Development of teaching digital competencies through virtual environments: a systematic review

Desarrollo de competencias digitales docentes mediante entornos virtuales: una revisión sistemática

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Diana Margarita Córdova Esparza*
Julio Alejandro Romero González**
Rocío Edith López Martínez***
Ma. Teresa García Ramírez****
Dulce Carolina Sánchez Hernández*****

Keywords
Digital skills; teachers; virtual environments; teaching; learning

ABSTRACT

The purpose of this research is to analyze the acquisition of teachers' digital competencies through the use of virtual environments and information and communication technologies to improve the teaching-learning process. A systematic review was conducted through the search and compilation of empirical studies over five years (2019 to 2023), in the specialized databases: Scopus, Redalyc, SciELO, and the academic search engine Google Scholar. Based on the PRISMA statement, and through inclusion and exclusion criteria, a total of fourteen research papers were selected. After examining them, it was possible to identify how digital literacy through the use of virtual learning environments influences the development of teaching work and performance and consequently also contributes to student learning. Among the digital skills most used by teachers that have allowed innovation and improvement of the teaching process are mainly the management of information and mastery of digital tools for the creation and management of educational resources.

Palabras clave
Competencias digitales; docentes; enseñanza; entornos virtuales; aprendizaje

RESUMEN

El propósito de esta investigación es analizar la adquisición de competencias digitales docentes mediante el uso de los entornos virtuales y las tecnologías de la información y la comunicación para mejorar el proceso de enseñanza-aprendizaje. Se realizó una revisión sistemática a través de la búsqueda y compilación de estudios empíricos en un período de cinco años (2019 a 2023) en las bases de datos especializadas: Scopus, Redalyc, SciELO y el buscador Google Académico. Con fundamento en la declaración PRISMA, y siguiendo criterios de inclusión y exclusión, se seleccionó un total de catorce trabajos de investigación. Tras examinarlos se pudo identificar cómo la alfabetización digital, haciendo uso de los entornos virtuales de aprendizaje, influye en el desarrollo de la labor y el desempeño docente, lo que en consecuencia también contribuye en el aprendizaje de los estudiantes. Entre las competencias digitales más utilizadas por los profesores que les han permitido innovar y mejorar el proceso de enseñanza, se sitúan principalmente la gestión de la información y el dominio de herramientas digitales para la creación y gestión de recursos educativos.

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* Doctora en Tecnología Avanzada por el Instituto Politécnico Nacional. Profesora investigadora de la Facultad de Informática de la Universidad Autónoma de Querétaro, México. http://orcid.org/0000-0002-5657-7752, correo electrónico: diana.cordova@uaq.mx | ** Doctor en Ciencias de la Computación por la Universidad Autónoma de Querétaro. Profesor investigador de la Facultad de Informática de la Universidad Autónoma de Querétaro, México. http://orcid.org/0000-0001-7257-7595, correo electrónico: julio.romero@uaq.mx | *** Doctora en Alta Dirección por la Universidad Hispano Mexicana. Profesora investigadora de la Facultad de Informática de la Universidad Autónoma de Querétaro, México. http://orcid.org/0000-0002-5209-3523, correo electrónico: rocio.edith.lopez@uaq.mx | **** Doctora en Tecnología Avanzada por el Instituto Politécnico Nacional. Profesora investigadora de la Facultad de Informática de la Universidad Autónoma de Querétaro, México. http://orcid.org/0000-0002-5524-2002, correo electrónico: teregar@uaq.mx | ***** Máster en Ingeniería de Telecomunicaciones. Profesora Investigadora de la Facultad de Informática de la Universidad Autónoma de Querétaro, México. http://orcid.org/0000-0002-4877-3155, correo electrónico: dulce.car.san@uaq.mx

INTRODUCTION

The use of virtual learning environments (VLE) has driven innovation in education by creating new strategies for knowledge delivery and acquisition, as well as for the development of digital competencies at different educational levels. Integrating technological tools with active methodologies has enhanced and enabled self-regulated student learning.

González and Granera (2021) indicate that VLE s include both a technological and an educational dimension, which are interrelated and mutually reinforcing. According to Salinas (2011), "a virtual learning environment is an educational space hosted on the web, made up of a set of computer tools that enable didactic interaction" (p.1). It is evident that these environments facilitate meaningful learning for students, but for this to happen, teachers must possess strong digital competencies that enable them to effectively leverage both VLEs and the innovative tools and technologies available in education.

Thus, teacher training and development programs are essential to build competencies in the use of information and communication technologies (ICT) and to design effective learning experiences. VLEs allow educators to create and manage content through various digital platforms, enabling the implementation of engaging, dynamic, and adaptable activities tailored to each learning objective required by students. These environments create a conducive space for fostering digital literacy, which includes three fundamental dimensions: 1) knowledge and instrumental use of computer applications, 2) acquisition of cognitive skills, and 3) development of critical and reflective abilities to evaluate information and technological tools (Salinas, 2011).

