital content and possessing the necessary competencies and skills to use and share such content.

We must also invest in assessing teachers’ self-perception. Only by knowing their opinion, skills, and shortcomings, can digital training programs be designed. Digital literacy is a predictor of good digital use and a predictor of the good use and employment of digital devices and the Internet in the future when they would be teaching.

The findings of this study compel us to consider the following: first, we need to rethink the form and manner in which future teachers are capacitated in digital literacy, if we are doing it in the best way, or if on the contrary there are gaps that should be solved. Second, we should take into account the contributions of the results found and their consequences to formulate effective intervention designs and strategies to effectively capacitate pre-service teachers in digital literacy.

Data availability statement

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

Author contributions

J-NS-G, NG-Á, IM-R, JG-M, and SB-C: conceptualization, methodology, software, writing—review and editing, visualization, supervision, and validation. NG-Á: formal analysis, investigation, and resources: UAL, ULE, USAL, IPC, data curation, writing—original draft preparation, and funding acquisition. J-NS-G and NG-Á: project administration. All authors contributed to the article and approved the submitted version.

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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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