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Digital competence learning ecosystem in higher education: A mapping and systematic review of the literature.

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ABSTRACT The digital competencies of university students are developed using a digital learning ecosystem that integrates: (a) virtual learning environments, (b) digital learning tools, and (c) learning methodologies. This research followed the methodology of systematic literature mapping and review, searching the WoS and Scopus databases and obtaining a total of 5,652 articles between 2001 and 2023. Inclusion and exclusion criteria were then applied to reduce the number of selected articles and carry out a systematic literature mapping and review. Among the relevant results of the literature mapping and systematic review, the geographic distribution of scientific publications, the educational areas in which they have been worked on, and the universities were identified. Educational methodologies, technological tools, and virtual learning environments used to develop university students' digital competences holistically were also determined. This study is useful as it provides a comprehensive, general, and detailed overview of scientific production and its main contributions regarding the methodologies, tools, and environments that contribute to developing students' the digital competencies in higher education.

INDEX TERMS Educational technology, learning systems, Computer aided learning, Computer applications, Information technology, Multiskilling.

I. INTRODUCTION

The acquisition of skills that enable the innovative, critical, and secure use of information and communication technologies to meet goals about employment, education, leisure, inclusion, and social participation is crucial in today's ever-digitalizing world [1]. The application of methodologies, tools, and learning environments can positively impact the conception of digital competences, technological skills, and the type of communication between students and teachers [2].

In this new environment, individuals who possess competences to produce, disseminate, and consume information quickly, effectively, and efficiently stand out. To achieve this, it is essential to know how to transform information into knowledge, have the skills and abilities to use search and production resources and tools, and communicate through digital environments [2].

Digital competences represent an individual's ability to effectively integrate into an increasingly changing world. Development or training in this type of competence is linked to many elements with which the individual comes into contact. In higher education, the use of open educational resources is becoming a current discourse in developing countries due to the improved quality and accessibility of materials [3]. The new open-source technology is trying to integrate social learning communities to promote collaboration, and interaction, and, above all, empower users to master their digital competences. Digital competences are primarily developed through the users' contact with their environment, through the use of technology. Therefore, the use of digital tools is essential. In the study conducted by Pérez-Álvarez et al. [4], a significant weakness is identified in the evaluation of existing tools, as the assessment primarily focuses on usability and utility, leaving gaps in measuring the impact of these tools on the development of digital competences or other implications that could be addressed through a systematic literature review (SLR).

For example, during the COVID-19 pandemic, the demand for digital skills increased significantly as students and instructors had to rapidly adjust to online learning platforms. The International Association of Universities conducted a study demonstrating how higher education institutions worldwide utilized emergency plans to ensure educational continuity. The study emphasizes the significant role of digital capabilities during this tumultuous period [5]. Similarly, Hodges et al. examine the distinction between

emergency remote teaching and planned online learning. They emphasize that schools with established digital competency programs experienced a more efficient and swifter shift to online teaching. As a result, both students and teachers demonstrated greater levels of autonomy and adaptability [6].

To understand the current state of digital competence development and its link to tools, methodologies, and virtual learning environments, a systematic literature review of 83 articles on digital competences was conducted, all obtained from the Web of Science (WoS) and Scopus databases from 2001 to 2023. The results reveal the significant focus on the use of ICTs (Information and Communication Technologies) for learning and how this use has been linked to the development of students' digital competences in higher education. The review highlights various methodologies applicable in digital contexts and the impact of tools on the teaching-learning process. However, so far, no studies have highlighted how the integration of the three areas benefits the positive development of digital competences in university students.

Given the findings, the educational technology community has the responsibility to open a critical discussion on the importance of integrating the three areas that benefit the applicability of digital competences: virtual learning environments, methodologies, and tools. In the fourth industrial revolution, society will face a series of challenges that amalgamate irreversibly, and with it comes the need for changes, where technologies and their increasing use lead to differentiating between those who possess certain digital competences and those who ignorantly disregard their impact in the current context [7].

This study is relevant at a time when the acquisition of digital skills in higher education has transitioned from being an advantage to becoming an essential need. This study differs from other studies by offering a holistic perspective on how learning approaches, resources, and settings interact as a cohesive system to improve key skills in a worldwide educational setting. The text emphasizes how current global crises, such as the COVID-19 epidemic, have changed the requirements and uses of these fundamental talents. This study greatly enhances the existing body of literature by thoroughly examining the interaction between technology and pedagogy. As a result, it equips students and educators with the necessary skills to navigate the complexities of a linked and ever-changing world.

II. CONCEPTUAL FRAMEWORK

Student digital competences

The prioritization of digital skills development persists in higher education. This phenomenon can be attributed to the circumstances surrounding university students in the 21st century, who have been raised in a swiftly changing technological milieu. The advent of the digital era has marked a decisive turning point in societal advancement, characterized by the remarkable development of computer networks and the proliferation of the Internet, which serves as the foundational platform supporting other innovations. Among these are virtual reality (VR) and artificial intelligence (AI), which are technologies that have assumed a prominent role in our culture, especially during the COVID-19 epidemic. These technologies are frequently utilized through various online platforms [8].

The key areas of digital competence are digital information and technology literacy, communication and cooperation, the creation of digital material, security, and troubleshooting [9].

Students possess advanced digital literacy, encompassing more than just basic technological expertise. The emphasis is on equipping students to engage in digital settings with critical thinking and thoughtful analysis. This entails not just utilizing digital technologies but also comprehending their functionality and assessing them in diverse scenarios, such as generating content, resolving issues, and acquiring information [10–11]. The European Commission has emphasized the significance of integrating these competencies into higher education to provide students with the necessary tools to navigate a dynamic digital landscape [12].

Today, for example, students need to acquire digital skills to access a wide range of information sources and critically evaluate through academic databases. On the other hand, teachers and students can leverage learning management platforms for seamless communication and collaboration, thus facilitating joint work and the sharing of educational materials. Furthermore, in digital content creation, students and teachers can use these skills to integrate text, graphics, and multimedia in digital presentations that enrich learning, showing not only their understanding of the content but also their ability to use technological tools effectively. This equips individuals with the necessary skills and knowledge to fulfill their responsibilities as conscientious members of the digital society [13–14].

Developing digital abilities among university students has become a primary goal in today's educational environment. In this context, a learning ecosystem is seen as a crucial platform for cultivating these talents.

Recent research [15] has shown that digital literacy is crucial for university students to have the necessary skills to navigate and thrive in a technology-driven world. This includes being prepared to tackle issues in many sectors, such as education, industry, and global markets.

Student digital competences are cultivated within a digital learning environment, enabling students to gain technical skills and successfully utilize digital tools and resources to improve their learning.

Digital Learning Ecosystem:

The idea of a "learning ecosystem" goes beyond simple information transfer, delving into the intricate interplay of many variables in today's educational landscape. This approach views learning as a complex and interconnected system in which various factors influence the development of skills and abilities. It imagines a varied and enhanced educational setting that includes both physical and virtual elements.[16]

The Digital Learning Ecosystem (DLE) consists of two main components: establishing a digital environment that supports learning management for learners and instructors and fostering continuous learning by promoting autonomy and self-regulation in the learning process. This strategy empowers learners by providing them with more autonomy over their time, place, and study style, which promotes self-directed learning and flexibility [17].

A learning ecosystem is a complex and flexible setting that incorporates many components such as pedagogical approaches, educational technology, physical and virtual locations, and social interaction [18]. This method highlights that learning takes place within a dynamic and changing environment, where the interaction among many aspects is essential for the educational process.

There are several understandings of the digital learning ecosystem, but it is generally accepted that it should consist of a digital learning environment, learning tools and resources, and proven learning methodologies [19-22]. Figure 1 depicts a comprehensive approach that lays the groundwork for creating and implementing effective digital educational environments that promote meaningful and long-term learning.