The National Institute of Educational Technologies and Teacher Training (INTEF, 2022) states that digital teaching competencies are crucial in modern education due to their ability to enhance teaching, promote equity, encourage problem-solving, increase student engagement, and facilitate learning through the effective use of technologies. These competencies include planning and implementing digital technologies, motivating and providing meaningful instruction through digital resources, adapting learning to meet individual student needs, and promoting collaboration and autonomy. Furthermore, these competencies are vital for teachers' continuous professional development, enabling them to implement teaching strategies that foster collaborative work and to adopt learning methodologies that optimize the use of digital resources.

Horna and Seminario (2023) emphasize that teachers play a critical role in virtual environments as pedagogical mediators. They must be capable of designing and executing instructional planning with flexible teaching methodologies that address various learning contexts. Padilla-Escobedo

(2019) classifies the digital competencies teachers can acquire and apply into five main areas (see Figure 1).

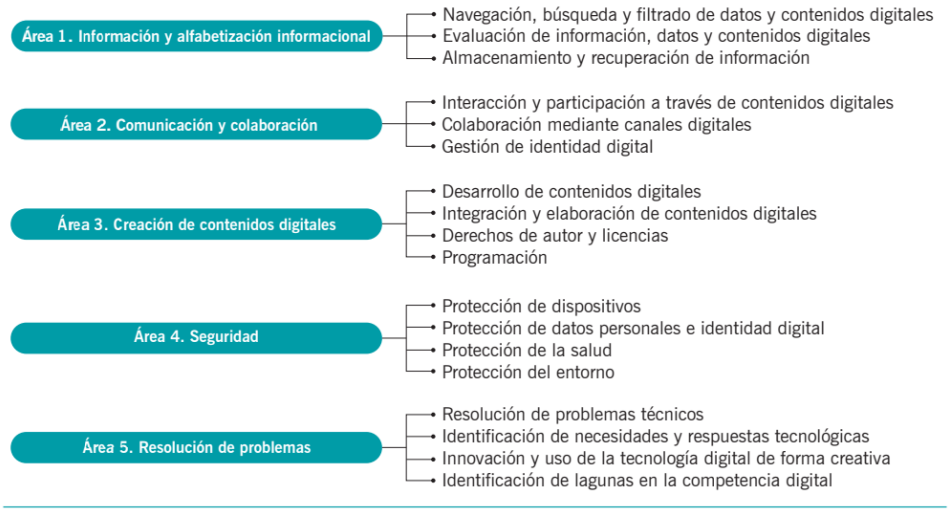


Figure 1. Areas of digital competencies that teachers can acquire and apply.

Source: Adapted from Padilla-Escobedo (2019).

Technological advances have revolutionized education by offering high-quality programs in face-to-face, virtual, and hybrid formats. Educational institutions leverage the potential of VLEs to enhance educational processes and facilitate interaction within digital ecosystems. This approach necessitates strong techno-pedagogical support, which includes essential digital competencies for content creation and assessment.

Authors such as Monsalve-Lorente and Aguasanta-Regalado (2020) illustrate how ICT has expanded learning opportunities, promoting pedagogical practices that support self-initiated learning. Within this context, three main learning modalities are identified: project-based and problem-solving learning, supported self-directed learning, and independent self-directed learning. Across these modalities, the learner's active role in establishing objectives, seeking resources, and building relationships that support their interests and learning needs is emphasized.

Barron (2006) introduces the concept of learning ecologies as a framework for teachers to understand how various elements interact within educational environments. This approach promotes teaching practices tailored to students' specific needs, while encouraging continuous professional development by identifying opportunities to enhance skills and knowledge through diverse educational resources. Fataar and Norodien-Fataar (2021) assert that this paradigm transforms traditional learning environments into more interactive and personalized spaces.

Here, digital technology plays a central role, enabling personalized learning by adapting educational resources and fostering pedagogical innovation through digital tools that create more dynamic and collaborative learning experiences.

The need for teachers to update their methodologies to incorporate digital skills is highlighted in the research conducted by Hervás-Gómez *et al.* (2021). Their study underscores how autonomy, motivation, and digital pedagogy influence students' perceptions of online learning. The authors advocate for a model of adaptation to digital teaching, presenting it as a key component of teachers' professional development.