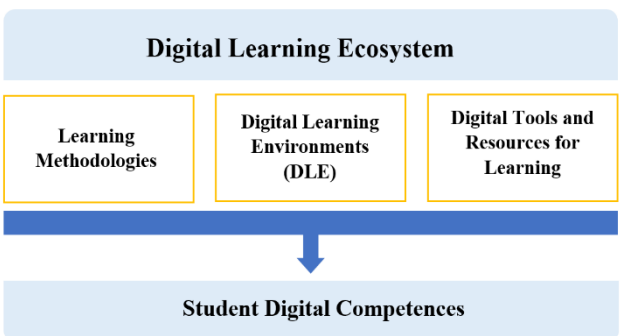

Fig. 1. Digital Learning Ecosystem.

Learning Methodologies:

Pedagogical methodologies are essential in the digital learning ecosystem. Learning methodologies encompass techniques and pedagogical approaches that assist students in acquiring knowledge [23]. Barak and Levenberg emphasize how adaptive methodologies and flexible thinking in technologically enriched environments not only improve students' adaptation to learning environments but also foster greater retention and understanding of knowledge [24].

These methodologies in the digital environment may involve active methods, project-based learning, online collaboration, and other practices that utilize technology to enhance education and learning [25-27].

It is vital to emphasize that educators require a combination of pedagogical skills and technological competencies to effectively execute these methodologies [28].

Digital Learning Environments (DLE)

Digital learning environments are a fusion of instructional design, technology, and pedagogy. These settings encompass all the factors that either help or hinder learning, as defined by one source [29]. A prominent example of a digital learning environment is Moodle LMS, one of the most popular open-source educational platforms. In this regard Keskin, et al. [30] assert that these digital learning environments can be utilized to enhance teaching and learning processes, emphasizing the incorporation of digital technology in education as a pivotal instrument for educational advancement.

In the changing world of education, technology has become a catalyst for new ways to collaborate, personalize learning, and access extensive educational resources. Digital learning environments encourage students to take an active role in their education, allowing them to construct knowledge through exploration and experimentation in virtual spaces designed specifically for this purpose. During the COVID-19 pandemic, these environments showed impressive resilience, ensuring educational continuity in times of global uncertainty.

The effectiveness of these digital environments lies in their ability to adjust to specific requirements that meet the unique needs of each learner. For example, for students with disabilities, the incorporation of technologies such as screen readers and adaptive interfaces is essential. In addition, these environments must be customizable to accommodate students' diverse learning styles and paces, maintain high levels of interactivity that promote active and deep learning, scale to serve a growing number of users and ensure the security and privacy of student data.

In terms of basic skills, digital learning environments are invaluable for developing crucial 21st-century skills. Digital literacy, for example, is fundamental to teaching students how to effectively navigate online information and assess its credibility. They also foster critical thinking through activities that challenge students to analyze information, detect biases, and make informed decisions. In addition, collaborative skills are reinforced in projects in which students use digital tools to work in teams, a crucial practice is preparing young people for the challenges of modern professional environments, while promoting creativity and innovation to address complex real-world problems.

Digital Tools and Resources for Learning:

Us Digital tools and resources for learning are real and virtual instruments and materials utilized to improve the acquisition of information and skills. In the digital realm, these tools

include online educational platforms, interactive software, simulations, and various multimedia resources aimed at enhancing the learning process [31].

This framework emphasizes the significance of cultural and technical instruments in facilitating learning. Technology, like Moodle and interactive digital resources such as simulations and instructional games, is widely used in education to improve teaching methods and engage students actively [30]. Integrating these tools expands access to knowledge and promotes interactive and participatory learning. Educational games may successfully engage pupils and enhance information retention [32]. The development of digital competencies under a learning ecosystem demonstrates the increasing alignment of technology (tools) and teaching methods to improve learning effectiveness.

III. REVIEW METHODS

This study adopts the systematic methodology proposed by Kitchenham and other leading researchers [33] [34] [35] [36] [37], focused on the exhaustive review of the existing literature on a specific research topic to identify, evaluate and interpret previous studies. Through the systematic mapping and review of the literature related to methodologies, tools, and virtual environments used in the development of digital competencies, we have established the main references to studies conducted in this context. However, beyond methodological rigor, this study seeks to transcend academic barriers to resonate in a meaningful way with the daily experiences and challenges of educators, students, and educational technology professionals. By integrating studies that present concrete examples that illustrate the application of these tools and methodologies, we aim to provide a richer perspective, in a context that highlights their relevance and immediate applicability.

A. Planning Review and Mapping

To carry out the review and mapping procedure, a review protocol was used, which consists of defining specific guidelines for information retrieval. This process involves a thorough exploration of specialized databases to obtain relevant documentation that will be used as study material. The documentation was obtained by applying filters based on both inclusion and exclusion criteria in the selected databases. Subsequently, the results obtained were analyzed and evaluated, which will form the theoretical and empirical foundation of the research.

We utilized a standardized data extraction form to extract relevant data from each selected study, including study characteristics, methodological details, and key findings. The data were entered into a centralized database to ensure consistency and facilitate analysis. We conducted qualitative analysis to identify recurring themes and quantitative analysis to synthesize findings using descriptive statistics and meta-analytic techniques.

B. Research questions

The research questions delimit the scope and focus of the investigation. These were formulated within two lines of inquiry: those about the mapping process and those that guided the literature review. The following are the two sets of questions presented.

1) MAPPING QUESTION (MQ)

The mapping research questions serve to identify and analyze the availability, scope, and characteristics of relevant resources, tools, or elements in a specific area or field of study, to obtain a panoramic and contextualized view of the research topic.

MQ1. What is the scientific production related to digital competences in university students in the academic databases Scopus and WoS from 2001 to 2023?

MQ2. In which year happened the highest scientific production on digital competences in students?

MQ3. What are the concepts that emerge during the search process related to students' digital competences?

MQ4. What is the geographical distribution of high-impact scientific knowledge in this topic?

MQ5. Who are the most outstanding authors in the field of digital competences in university students?

MQ6. In which areas have studies on digital competences in university students been published?

MQ7. What are the universities that have published works related to digital competences in university students in the academic databases Scopus and WoS between 2001 and 2023?

2) RESEARCH QUESTIONS (RQ)

The systematic literature review answers the following research questions:

RQ1. What are the areas of digital competences that have been developed in universities?

RQ2. What are the methodologies that have been implemented in higher education to develop digital competences in students?

RQ3. What are the technological tools that have been incorporated into teaching practice to facilitate digital competences in students?

RQ4. What contexts, areas, or learning environments have been used to develop digital competences in university students?

3) SCOPE OF THE RESEARCH

To define the scope and approach of a systematic review, research questions were established as the starting point of the systematic review, followed by the following steps:

1) Establishment of inclusion and exclusion criteria: These criteria were based on population, intervention,

comparison, outcome, and study design (known as PICO criteria) [38] [39] [40] [41].

a) Population/Problem (P): The target group for the research. In this study: digital competences.
b) Intervention (I): The topics of interest were detailed. In this case, the development of digital competences, methodologies used for that purpose, and virtual tools and environments.
c) Comparison/Control (C): Aspect of the research against which the intervention is compared. In the case of this study, we do not seek to make comparisons between different areas of application of digital literacy studies but to make inferences and find interrelationships based on the analysis.
d) Outcome of interest (O): The results were structured, and the analysis was carried out.

2) Determination of databases and sources of information: The databases used for the search of studies were Scopus and Web of Science.
3) Development of a search strategy: This strategy included the search for relevant terms and appropriate Boolean operators to retrieve relevant studies (i.e., search equations).
4) Conducting the search and selection of studies.
5) Data extraction and analysis: Once the studies were selected, relevant data were identified, and the corresponding analysis was carried out.
6) Evaluating the quality of the studies.
7) Synthesizing the results and preparing the review, including a discussion of the limitations and implications of the results.

C. Search Strategy

According to Lasserson, et al. [40] inclusion criteria are designed to identify those fundamental characteristics that studies must present to be considered relevant and contribute significantly to our field of research. In contrast, exclusion criteria detail the specific conditions under which studies will be omitted, avoiding the incorporation of research that does not meet essential methodological or thematic requirements. This distinction is vital to maintaining the integrity and objectivity of our systematic review, following internationally recognized standards of academic excellence. Within the framework of this study, we have meticulously defined inclusion (IC) and exclusion (EC) criteria to ensure a rigorous and accurate selection of articles.

The researchers independently extracted data and compared results to ensure consistency. We tested and refined the extraction form before full implementation and triangulated data from different sources to corroborate findings. We implemented a comprehensive search strategy to identify all relevant studies, minimizing publication bias.

To address the research questions, inclusion and exclusion criteria were employed, as shown in Table 1.

TABLE I
INCLUSION AND EXCLUSION CRITERIA FOR SOURCES IN THE STUDY.

Inclusion criteria	Exclusion criteria
• IC1: Articles contain a proposal or approach related to the development of digital competences in higher education contexts. • IC2: The selected study applies or integrates methodologies for the development of digital competences. • IC3: The study presents, supports, analyzes, or improves the development of digital competences using diverse technological tools or different virtual environments. • IC4: Works were written in English/Spanish. • IC5: Articles were published in peer-reviewed journals.	• EC1: Absence of proposal or approach related to digital competences. • EC2: The study does not apply or integrate the development of digital competences. • EC3: The presented solution does not aim to support, analyze, or improve digital competences in virtual environments. • EC4: Works were not written in English or Spanish. • EC5: Articles were not published in peer-reviewed journals.

D. Database selection criteria

After defining the research questions and the inclusion and exclusion criteria, the sources of the works and the search strings to be used in those sources were established. To this end, databases that met certain requirements were selected:

- The database had to allow the use of logical expressions or a similar mechanism that facilitated the search.
- It was valued that the database allowed for complete searches or searches in specific fields of the works.
- It was verified that the database was available to the authors, either through their research institutions, personal subscriptions, or others.
- It was evaluated that the database was relevant and that it only contained quality-assured contents.

As a result, two electronic databases were chosen: Web of Science and Scopus. These two databases were considered sufficient to conduct valid literature reviews and systematic mappings. It should be noted that these databases are widely recognized for their coverage, quality, and reliability in the scientific field, ensuring the rigor and solidity of the research.

E. Search query.

Once the databases were selected, search queries were created, which included critical concepts linked by boolean operators. For this purpose, each keyword was searched in the two established languages. Based on the keywords, various combinations were used to optimize the search, based on the search queries detailed in Table 2

TABLE II
SEARCH EQUATIONS IN THE DATABASES USED.

WoS	Scopus
• (TS=("digital competencies" OR "digital literacy" OR "digital skills" OR "digital fluency") AND TS=("university students" OR "college students" OR "higher education students") AND TS=("methodologies" OR "tools" OR "learning environments"))	• ("digital competencies" OR "digital literacy" OR "digital skills" OR "digital fluency") AND ("university students" OR "college students" OR "higher education students") AND ("methodologies" OR "tools" OR "learning environments")

Regarding this search query, the search was restricted by the publication date included in the database filters from the year 2001 to the year 2023.

F. Quality Assessment

To collect all the results obtained from the databases, a repository was created following the procedure described by Gómez-Isla et al. [42]. Subsequently, a spreadsheet was designed to perform a final filter on the selected documents, based on the previously established inclusion criteria. The form consisted of two sections:

In Section 1, aspects related to the dissemination of the document were evaluated, such as the source database, document type, language, author, year of publication, title, and means of dissemination.

In section 2, theoretical-methodological aspects were evaluated, including the state of the art, context, methodology, instruments (validity and reliability), underlying theory, text related to keywords, participants, and emerging concepts. Each indicator was valued with a score of 5 (central topic), 3 (mentioned, but not central), or 1 (not mentioned).

This stage allowed the selection of articles that would be analyzed in-depth during the systematic literature review, considering the score obtained for each indicator about the average. In this way, the most relevant and appropriate documents were ensured to answer the research questions.

In this sequence of actions, the resulting articles were first analyzed through the review of their title and abstract, by applying the inclusion and exclusion criteria previously established. In cases where the title and abstract were not sufficient to decide, the content of the document was evaluated.

Finally, the selected articles were read in detail and analyzed by following the research questions previously established. The documents that passed this phase went through a quality evaluation checklist with the criteria detailed in the following section.

The researchers evaluated each study for methodological quality and applied clearly defined inclusion and exclusion criteria. To ensure reliability, the researchers independently extracted data and compared results. The extraction form was tested and refined before full use.

To ensure validity, data were triangulated from different sources to corroborate findings, and a comprehensive search strategy was implemented to identify all relevant studies, minimizing publication bias.

G. Data extraction and synthesis

During this stage, folders were created in the EdNote manager for each database to store the discovered publications. Then, searches were conducted in the selected databases using a series of filters that included author details, subject area, publication year, institution, document type (review), publication type (open access), country, and language.

The search and filtering process was adapted to the characteristics of each academic database and was carried out differently for each of them.

To provide detailed information on the total number of articles considered in the study, we used the PRISMA flow diagram commonly applied to report systematic reviews [38]. Tables and graphics were used to synthesize information and perform in-depth mapping and analysis of the review based on the following dimensions:

Dimension 1 Development of digital competences in students.

Dimension 2 Learning methodologies for the development of digital competences.

Dimension 3 Technological tools for the development of digital competences.

Dimension 4 Learning environments for the development of digital competences.

Figure 2 shows how the publications found have been filtered along the phases in the systematic literature review.

IV. RESULTS

This study has been performed to conduct a mapping and systematic review of the literature on methodologies, tools, and learning environments for developing digital competences in university students. The following are the relevant results obtained.

A. MAPPING RESULTS

During the systematic literature review, 83 articles were studied based on the questions established for analysis. Some of the articles were placed in more than one dimension as they addressed multiple terms of interest, such as tools and methodologies, or virtual learning environments and tools.

The results are based on the research questions.

MQ1. What is the scientific production related to digital competences in university students in the academic databases Scopus and WoS from 2001 to 2023?

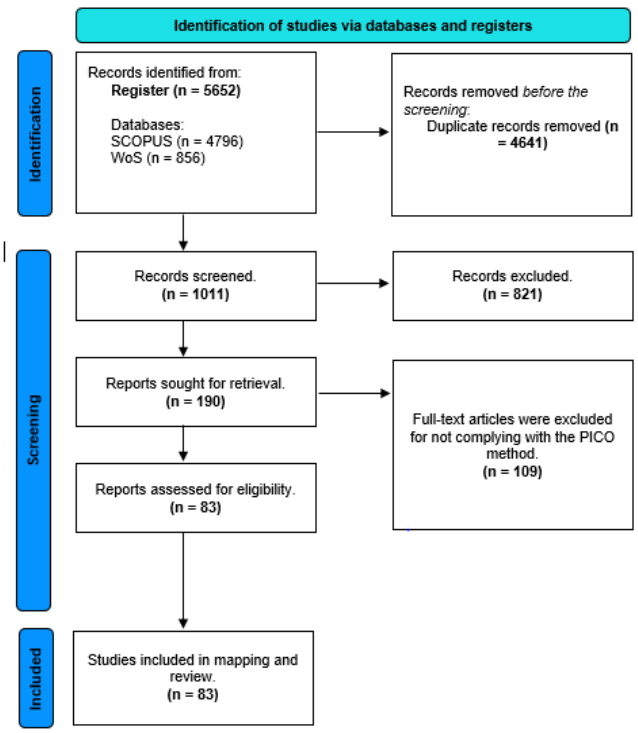

Fig. 2. Distribution of Found Publications.