Similarly, Zhao *et al.* (2021) emphasize that the use of VLEs is closely tied to teaching digital competencies. To ensure students experience effective learning, teachers must develop specific digital skills, such as:

- Mastery of technological tools: This includes learning management platforms, multimedia resources, online assessment tools, and more, all of which are accessible in virtual environments.
- Design of online learning activities: The goal is to develop interactive and collaborative activities that promote student engagement and facilitate the acquisition of knowledge and skills. Chiu (2021) highlights that learning resource design should encourage autonomy and evoke positive emotions to enhance the learning experience. It should also consider the diversity of students.
- Effective online communication: Teachers with digital competencies can utilize various communication tools, such as chats, video conferencing, and discussion forums, to maintain consistent communication and provide timely feedback.
- Assessment and feedback: To promote meaningful learning, it is essential to design and administer online assessments that enable personalized and constructive feedback for each student through virtual environments.

The following section outlines the methodology employed in this study for conducting a systematic review of research related to the topic. It then presents the findings from the literature review, followed by a discussion of these results. Finally, the main conclusions are presented.

METHOD

Building upon the work of Grijalva *et al.* (2019), this study conducted a systematic review of research focused on the use of VTLE (Virtual Learning Environment) to develop teachers' digital competencies. The goal was to gather evidence and key findings on this topic. The article selection process consisted of four phases—planning, selection, information extraction, and execution—each with specific steps, as shown in Figure 2.

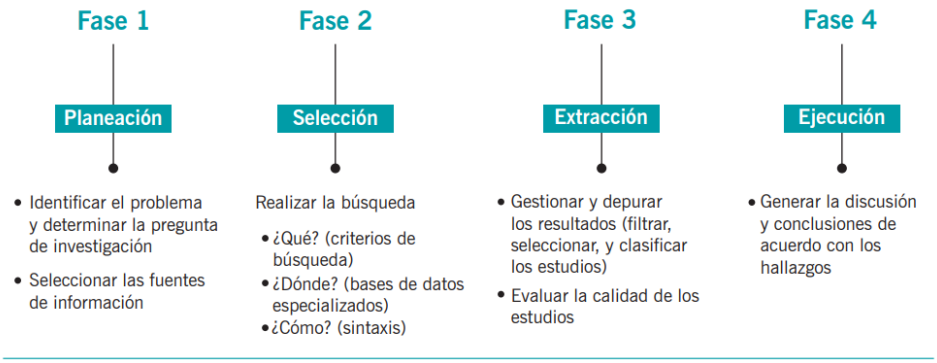


Figure 2. Phases of the systematic review.

Planning

In this phase, the following research questions were formulated to guide the analysis:

- Does the use of virtual teaching and learning environments facilitate the acquisition of digital teaching skills?
- What digital teaching skills can be developed through VLE?
- What platforms have been utilized to foster digital teaching competencies via VLE?
- What ICT tools have been employed within VLE to develop digital teaching competencies?
- What instruments have been used to validate VLE as a medium for acquiring digital teaching skills?

The literature search was conducted using specialized databases such as Scopus, Redalyc, SciELO, and Google Scholar. The review focused on scientific studies published between 2019 and 2023, available in Spanish and English.

The keywords used for the search were: (ab:((ti:("teaching digital competencies" AND "virtual teaching and learning environments")))). Table 1 provides the number of results obtained from each database.

Table 1. Number of articles found in each database

Source of reference	Identified articles	Included articles
Scopus	6	3
Redalyc	10	1
SciELO	4	2
Google Scholar	22	8
Total	42	14

Selection and extraction

To determine which articles to analyze, the following inclusion and exclusion criteria were established:

Inclusion criteria:

- Studies published between 2019 and 2023.
- Articles in Spanish and English.
- Studies directly related to the search terms based on the research questions outlined in the planning phase.

Exclusion criteria:

- Studies published before 2019.
- Articles in languages other than Spanish or English.
- Studies unrelated to the search terms and research questions defined in phase one.
- Duplicate studies.

The PRISMA statement (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) (Page *et al.*, 2021) was applied to filter studies meeting these inclusion and exclusion criteria, ensuring a precise selection of articles aligned with the objectives of this systematic review (see Figure 3).

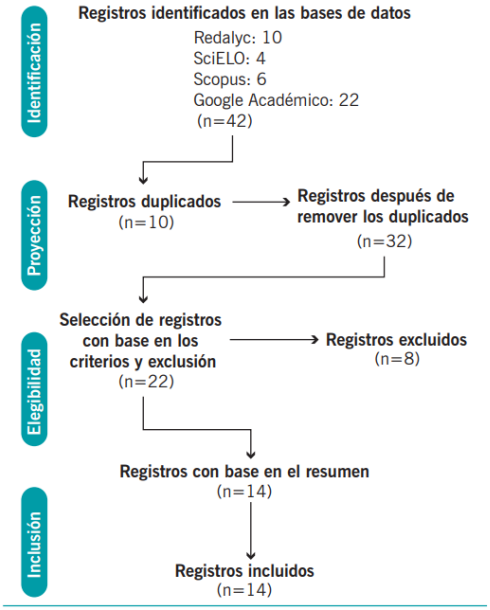


Figure 3. Selection process of scientific articles for the systematic review.