After analyzing and applying the inclusion and exclusion criteria to address this question, the year 2001 was considered as the starting point for the search. However, it was identified that it is from 2014 onwards when publications related to digital competence in university students began to emerge. The selected articles were counted by year, and the results cover the period from 2014 to 2023. Figure 2 shows the distribution of the number of articles published by year. It should be noted that scientific production related to the development of digital competences reached its highest percentage in 2020.

Of the total, 65.4% of articles were obtained from Scopus and 34.6% from WoS. The selection was made using inclusion and exclusion criteria applied in each of the databases.

MQ2. In which year did the highest scientific production on digital competences in students?

Based on the analyzed articles and Figure 3, it is concluded that the year with the highest scientific productions on digital competences in university students was 2022 since 22% of the 84 selected articles were produced in that year, i.e., 18 publications took place during that year. From 2014 to 2016, it comprises 6%, which is 2% per year. In 2017, 5%; in 2018, 6%; in 2019, 8%; and in 2020 and 2021, scientific production increased by 18% and 19%, respectively. During the first bimester of 2023, regarding the development of digital competences in virtual learning environments, tools, and methodologies, 14 studies have already been published, which is equivalent to 14% of the total studies selected.

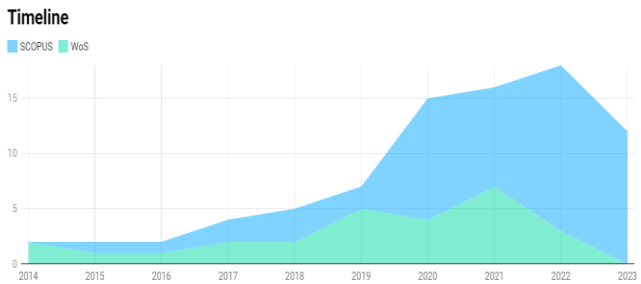

Fig. 3. Timeline of the distribution of scientific production.

MQ3. What are the concepts that emerge during the search process related to students' digital competences?

Most articles focus on the development of digital competence areas, mainly digital literacy, communication, and content creation (Figure 4). There is also a lot of emphasis on the curricular integration of ICTs. However, it is possible to highlight some other concepts such as active methodologies, gamification, use of tools and learning environments such as digital libraries or simulation environments, collaborative learning methodologies, and the MOOC methodology.

The answer to this question arises from the analysis of the titles and abstracts presented in the selected papers for the study. In this way, emerging concepts related to digital competences have been identified.

Fig. 4. Emerging Concepts in the Search Process.

MQ4. What is the geographical distribution of high-impact scientific knowledge in this topic?

Based on the analyzed articles, the data shows that the most important scientific production on methodologies, tools, and learning environments for the development of digital competences in university students is mainly centered in Spain and Mexico. However, some other countries such as Chile, Iran, United Kingdom, among others, can also be highlighted. Spain (37%), China (7%), Mexico (6%), United Kingdom (5%), Bulgaria (4%), as shown in Figure 5.

To ascertain the geographical distribution of high-impact scientific knowledge on this topic, the affiliation of the corresponding author of the publication was taken into consideration.

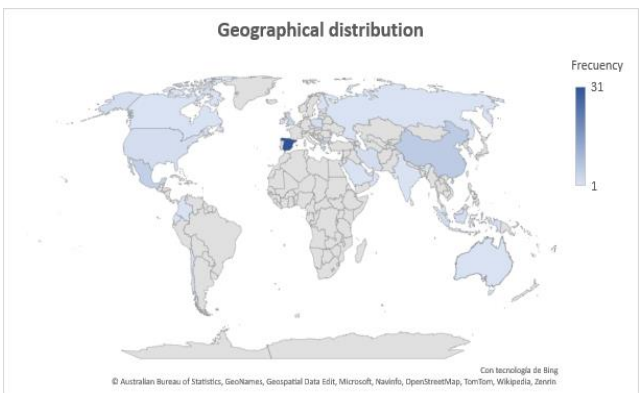

Fig. 5. Geographical Distribution of Scientific Knowledge to digital competences

MQ5. Who are the most outstanding authors in the field of digital competences in university students?

According to the analysis of the articles related to digital competences, Figure 6 includes the most outstanding authors in the academic databases of Scopus and Web of Science.

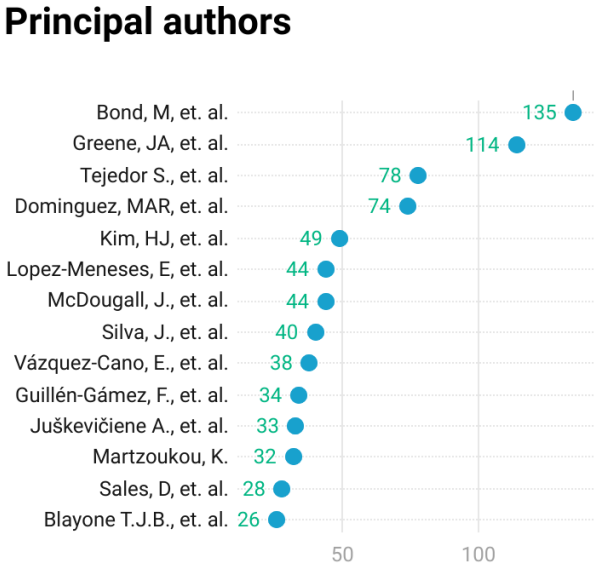

Fig. 6. Outstanding authors about Digital Competences

MQ6. In which areas have studies on digital competences in university students been published?

Based on the articles analyzed, the data shows that the most important scientific production on methodologies, tools, and learning environments for the development of digital competences in university students has been mainly carried out within the discipline of Social Sciences, especially in the areas of education, pedagogy, and psychology. Figure 7 shows the areas in which studies have been published using the funnel chart.

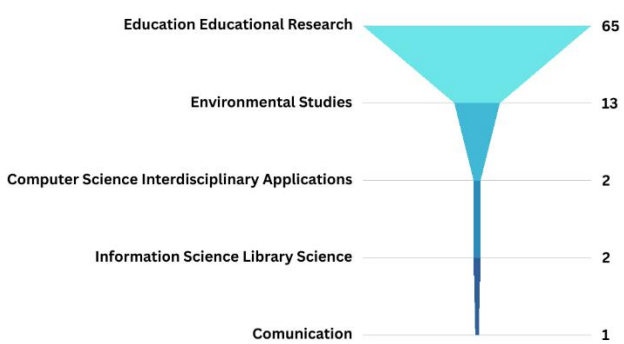

Fig. 7. Areas of the Published Studies.

MQ7. What are the universities that have published works related to digital competences in university students in the academic databases Scopus and WoS between 2001 and 2023?

Considering the analysis of the articles related to digital competences, Figure 8 details the universities that have published works related to digital competences in university.

students, according to the databases used. 68 universities were identified, of which the first 4 with the greatest number of publications are in Spain. To locate the study in one of the universities, the affiliation of the first author was

considered. The term "first author" refers to the primary or lead author of a research article. Typically, the list of authors in a scientific paper is organized in order of contribution, and the first author is the one who has carried out much of the work.

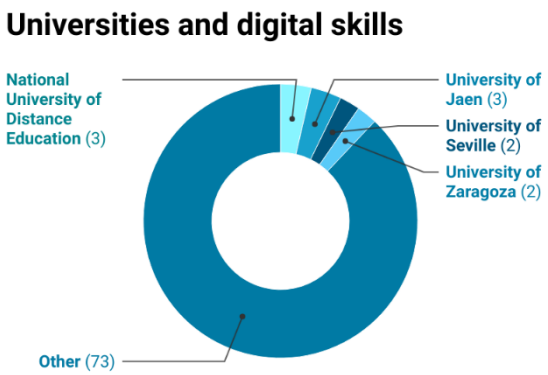

Fig. 8. Comparative analysis of digital competences in higher education institutions from scientific publications

B. RESULTS OF THE SYSTEMATIC LITERATURE REVIEW

To organize the presentation of the results and facilitate the interpretation of the answers to the research questions, four dimensions are presented, which correspond to each one of the questions, that is, each question is simplified as follows in one dimension:

- **D1. Development of digital skills in students:** RQ1. What are the areas of digital competences that have been developed in universities?
- **D2. Learning methodologies for the development of digital skills:** RQ2. What are the methodologies that have been implemented in higher education to develop digital competences in students?
- **D3. Technological tools for the development of digital skills:** RQ3. What are the technological tools that have been incorporated into teaching practice to facilitate digital competences in students?
- **D4. Learning environments for the development of digital competences:** RQ4. What contexts, areas, or learning environments have been used to develop digital competences in university students?

D1. Development of digital competences in students.

RQ1. What are the areas of digital competences that have been developed in universities?

Changes in digital environments are necessary to provide a quality education that meets the needs of students and digital competences. Digital competences are not just the ability to use a computer or a device. According to a systematic review of the literature, digital competences include five areas: digital literacy, communication and collaboration, content creation, safety, and problem-solving [41]. Digital competences help students design programs or plans related to their scientific needs, develop computational thinking [42], solve software problems by searching online, communicate rationally with others online, and find answers to their scientific questions and problems [43] [44] [45].

Developing students' digital competences would lead to a more effective, efficient, and engaging use of digital spaces for better learning [46] [47]. On the other hand, Monroy García et al. (2020) [48] and Toh et al. (2022) [51] point out that students who use ICTs have better knowledge. The University of Zaragoza observed that navigation in digital environments is becoming more common, and there is increasing awareness that not everything on the Internet is "valid," but it is necessary to know how to select, store, and retrieve data safely [44]. Also, Heidari et al. (2021) [48] and Tejedor et al. (2020) [52] state that developing digital competences in students can improve their digital literacy and critical thinking when dealing with the digital world. Regarding communication, the data obtained indicate that the level of proficiency in digital spaces as a means of communication is increasingly higher, as well as the use of digital services [44]; considering individual motivation and commitment to digital incentives is an important factor [52]. A study conducted in Finland, related to the design of virtual games, indicates that some students make significant leaps in the development of their digital competences, especially problem-solving, with their participation in design projects [50]. Students feel motivated to complete the training processes when they have developed digital competences in all dimensions [53]. Table 3 shows the classification of digital competences described in different studies related to the development of digital competences.

TABLE III
AREAS OF DIGITAL COMPETENCES

Areas of digital competence	Author	Year
Digital literacy	Blayone T.J.B., et al.	2018
	Juškevičiene A., et al.	2018
	Nowak B.M.	2019
	Tejedor S., Cervi L., et al.	2020
	Grande-De-prado M., et al.	2020
	Romero-García C., et al.	2020
	Romero-Rodriguez L.M., et al.	2020

Areas of digital competence	Author	Year
	Llorent-Vaquero M., et al.	2020
	Sales, D; et al	2020
	Martzoukou, K; et al.	2020
	Romero-García, C., et al.	2020
	Mehrvarz M., et al.	2021
	Romero-Tena R., et al.	2021
	del Arco, I, et al	2021
	Burgos-Videla, C. G., et al.	2021
	Gómez-Poyato M.J., et al.	2022
	Prince, M. S., et al	2016
	Lopez-Meneses, E, et al	2020
Communication and Collaboration	Martin-Suarez, A, et al	2014
	Jiménez-Cortés R., et al.	2017
	Grande-De-prado M., et al.	2020
	Romero-García C., et al.	2020
	Arango-Morales A.J., et al.	2020
	Vázquez-Cano E., et al	2020
	Lopez-Meneses, E, et al.	2020
	Heidari E., et al.	2021
	Cebrian-Cifuentes, S, et al.	2021
	Blasco-Serrano, A. C.,, et al.	2022
	Vonkova H., et al.	2022
Content creation	Esteve-Mon, FM, et al.	2019
	Vázquez-Cano E.,et al.	2020
	Lopez-Meneses, E, et al	2020
	Laakso N.L., et al.	2021
	Heidari E., et al.	2021
	Cebrian-Cifuentes, S, et al.	2021
	Blasco-Serrano, A., et al	2022
	Roselló, T	2022
Security	Grande-De-prado M., et al.	2020
	Romero-García C., et al.	2020
	Arango-Morales A.J., et al.	2020
	Blasco-Serrano, A. C., et al.	2022
Troubleshooting	Grande-De-prado M., et al.	2020
	Romero-García C., et al.	2020
	Arango-Morales A.J., et al.	2020
	Mehrvarz M., et al.	2021
	Blasco-Serrano, A. C., et al.	2022

D2. Learning methodologies for the development of digital competences.

RQ2. What are the methodologies that have been implemented in higher education to develop digital competences in students?

Through the analysis of various studies, it is deduced that there is no single way to develop digital competences, but versatile learning methods should be employed, considering individual differences [54].

It has been shown that the application of methodologies in the classroom improves the learning and use of some tools. These results highlight the importance of incorporating experiences to improve the digital competences of university students [55] [56] [57].

Various educational methodologies are used to develop digital competences in university students, and this may vary depending on the discipline and specific objectives of each course or educational program.

Some studies highlight the integration of digital methodologies and strategies into curricula to improve online learning during and after the pandemic [58] [59]. In [60], it is stated that the emphasis on curricular programs and methodologies, as well as support for teachers, plays an important role in the phenomenon of digital competence [61] [62]. Therefore, educational institutions should have mechanisms to train teachers in technology.

Grande-de-Prado et al. [63] state that gamification has the potential to promote digital literacy. In this sense, the teacher must be prepared to implement new emerging and innovative methodologies [64]. On the other hand, courses with pedagogical proposals based on active methodologies [65] supported by digital tools generate an improvement in all areas of digital competence [66] [67]. Another methodology that several authors highlight is the one used in Massive Open Online Courses (MOOCs) [53], through which improvements in students' technological skills are sought. The Flipped Classroom methodology is also another alternative proposed by Blasco-Serrano et al. [68] to improve inclusive education using technology and to benefit the entire academic community. Narrative hypertexts are another methodological resource presented by Cantero Sandoval et al. (2022) [70], which promotes the development of digital competences, like the interaction through forums presented by Al-Ajmi (2021) [76]. These actions favor collaborative and cooperative learning through the online community.

The integration of robotics to develop computational thinking is a favorable alternative that will contribute to the effective achievement of digital competences [52]. Table 4 shows some methodologies and strategies used and proposed by different authors in research related to the development of digital competences.