Execution

The selected studies that addressed the research questions formulated in the planning phase were analyzed. The final sample included fourteen articles, organized by publication year, database, document type, author(s), and research title (see Table 2).

When reviewing the selected articles, two main categories emerged: the use of VLE for developing digital teaching competencies in response to the COVID-19 pandemic and the use of VLE for digital teacher training.

Table 2. Sample of documents analyzed

Año de publicación	Base de datos	Tipo de documento	Autores	Titulo de la investigación
2020	Redalyc	Artículo de investigación	Laurente, Rengifo, Asmat y Neyra	Desarrollo de competencias digitales en docentes universitarios a través de entornos virtuales: experiencias de docentes universitarios en Lima
	Google Académico	Artículo de investigación	Soroko	Methodology for Teachers' Digital Competence Developing through the Use of the STEAM-oriented Learning Environment
2021	Scopus	Artículo de investigación	Iglesias-Pradas, Hernández-García, Chaparro-Peláez y Prieto	Emergency remote teaching and students' academic performance in higher education during the covid-19 pandemic: A case study
2022	Google Académico	Artículo de investigación	Delgado, Martínez y Tigrero	Desarrollo de competencias digitales del profesorado mediante entornos virtuales
	Google Académico	Artículo de investigación	Losada y Peña	Diseño instruccional: fortalecimiento de las competencias digitales a partir del modelo ADDIE
	Scielo	Artículo de investigación	López-Campuzano y Estrada-Orrego	Desconexión entre actores: percepciones del uso de tecnologías educativas durante la pandemia por covid-19
	Google Académico	Artículo de investigación	Torres-Flórez, Rincón-Ramírez y Medina-Moreno	Competencias digitales de los docentes en la Universidad de los Llanos, Colombia
	Scopus	Artículo de investigación	Antón-Sancho y Sánchez-Calvo	Variables Influencing Professors' Adaptation to Digital Learning Environments during the covid-19 Pandemic
	Scopus	Artículo de investigación	Pérez-Sánchez, Lavandera-Ponce, Mora-Jaureguialde y Martín-Cuadrado	Training Plan for the Continuity of Non-Presential Education in Six Peruvian Universities during covid-19
	SciELO	Artículo de investigación	Oliva-Cruz y Mata-Puente	Uso de las habilidades digitales en el proceso de enseñanza-aprendizaje en ciencias de la información en un entorno virtual durante la pandemia por covid-19
2023	Google Académico	Artículo de investigación	Centeno-Caamal y Acuña-Gamboa	Competencias digitales docentes y formación continua: una propuesta desde el paradigma cualitativo
	Google Académico	Artículo de investigación	Alaniz, Varas y Vilanova	Las competencias digitales de los docentes de nivel primario en la Cuenca Carbonífera de Santa Cruz
2023	Google Académico	Artículo de investigación	Matos y Yánez	Entornos virtuales de aprendizaje en la educación universitaria, una mirada tecnoeducativa: Virtual Learning Environments in university education, a techno-educational view
	Google Académico	Artículo de investigación	Cobeña, Mendoza, Cevallos, Murillo, Moreira y Álava	Competencias digitales docentes para el fortalecimiento de la pedagogía universitaria

ANALYSIS

The use of VLE for developing digital teaching skills in response to the COVID-19 pandemic

In the work of Iglesias-Pradas *et al.* (2021), the transition to remote teaching caused by the COVID-19 pandemic was analyzed through a case study of the School of Telecommunications Engineering at the Polytechnic University of Madrid. Specifically, the study examined how teachers adapted their face-to-face teaching methods to virtual environments and the impact this transition had on students' academic performance. The study highlighted the importance of teaching digital skills for success in using virtual environments and the need to leverage digital technologies effectively.

Some of the digital competencies mentioned in this study include the ability to use supportive technological tools (such as online learning platforms or digital communication tools), skill in managing online communication with students, and utilizing digital technologies to enhance teaching and learning. The main findings indicate an increase in students' academic performance during remote teaching, suggesting that teachers' adaptation to virtual environments positively impacted learning. Finally, the study emphasizes that teaching digital competencies is crucial for the transition to virtual teaching.

Similarly, Antón-Sancho and Sánchez Calvo (2022) conducted quantitative research on the influence the health crisis had on university professors' adaptation to digital learning environments. The authors compared the perceptions of participants who were digital natives with those of digital immigrants. A survey was used as a validation tool, and the responses were statistically analyzed to identify the variables affecting teachers' digital competence and adaptation skills. The results recommend that teachers participate in digital training courses specifically oriented toward their teaching activities to improve their digital teaching skills.

Along these lines, Pérez-Sánchez *et al.* (2022) developed an assessment to analyze the academic and managerial training needs during the COVID-19 pandemic in six Peruvian universities, which led to a training plan to sustain non-face-to-face education. This plan covered different thematic categories, including courses on general and specific aspects of e-learning, its complexity, and theoretical foundations. Additionally, digital competencies such as email usage, web browsing, and file management were examined, along with more advanced skills such as the use of learning management systems, online collaboration tools, and multimedia resources.

The training plan proposed by the authors also considered the development of digital skills related to teaching and learning, such as designing and implementing online courses, using assessment and

formative feedback, and promoting self-regulated learning. Surveys and questionnaires were used to gather data on participant satisfaction and learning outcomes. In conclusion, the study recommends that universities increase specific training for teachers in the pedagogical use of TIC and review the specific needs of each field of knowledge.

The study by López-Campuzano and Estrada-Orrego (2022) explored the impact of educational technologies during the COVID-19 pandemic, focusing on a specific case: the Vermont School experience. Information was collected through surveys, interviews, and focus groups. The results indicate that technology in teaching caused significant changes in the dynamics between designers, teachers, and students. This was due to the consideration of several factors that influenced the perceptions, intentions, and expectations of each participant.

For their part, Oliva-Cruz and Mata-Puente (2022) analyzed the digital and pedagogical skills developed by teachers and students at the Faculty of Sciences of the Autonomous University of San Luis Potosí (UASLP) in response to an emergency situation like the health crisis. The teachers sample for this research was divided into three groups. The first group, representing 20% of the sample, relied on WhatsApp or email to communicate with students, while also using digital tools such as blogs, videos, or web pages relevant to their courses. The second group, comprising 50% of the sample, developed digital skills and gradually integrated them into their teaching practice to achieve learning objectives, transitioning from traditional classrooms to digital environments. The third group, representing 30% of the participants, demonstrated mastery of instrumental competencies and incorporated them into their teaching planning. They also designed activities to enhance learning and communication with students.

The main conclusions regarding the technological and didactic skills of these participants include the need to develop new strategies in teaching practices to adapt to virtual environments. Furthermore, the importance of collaboration among teachers to share knowledge and experiences with educational technologies was emphasized, along with the need to implement pedagogical strategies suited to digital environments to facilitate student learning. This study revealed that adapting to virtual education during the pandemic required effort, dedication, and a swift response from educators to address the challenges posed by the abrupt shift to online teaching.

The studies described above, along with the systematic review by Papaioannou *et al.* (2023), underscore the importance of virtual learning spaces during the COVID-19 pandemic. They also highlight how the recent health crisis brought significant changes to the teaching-learning process, such as increased student participation in online activities, more time dedicated to digital platforms, and attendance in virtual classes. At the

same time, challenges were identified, including connectivity issues, lack of human interaction, and the absence of hands-on instruction. These findings point to the need for developing new strategies and support mechanisms for teachers to facilitate teaching and ensure effective learning in remote environments that are inclusive and adaptable to diverse student needs.

The use of VLE for digital teacher training

Soroko (2020) presents a specialized course designed to develop digital teaching competencies through a STEAM-oriented virtual learning environment. A survey conducted among teachers reveals that ICT is commonly used in general class activities, encouraging collaborative work through tools such as Google Drive, Padlet, and Moodle. Regarding skills for creating and managing STEAM-oriented virtual learning environments, the use of online tools to develop and manage training projects, open educational resources, tools for seminars and forums, and exam creation instruments is highlighted.

The author developed a teacher training course to provide methods and tools for using and creating e-learning resources. The course consisted of three modules: the first focused on strategies in a STEAM-oriented learning environment, the second examined ICT used to support the STEAM proposal, and the third addressed electronic learning resources for evaluating and self-assessing teachers' digital skills.

Laurente *et al.* (2020) describe how virtual environments promote the development of digital skills. Using a mixed-method research approach with qualitative and quantitative data, the results demonstrate that university professors who integrate face-to-face teaching with virtual environments have found innovative ways to teach and learn through these spaces.

As well, Torres-Flórez *et al.* (2022) conducted a study at the University of Los Llanos to assess teachers' digital competencies. A sample of 180 out of 547 teachers was selected through systematic sampling. Using a Google Forms questionnaire, the survey covered sociodemographic aspects and ICT use. Digital competencies were divided into four dimensions: Information, Communication and Collaboration, Use of Digital Devices and Tools, and Content Creation.