TABLE IV
METHODOLOGIES FOR DEVELOPING DIGITAL COMPETENCES

Methodologies and strategies	Author	Year
Independent and collaborative learning	Martin-Suarez, A,et al.	2014
	Jiménez-Cortés R., et al	2017
	Blayone T.J.B., et al.	2018
	Arango-Morales A.J., et al.	2020
	Burgos-Videla, C. G., et al	2021
MOOC Methodology	Prince, M. S., et al	2016
	Nowak B.M.	2019

Methodologies and strategies	Author	Year
	Romero-Rodriguez L.M., et al.	2020
Active Methodology	Romero-García C., et al.	2020
	Arango-Morales A.J., et al.	2020
	Burgos-Videla, C. G., et al.	2021
	Cebrian-Cifuentes, S; et al.	2021
	Blasco-Serrano, A. C., et al.	2022
Gamification	Esteve-Mon, FM, et al.	2019
	Laakso N.L., et al.	2021
	Heidari E., et al.	2021
	Cebrian-Cifuentes, S, et al.	2021
Digital informal learning	Mehrvarz M., et al.	2021
	del Arco, I,et al.	2021
Curricular integration of ICT	Juškevičiene A.,et al.	2018
	Arango-Morales A.J., et al.	2020
	Sales, D, et al.	2020
	Grande-De-prado M., et al.	2020
	Llorent-Vaquero M., et al.	2020
	Romero-Tena R., et al.	2021
	Burgos-Videla, C. G., et al.	2021
	Gómez-Poyato M.J., et al.	2022

The DigComp model [77] [78], for instance, employs a task-based learning method based on the 5 dimensions of digital competences defined by the European Commission. It is worth highlighting that the quality of the application of methodologies for developing digital competences is also related to the technology (equipment and connectivity) [79] [80] available to students in both academic and everyday life [81] [82] [83].

D3. Technological tools for the development of digital competences.

RQ3. What are the technological tools that have been incorporated into teaching practice to facilitate digital competences in students?

Digital educational tools enable interaction among students, teachers, and didactic resources, generating continuous and significant amounts of data that can be analyzed using different methodologies. Teachers' digital competence is key to the implementation of ICT in the classroom [62], as they are the ones who encourage the use of technological tools to improve their students' digital competences [84] [85] [86]. Students with high levels of digital competences can identify and organize the most appropriate digital tools and make use of them [55] [53]. Subaveerapandiyan [87] emphasizes that, to improve the digital literacy of university students, it would be interesting to promote the use of virtual tools to develop teamwork, with YouTube being a significant example in this study. Additionally, the use of social media platforms such as Instagram and Pinterest is highlighted, as it can encourage creativity and the use of images as a means of expression by university students [88].

There is a wide variety of technological tools that can be used to develop digital competences in university students and transform higher education [89], such as tools for searching for information and content, selecting, creating, and organizing content, communication, and learning management systems. Table 5 displays some categories of tools used or described by different authors in research on the development of digital competences.

TABLE V
DIGITAL TOOLS FOR DEVELOPING DIGITAL COMPETENCES

Classification of tools	Author	Year
Searching for information and content	Araújo-Vila N., et al.	2020
	Vázquez-Cano E., et al.	2020
	Lopez-Meneses, E, et al	2020
	Rodríguez-Moreno J., et al.	2021
	Moral F.J.R., et al.	2021
	Rodríguez-Moreno, J., et al.	2021
Filtering and selection of information	Eugenia Carrasco Lozano M.E., et al.	2015
	García F.A.M., et al.	2020
	Araújo-Vila N., et al.	2020
	Guillén-Gámez F.D., et al.	2020
	Vázquez-Cano E., et al.	2020
	Lopez-Meneses, E; et al.	2020
	Rodríguez-Moreno, J., et al.	2021
Content creation	Gavaldon, G; McGarr, O	2019
	García F.A.M. et al.	2020
	Araújo-Vila N. et al.	2020
	Vázquez-Cano E. et al.	2020
	Rodríguez-Moreno J. et al.	2021
	Vidal, IMG, et al.	2021
Content organization	García F.A.M., et al.	2020
	Araújo-Vila N., et al.	2020
	Guillén-Gámez F.D., et al.	2020
	Vázquez-Cano E., et al.	2020
	Vidal, IMG, et al.	2021
Learning Management System	Bond, M, et al.	2018
Communication	Vonkova H., et al.	2022

Classification of tools	Author	Year
	Eugenia Carrasco Lozano M.E., et al.	2015
	García F.A.M., et al.	2020
	Araújo-Vila N., et al	2020
	Vázquez-Cano E., et al.	2020
	Vonkova H., et al.	2022

The explicit discussion of online learning systems that support virtual classroom management emphasizes technology's critical role in assisting learning. [90] [91]. Video conferencing tools facilitate the development of digital competences in communication and judgment for sharing and consuming information in the information and knowledge society [92] [93]. Integrating digital tools [88] for content creation, texts, presentations, comics [94], videos or websites, will allow students to manage their learning, optimizing the technical and technological resources they have at their disposal and raising their digital competences to a favorable level [95]. Online tools [96], simulators, and data analysis tools will favor critical thinking; digital scientific literacy [97], as a computational thinking tool [98], will enable students to take charge of their education and develop the digital skills necessary for success in their academic, social, and professional lives [99] [100]. It is important to note that augmented reality digital tools constitute a new scenario for developing digital competences [101].

According to Afrilyasanti & Basthomi [95], several factors influence the use of tools to enhance the development of digital competences; these are: (1) 'age' affects the area of 'Communication and collaboration' [102]; (2) 'educational level' affects 'Digital content creation'; (3) 'specialization' affects 'Communication and collaboration'; (4) 'possession and use of PC' affects 'information and data literacy,' as well as 'problem-solving'; (5) 'possession and use of smartphones' affects 'Communication and collaboration'; and (6) 'use of the Internet' affects 'information and data literacy'.

D4. Learning environments for the development of digital competences.

RQ4. What contexts, areas, or learning environments have been used to develop digital competences in university students?

The development of new skills and competencies is required by the advancements in the information and knowledge society, which also offer new situations and learning environments. [103]. With the start of the twenty-first century and the development of technology, these are now included in educational settings. There are two ways that ICTs can be used in education: either as a supplement to traditional classroom instruction in hybrid environments where traditional and technological approaches coexist or as online training in virtual worlds [104] [98]. Learning environments, both before and after university, should reflect the possible uses of the knowledge that is expected of students, to avoid losing the skills once acquired [105]. Accordingly, the authorities in charge must modify the learning environment to suit the needs and abilities of the students so that high digital competency levels are promoted starting in pre-university education and users of the virtual community produce genuine, long-lasting motivation [106].

According to Subaveerapandiyan [79], the crisis caused by COVID-19 has facilitated the creation of alternative and varied environments for the search for information, consumption, and creation of content, and other factors that allow greater communication [107]. According to Greene et al (2014) [108], academic libraries have a renewed mission to help students in virtual learning environments, making them information-rich and competent. They also have the mission of training them to overcome digital gaps. Digital literacy requires effective self-regulated learning skills [109].

Due to their ability to promote student participation and guarantee active and collaborative learning, virtual learning environments and classroom learning methodologies have garnered a lot of attention lately [110]. This is important to remember since the student needs to demonstrate both digital readiness and academic commitment in these situations [111]. The digital competences that students acquire in an academic and institutional virtual environment can also be developed in open learning environments. Currently, in virtual environments, the form, context, and nature have diversified and are not restricted or limited. In this situation, digital learning constitutes a model of cross-cultural alignment for research and development in educational technology, in addition to allowing a series of comprehensive activities within the pedagogical framework. After the technological revolution, as indicated by Sharpe et al. (2019). [112], Digital material and digital literacy promote learning, and they have a big influence on education. It is noteworthy that digital settings facilitate the examination of pupils' technology usage tendencies [113] and through the artificial intelligence included in different environments, it is possible to analyze and evaluate digital competences [114] and measure their level of achievement [115].