The results show medium-high levels of competence in the first three dimensions. Notably, the Use of Digital Devices and Tools dimension stood out, demonstrating high proficiency in using portable devices, cloud storage platforms, and collecting digital information. However, the Content Creation dimension showed the lowest competence, particularly in the use of software for content design.

Delgado *et al.* (2022) focused on using virtual environments to conduct quantitative, descriptive-correlational research. A pre-experimental design with a pre-test-post-test model was implemented. Data collection instruments, adapted for the research, assessed teacher training and digital competencies. After the intervention, improvements of 88.67% in communication skills, 84.9% in content creation, and 83.02% in digital literacy were recorded.

Losada and Peña (2022) explore the application of the ADDIE approach (Analysis, Design, Development, Implementation, and Evaluation) to create, deliver, and evaluate educational resources. This structured framework, known for its flexibility, allows adjustments based on participant feedback. The quasi-experimental design used surveys, interviews, and a digital competency measurement tool. Results showed positive impacts on teacher training, particularly in the DigCompEdu framework. The inclusion of formative evaluation promoted constructive feedback, collaborative strategies, and active participation.

Centeno-Caamal and Acuña-Gamboa (2023) conducted qualitative research through institutional material analysis, semi-structured interviews, and discussion groups. Findings highlight the limited influence of digital technologies in the examined educational process and emphasize the need for continuous training tailored to specific requirements. Promoting digital skills in content creation and hybrid modalities was also identified as essential.

Alaniz *et al.* (2023) used a DigCompEdu-based questionnaire to study primary school teachers in Argentina's Río Turbio Coal Basin. Results provide insights into creating a virtual learning community aimed at expanding digital skills and improving teaching practices through ICT-based pedagogical proposals.

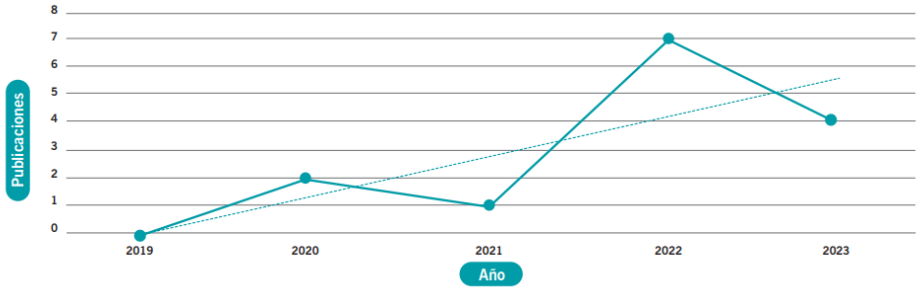
Matos and Yánez (2023) analyzed the use of virtual learning environments (VLE) in university education through a qualitative documentary review. Their findings highlight VLEs' flexibility, enabling access to online materials, promoting student-teacher interaction, personalizing content, improving accessibility for students with disabilities, and enriching learning through multimedia resources, interactive activities, and assessments.

Cobeña Napa *et al.* (2023) evaluated digital competencies at the Universidad Técnica Luis Vargas Torres' Faculty of Pedagogy. Using a quantitative, descriptive, non-experimental approach, data was gathered through a Likert-scale questionnaire. Results indicate high competency in initial exploration, moderate competency in integration, and low competency in innovation. Descriptive statistical analysis was used to interpret the findings.

These studies collectively highlight how virtual environments enable teachers to develop specific digital competencies, which are essential for leveraging digital technologies in education.

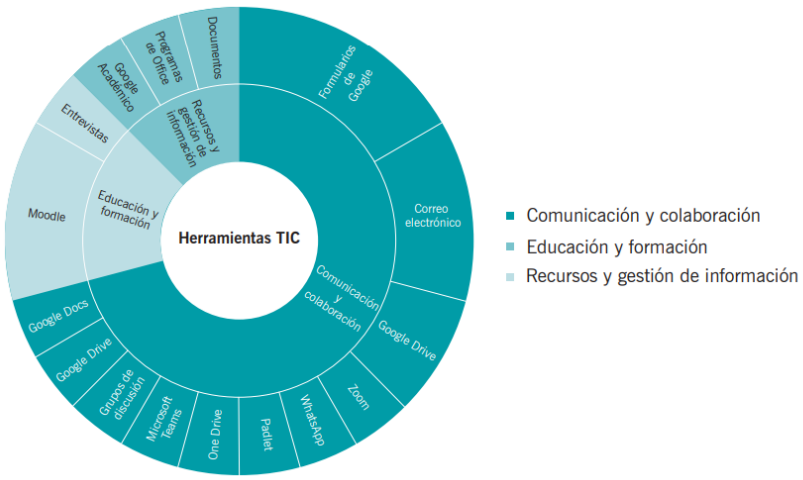
RESULTS

Graph 1 shows the distribution of the articles selected for analysis by year. As observed, there is an increase in publications on the use of VLEs for the development of digital skills between 2022 and 2023.