A key example is the virtual environment of the Digital Library of Higher Education in Scotland, which allows for

the acquisition of joint licenses from publishers that provide access to more than 3,000 journals and 60,000 e-books [3]. Likewise, generalized learning management systems provide a common set of basic functionalities. Pampouri et al. (2021) [116] present an evaluation of education students' preferences on the main functionalities of electronic platforms used in the context of blended learning in university education. The results reveal a preference for organizational and informative functionalities and less for communication features.

Table 6 shows some categories of learning environments studied by different authors in research on the development of digital competences.

TABLE VI
LEARNING ENVIRONMENTS FOR DEVELOPING DIGITAL COMPETENCIES

Classification of learning environments	Author	Year
E-learning platforms	Tsankov N., et al.	2017
	J. Silva, M. et al.	2019
	Bond, M, et al.	2018
Wikis and Digital Libraries	Martzoukou K.	2020
	Shopova, T	2022
Social networks	López-Gil, K. S., et al.	2020
Simulation environments	Francesc Esteve Mon, et al.	2013
	J. Silva, et al.	2019

Figure 9 shows how digital competencies are related to teaching methodologies and learning environments. In addition, Digital Literacy competence (18 studies) is strongly related to ICT curricular integration (22 mentions), underlining its importance (1). Communication and Collaboration (11 studies) is associated with independent and collaborative learning (12 mentions), highlighting the relevance of these methodologies ([2]. Content Creation (8 studies) is linked to active methodology (8 mentions), highlighting the importance of dynamic methodologies ([4].

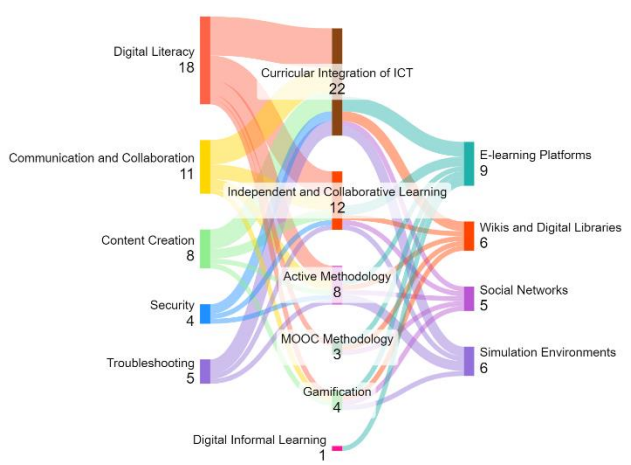

Fig. 9. Relationship between Digital competences, Learning Methodologies, and Digital Learning Environments (DLE)

On the other hand, Figure 10 shows the relationship between digital competencies and technological tools. Digital Literacy (18 studies) is strongly linked to information and content search tools (10 mentions) and information filtering and selection (11 mentions), highlighting its importance in the development of digital competencies [1]. Communication and Collaboration (11 studies) are mainly associated with communication tools (8 mentions) and content creation (10 mentions), highlighting their role in collaborative interaction and production [2]. Troubleshooting (5 studies) is notably related to content organization tools (7 mentions), indicating the importance of structuring information to solve problems [7].

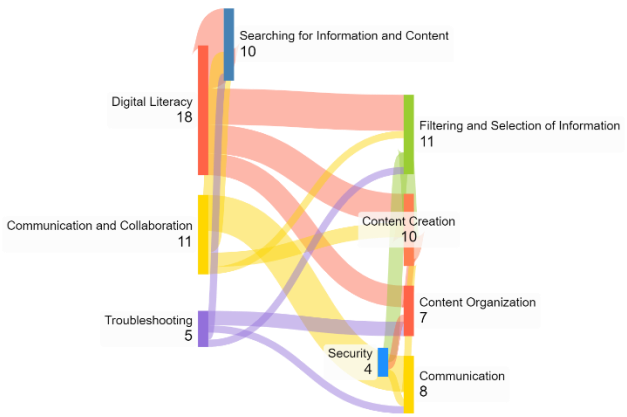

Fig. 10. Relationship between Digital competences, and Digital Tools and Resources for Learning.

V. ANALYSIS OF FINDINGS

From the findings, it is identified that digital competences are developed using digital tools and active methodologies used in virtual learning environments. The information, abilities, attitudes, and values that are required for the critical, inventive, and safe use of digital technology for problem-solving and goal-achieving in social, professional, and personal contexts are known as digital competencies [48].

A widely accepted definition of digital competences is provided by UNESCO, which characterizes them as a collection of abilities, knowledge, and attitudes about the use of digital technologies to access, manage, integrate, communicate, analyze, and create information in a way that is ethical, critical, and effective for problem-solving and task-accomplishment in dynamic social, cultural, and occupational contexts [116].

Regarding methodologies that promote the development of digital competences, active methodology in the digital society stands out. This type of method holistically integrates technical, cognitive, and social skills that allow students to take full advantage of the possibilities offered by digital technologies. Within the active methodologies referred to by the authors, the following stand out: [117].

- Project-based learning (PBL): This approach emphasizes problem-solving in a practical setting and active learning by using digital competencies in projects. PBL applies to both in-person and virtual learning environments.
- Challenge-based learning (CBL): This approach, like PBL, emphasizes problem-solving via challenges linked to the acquisition of digital competencies. Students collaborate in groups to find creative answers to challenging issues and gain digital skills in the process [118].
- Flipped learning: Under this approach, students study the theoretical material outside of class so that they can use the time in class to apply and expand their knowledge through group projects, debates, and problem-solving. This approach is used in conjunction with instructional technology like interactive exercises, educational videos, simulations, and online tests in a digital setting.
- Online collaborative learning: Using digital platforms, this methodology emphasizes teamwork and collaboration to build social skills like leadership, negotiation, and communication as well as digital competencies. [119]
- Gamification: This approach makes use of game dynamics and aspects to promote engagement and active learning in the acquisition of digital competencies. Gamification can be applied in a variety of contexts, including online games, workouts, interactive activities, challenges, and competitions.

Regarding the most common technological tools identified in scientific literature, the following stand out:

- Online learning environments that let students engage in discussion boards, access digital materials, and complete assignments and tests online.
- Virtual classrooms, meetings, and online tutoring are made possible by videoconferencing and communication systems that support online cooperation between educators and learners [120] [121].
- Text and presentation editing tools that facilitate online teamwork by enabling students to create and modify documents in real time and collaboratively.
- Students can produce and modify multimedia content with video production and editing tools, which is helpful for online presentations and projects [122].
- Simulation tools: these can be helpful in teaching subjects like engineering or physics since they let students investigate and examine complicated systems and processes.
- Tools for data analysis that are helpful in fields like statistics or economics for gathering and evaluating data for study and decision-making [123].

In the systematic review of the literature, it has been identified that, using these categorized tools, students will successfully develop digital competences [124] [125].

In the scientific literature, different learning environments or systems have been identified, in which digital competences are being developed in university students [126].

This systematic literature review (SLR) aims to comprehend the existing research in the literature regarding digital competences, including the areas of competences, methodologies, resources, and tools used in higher education to develop these competences. As with any research process, there may be various threats to the validity and limitations of these studies. In the case of SLRs, authors like Neiva et al. (2016) have pointed out that the results "may be influenced by certain uncontrollable limitations".

Access to and availability of databases is one of the study's primary limitations. Even while WoS and Scopus are frequently utilized in scientific publications, likely, some applicable research that was published in lesser-known or other databases has not been included, leading to the potential omission of some important studies. The possible variation in the accuracy and consistency of data stored in databases is an additional constraint.

Although WoS and Scopus are regarded as trustworthy sources, the precision and thoroughness of article indexing determines the quality of the data. The reliability and representativeness of the results could be impacted if any pertinent research is indexed or left out because of technical or human mistakes during the indexing procedure.

In addition, the selected period for the study (2001 to 2023) may have implications for the reliability of the results. During this timeframe, the quantity and quality of studies published in WoS and Scopus may have changed, which could affect the representativeness and generalizability of the obtained results. There may have also been changes in the indexing policies of the databases or inclusion criteria of the studies.

Another significant limitation is the potential presence of biases in the selection of studies included in the SLR. The selection of studies is based on predefined inclusion and exclusion criteria, but the subjectivity and biases of the reviewer may influence the selection of studies, which could affect the validity and reliability of the obtained results.

Furthermore, the interpretation of the SLR results may be affected by the possible variability in the quality and methodology of the included studies.

In summary, the SLR conducted using the WoS and Scopus databases from 2001 to 2023 has limitations in terms of availability and access to studies, quality and integrity of data, changes in the landscape of scientific publications over time, potential biases in the selection of studies, and variability in the quality and methodology of the included studies.

VI. DISCUSSION AND CONCLUSIONS

In this paper, we present a systematic review and mapping to identify, classify, and analyze the scientific production related to digital competencies, according to their areas; virtual learning environments, tools, and methodologies used in higher education to develop digital competencies in students. To achieve this, an in-depth study was conducted by examining all publications related to these knowledge areas. To analyze the texts, a protocol and review strategy were designed, based on the work of other authors, which systematizes and structures the information. This paper presents the extraction and comparison of the most notable characteristics of the selected texts, based on the detailed inclusion and exclusion criteria. During the review and mapping process of articles, originally 5,652 articles from different databases were identified. This number was reduced to 83 articles using various criteria, review strategies, and quality assessments. Thus, the most relevant works for this research were obtained. The selected works have been published between 2001 and 2023 (first quarter) in scientific journals.

It was identified that students need to develop digital competencies in different areas, namely: a) digital information and literacy, b) communication and collaboration, c) content creation, d) security, and e) problem-solving. The literature review grouped emerging topics into three specific themes: methodologies (37 articles), virtual learning environments (18 studies), and tools (29 articles); in the context of how these three thematic axes are used for the effective development of digital competencies in higher education. It is important to highlight that all the cited studies are linked to at least one of the areas of digital competency.

Academic quality will continue to be improved, and digital competencies will help university students successfully transition into the new society. A wide variety of approaches, resources, and platforms are employed to help university students build their digital competencies. This illustrates the fact that no one method or solution is appropriate for every situation and set of requirements for students. It is crucial to modify approaches and resources by the unique circumstances of each student and the intended learning goals.

Active and participatory methodologies that involve students in practical and collaborative activities are effective for the development of digital competences. These methodologies allow students to actively experience, practice, and apply digital skills in real contexts, promoting more meaningful and lasting learning.

Digital platforms and online tools, such as simulators, virtual learning environments, mobile applications, and social networks, can be effectively used for the development of digital competences in university students. These tools provide opportunities for practice and experimentation in safe and controlled environments and can also foster collaboration and communication among students, contributing to the development of necessary digital skills in today's world.

As a result, a diverse range of approaches, resources, and platforms are employed in higher education to foster the development of digital competencies. University students can benefit from the development of digital skills through active and participatory methodologies, digital platforms, and online tools. These students not only hone their digital skills but also take on the role of creators and builders of their learning.

Our analysis reveals several significant trends in the integration of digital competencies and technological tools in higher education. Notably, there is a strong link between digital literacy and the use of information search and filtering tools. This emphasizes the need for educational strategies that prioritize these skills, given the critical role of information literacy in a digital world [1]. Additionally, the relationship between communication and collaboration competencies and tools for content creation and communication underscores the importance of these tools in fostering student interaction and teamwork [2]. These trends suggest that higher education institutions should focus on incorporating specific technological tools to enhance critical competencies.

The observed trends have significant implications for educational practice. The strong connection between digital competencies and technological tools suggests that educational programs should explicitly integrate these tools into their curricula. For instance, enhancing digital literacy through dedicated modules on information search and filtering in introductory courses can be highly effective [7]. Similarly, integrating content creation and collaborative projects can develop communication and collaboration skills, better-preparing students for the digital workforce. These practices not only improve technical skills but also promote essential soft skills such as teamwork and problem-solving.

Beyond practice, these trends also point to key directions for educational policy development. Policymakers should consider establishing national or institutional standards that promote the use of technological tools to develop digital competencies. This could include funding for technological infrastructure and teacher training to ensure effective integration of these tools in classrooms [4]. By setting policies that support technological integration and digital competency development, students can be better equipped to face 21st-century challenges.

This systematic literature review has served to present an important research field, considered highly relevant

for the development of digital competences, which shapes the present and future of new ways of interacting and learning in society. However, there are several limitations in the results obtained. For instance, there is a lack of experimental publications, since articles describing participatory methods often lack sufficient participation or are limited to descriptive levels. There is also a noticeable lack of studies that provide a comprehensive review of the phenomenon, representing a gap in current research that can serve as an analysis of the current state of digital competencies in higher education students.

Digital learning environments are essential components of modern education and play a crucial role in fostering digital skills in college students. The ecosystems combine many components such as virtual learning environments, digital tools, and creative techniques to improve the educational process. By utilizing these digital settings, students may engage actively and collaboratively with the information, fostering practical skills crucial in the contemporary digital landscape. Digital learning ecosystems provide a flexible and responsive environment for students to investigate, test, and construct their knowledge, equipping them to tackle the demands of the 21st century.

In our study, we chose to review literature in English and Spanish due to the accessibility and prevalence of primary sources in these languages. While this methodological choice allows for a comprehensive review within these linguistic domains, certain geographic and cultural perspectives may not be fully represented.

We recognize that by including additional literature in other major languages, we could further enrich our analysis, providing a more global view of digital competencies in higher education. In future research, we suggest broadening the linguistic spectrum of the review to incorporate studies from diverse regions, which could reveal trends and innovative approaches that are specific to different cultural contexts.

This consideration would broaden the understanding of the topic and improve the comprehensiveness of the analysis, ensuring a more balanced coverage of digital skills practices and developments globally.

This study has shed light on the composition and effectiveness of learning ecosystems for the development of digital competencies in higher education, integrating active methodologies, advanced technological tools, and virtual learning environments. Through a systematic literature review, we have identified how these components interact synergistically to foster essential digital skills, which are increasingly crucial in our interconnected and technologically advanced world.

The results reveal that effective implementation of these ecosystems not only improves students' digital literacy and communication skills but also enhances critical skills such as content creation, online safety, and problem-solving. These competencies enable students not only to adapt to digital environments but also to thrive in them, taking active roles in the construction and design of their learning.

The study contributes significantly to the existing literature by providing a comprehensive understanding of how digital learning ecosystems can be structured to maximize educational effectiveness. It highlights the importance of tailoring teaching strategies to the individual needs of learners and the dynamic demands of today's society, ensuring that education is relevant and effective.

Despite the advances identified, we also recognize the inherent limitations of our approach, particularly in terms of the linguistic and geographic diversity of the sources examined. Future research must expand the linguistic and cultural spectrum to capture a wider variety of perspectives and further enrich our understanding of these learning ecosystems. Furthermore, it would be fruitful to explore the effectiveness of these methodologies and tools through experimental studies that can provide more robust evidence of their impact on learning.

In conclusion, this study underscores the vitality of digital learning ecosystems in higher education and their essential role in the formation of digital competencies. As we move into the future, educators and policymakers must continue to innovate and adapt these ecosystems to meet the changing needs of students and society, thus ensuring that higher education not only responds to current challenges but also anticipates them and shapes future learning and interaction dynamics in our digital society.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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