Graph 1. Annual distribution of articles

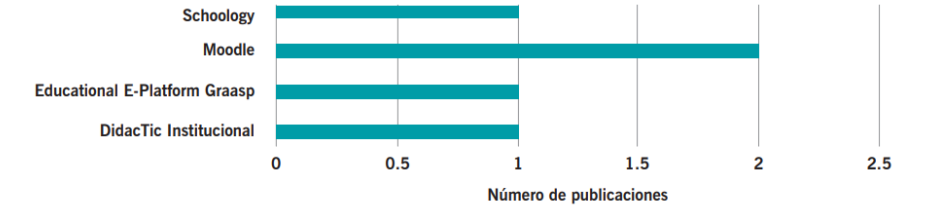
Graph 2 displays the ICT tools used in the sample of studies analyzed. The most prevalent tools fall under communication and collaboration, followed by tools focused on education and training.



Graph 2. ICT tools

Among the most widely used learning management systems (LMS), Moodle stands out as a free platform that enables teachers to create online

courses utilizing various ICT tools, while also monitoring students' learning progress (see Graph 3).



Graph 3. LMS platforms

Table 3 outlines the essential competencies in the educational and technological fields acquired and applied by teachers in their use of virtual learning environments and ICT. Based on the analysis conducted, the most notable competencies include information management and proficiency in digital tools for creating and managing educational resources. This highlights their central role in an academic environment marked by abundant information and the digitalization of the teaching-learning process.

Information management is vital for effectively locating, organizing and harnessing data and knowledge, while digital tools are essential for developing and managing educational resources. On the other hand, digital communication stands out due to its high number of mentions, which indicates its fundamental importance in online collaboration and interaction. In an increasingly interconnected world, digital communication becomes essential to facilitate distance teaching and learning information management is vital for effectively locating, organizing, and harnessing data and knowledge, while digital tools are essential for developing and managing educational resources. On the other hand, digital communication stands out due to its high number of mentions, indicating its fundamental importance in online collaboration and interaction. In an increasingly interconnected world, digital communication becomes essential to facilitate distance teaching and learning, as well as to promote collaboration between students and educators.

Competence in the development of projects, learning experiences, or teaching-learning strategies, although mentioned less frequently, is relevant due to the need to design effective pedagogical approaches and meaningful learning experiences. Other competencies, such as student empowerment and professional commitment, emphasize the importance of fostering student autonomy and teachers' dedication to the educational process. Likewise, formative feedback is crucial to guide and improve student learning. Finally, online safety and educational project management are also relevant, as they are essential to protect students in digital environments and ensure effective planning in educational projects.

Table 3. Digital competencies of the analyzed articles

Digital skills	Laurent *et al.* (2020)	My Shoulders (2020)	Iglesias-Pradas *et al.* (2021)	Delgado *et al.* (2022)	Losada and Peña (2022)	López-Campuzano and Estrada-Orrego (2022)	Antón and Sánchez (2022)	Perez-Sanchez *et al.* (2022)	Torres-Flórez *et al.* (2022)	Oliva and Mata (2022)	Centeno-Caamal and Acuña-Gamboa (2023)	Alaniz *et al.* (2023)	Matos and Yánez (2023)	Cobeña *et al.* (2023)
Agility							✓							
Information Literacy				✓										
Self-regulated learning								✓			✓			
Continuous learning							✓							
Professional commitment					✓							✓	✓	
Digital communication				✓		✓	✓		✓					
Develop shared work	✓					✓			✓	✓				
Development of projects, learning experiences or strategies for teaching-learning		✓												✓
Empower students					✓							✓	✓	
Evaluation and feedback												✓	✓	
Facilitate students' digital competence					✓							✓	✓	
Information management	✓		✓	✓		✓	✓		✓					
Training project management		✓												✓

Tools for content creation, exams, tests and questionnaires, face-to-face or online courses, online games or digital resources		✓		✓	✓	✓		✓	✓			✓	✓	✓
Tools for seminars, forums, among others		✓	✓											
Network leadership							✓							
Student orientation							✓							
Digital pedagogy					✓							✓	✓	
Resilience							✓							
Formative feedback					✓			✓				✓	✓	
Online security		✓		✓										
Collaborative work	✓						✓		✓	✓	✓			
Use or mastery of ICT tools		✓	✓							✓	✓			
Strategic vision							✓							

Table 4 shows the instruments used to validate competencies that encompass a variety of approaches and techniques that play crucial roles in the assessment of skills and knowledge. Among them, questionnaires and surveys are identified as highly relevant, due to their versatility in collecting data on competencies from different perspectives, since they allow valuable information to be obtained about the perception and level of competency of individuals. They also highlight the analysis of variance and Pearson correlation, which allow us to explore differences and relationships between competencies and other variables, which offers significant information about the factors that influence the development of competencies. It should be noted that these instruments must be reliable, so methods such as Cronbach's Alpha and the Guttman test have been used to guarantee accurate results.

Within the instruments, self-assessment and co-assessment promote self-responsibility and competency awareness among individuals, while traditional exams remain an important tool for formally measuring knowledge and competency application. In the technological context, ATLAS.ti software provides the ability to analyze qualitative data related to competencies, expanding research and validation possibilities. Online

forums, autonomous tasks, and the Hoc-Tukey test also play a significant role in assessing specific competencies related to online communication, independent task performance, and identifying significant differences between groups.

Table 4. Most used evaluation instruments

Instruments used for validation	Laurent *et al.* (2020)	My Shoulders (2020)	Iglesias-Pradas *et al.* (2021)	Delgado *et al.* (2022)	Losada and Peña (2022)	López-Campuzano and Estrada-Orrego (2022)	Antón and Sánchez (2022)	Perez-Sanchez *et al.* (2022)	Torres-Flórez *et al.* (2022)	Oliva and Mata (2022)	Centeno-Caamal and Acuña-Gamboa (2023)	Alaniz *et al.* (2023)	Matos and Yánez (2023)	Cobeña *et al.* (2023)
Cronbach's alpha					✓				✓					
Variance analysis						✓			✓					
Self and co-assessment	✓													
Self-assessment		✓												
Pearson correlation						✓								
Questionnaires			✓					✓		✓				✓
Surveys			✓				✓	✓				✓	✓	
Exams				✓										
Forums				✓										
Hoc-Tuckey						✓			✓					
Guttman test (of two halves)					✓									
Academic records			✓											
Software ATLAS.ti											✓			
Autonomous tasks				✓										

DISCUSSION

Digital technological tools have revolutionized education in its teaching-learning process. For teachers and students, their use implies a transformation in cognitive thinking that seeks new ways to teach and learn, respectively. One of the main tools that have supported teaching is VLEs, as these virtual spaces facilitate pedagogical communication between participants in the educational process, whether in-person, semi-in-person, or fully remote (Dreiz-zen *et al.*, 2016).

VLEs allow the integration of various ICTs that form the foundation for interaction between students and teachers, providing educators with the opportunity to develop teaching strategies that strengthen education by promoting meaningful learning experiences. As Guaña-Moya *et al.* (2015) highlight, "VLEs imply structural knowledge development, [where] ICT plays an important role in students since they promote technological transformation aligned with current social demands" (p. 1). However, for students to acquire new knowledge through these tools, teachers face technological and pedagogical challenges in creating content that promotes learning and facilitates interaction and collaboration. Based on this systematic review, it is recommended that teachers participate in digital training courses specifically tailored to their teaching roles to enhance their digital teaching skills.

Regarding the acquisition of digital teaching skills through VLEs and ICT usage, most of the articles analyzed indicate that teachers have been trained to use tools for content creation, exams, tests, and questionnaires, as well as the development of face-to-face or online courses, online games, or digital resources. These advances are complemented by digital competence in information management, digital communication, and formative feedback. Thus, teachers incorporating VLEs and ICT have improved their digital skills, particularly in using information and communication tools that enhance student learning. In this sense, teachers enhance their teaching practices through virtual spaces while encouraging students to develop their digital skills in a comprehensive and structured manner.

CONCLUSION

Following the systematic review, a trend was observed in the use of technological tools such as VLEs and ICT to promote student learning, train teachers, and develop techno-pedagogical strategies with digital competencies for content creation, feedback, and evaluation, ensuring educational quality. The literature emphasizes the importance of continuous training courses for acquiring digital skills that adapt technology to the specific needs of each area of knowledge. Teacher

training is essential to equip educators with the knowledge and competencies needed to create effective digital content and leverage platforms for managing learning.

Although virtual learning environments are innovative spaces that significantly improve education by fostering collaboration among teachers and students and integrating various technological tools, the transition from traditional learning spaces to virtual environments poses several challenges. These include the availability and accessibility of technology and the need for digital teacher training to design effective learning environments tailored to students' diverse needs and learning styles.

The analysis also highlights the importance of improving pedagogical mastery related to technology integration in the classroom. This suggests that teachers must enhance their ability to incorporate technology into their teaching through continuous training programs and professional development strategies that strengthen their digital competencies.

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