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Technological skills in virtual teaching post-COVID-19: a literature review

Capacidades tecnológicas en la enseñanza virtual pos-COVID-19: revisión de la literatura

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ABSTRACT

This literature review aims to reveal the digital competencies held by teachers during the implementation of virtual education in the post-COVID-19 period (2019–2021). A systematic review methodology was employed to identify scientific contributions regarding teachers' training in online education. The review included only sources in Spanish from the databases Google Scholar, Scopus, and SciELO. The language of the review was technical and academic, appropriate for the field of educational technology, allowing for a thorough and rigorous analysis of technological skills in post-pandemic virtual teaching. Among the main findings, the progressive strengthening of ICT use in teaching and learning processes stands out, with its integration serving various purposes. The key conclusion of this article indicates that teachers are not fully prepared for online education.

Keywords: *distance education; teacher effectiveness; education efficiency; teacher; virtual teaching; technological skill.*

RESUMEN

La siguiente investigación de revisión de la literatura tiene como propósito develar las capacidades digitales que poseían los docentes en la implementación de la educación virtual pos-COVID-19 entre 2019-2021, utilizando una metodología de revisión sistemática, para conocer los aportes científicos sobre la formación que poseen los docentes en la educación *online*. La revisión se realizó utilizando solo fuentes en español en las bases de datos Google Scholar, Scopus y Scielo. El lenguaje de la revisión fue técnico y académico, propio del área de tecnología educativa, lo que permitió un análisis profundo y riguroso de las capacidades tecnológicas en la enseñanza virtual pospandemia. Entre los principales resultados que se obtuvieron, destaca el hecho que el uso de las TIC en los procesos de enseñanza-aprendizaje ha tomado fuerza paulatinamente y su integración tiene varios propósitos. La principal conclusión emanada de este artículo indica que los docentes no se encuentran en condiciones para la educación *online*.

Palabras clave: *educación a distancia; eficiencia de los docentes; eficiencia de la educación; docente; enseñanza virtual; capacidad tecnológica.*

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INTRODUCCTION

The interconnected nature of today's world has created a generation of students who require digitally literate teachers to develop the competencies they need (Florián et al., 2018). The sudden arrival of the COVID-19 pandemic changed the world, and education had to adapt rapidly and aggressively, without prior preparation. In this context, technological capabilities for post-COVID-19 virtual teaching emerged, understood as the set of knowledge, skills, and attitudes that enable teachers to implement pedagogical strategies mediated by technology. These capabilities proved essential for sustaining educational continuity and advancing toward more flexible, inclusive, and innovative teaching.

The COVID-19 pandemic had a major impact on the educational sector, forcing the closure of public and private institutions and the abrupt implementation of virtual classes without adequate preparation for either teachers or students (García, 2020). This sudden change led to major transformations in teaching methodology, giving rise to online or hybrid education models supported by digital platforms, messaging apps, and social media, which began to play a central role in knowledge construction and technology-mediated learning (Cedeño et al., 2020).

Although this situation exposed significant shortcomings, such as the lack of teacher training in digital competencies (Aretio, 2020; Sánchez et al., 2020), it also presented an opportunity to rethink traditional education by incorporating technologies that promote more innovative and interactive models (Mangui et al., 2020). As a result, virtual learning environments (VLEs) were strengthened and became increasingly integrated into the landscape of contemporary education (Álvarez et al., 2020; Espina-Romero, 2022).

However, the impact was even more complex for students with learning difficulties and special educational needs (SEN), where the lack of digital competencies among teachers became even more evident (Armas & Alonso, 2022; García et al., 2021). In this new scenario, it is essential to promote interdisciplinary initiatives that foster the development of the 4Cs—collaboration, communication, critical thinking, and creativity—as the foundation for more inclusive, meaningful, and transformative education (Hasbún, 2021).

This process has driven the conceptual evolution from information and communication technologies (ICT) to learning and knowledge technologies (LKT), then to empowerment and participation technologies (EPT), and currently to relationship, information, and communication technologies (RICT), which are more aligned with collective intelligence and intelligent educational processes (Hasbún, 2021). This transformation highlights the need for academic innovation through active methodologies, versatile teaching materials, and student-centered approaches (Florián et al., 2018).

Virtual education was implemented in educational systems as a response to the onset of the pandemic; however, Rodríguez (2021) argues that distance education is not well suited to developing countries. Nevertheless, the growing availability of free digital resources represents a valuable opportunity if leveraged properly.

Virtual learning environments (VLEs) have a positive influence on students' meaningful learning (Vargas-Murrillo, 2021). Yet, some factors hinder the teaching and learning process when it is conducted solely online. As Gervacio and Castillo (2021) explain, psychological effects such as demotivation, discouragement, adaptation difficulties, and longing for in-person classes can emerge—outcomes of the prolonged confinement caused by COVID-19. The abrupt shift from in-person to virtual education due to the health emergency affected all actors in the educational system, generating high levels of stress and other adverse consequences (Rivera & Ponce, 2022).

Teachers' technological skills are not a new requirement, as they were already included in curricular designs. Nevertheless, it is necessary to constantly assess and update these skills given their direct link to the proper use of RICT to support learning (Rodríguez & Cabell, 2021). This underscores a strong dependency between online or virtual education and meaningful learning (Vivar & Dominici, 2022).

The rapid transition to digital education placed a heavy burden on teachers, administrators, and students to acquire digital competencies (Hernández et al., 2021). Nevertheless, significant disparities persist, especially among administrators, who often lack key skills in communication and collaboration (Holguín et al., 2021). Teacher training must be restructured to ensure high-quality pedagogy (Centeno, 2021). Many teachers still possess only basic levels of digital competence, influenced by factors such as age and economic situation (Estrada & Mamani, 2021).

In light of all the above, the objective of this review article was to identify the digital competencies that teachers possessed for post-COVID-19 virtual education during the period 2019–2021.

METHODS

The review conducted in the present study was a systematic literature review, as it follows an observational and retrospective design that allows for the synthesis of findings obtained from multiple studies.

To carry out this review, three bibliographic reference databases were consulted: Google Scholar, Scielo, and Scopus. A strategic search process was conducted to ensure that the most relevant results aligned with the selected methodology. This included both simple and Boolean searches using the keywords with *OR/AND* operators.

The methodology partially followed Fink's framework (2019), which includes the following steps: formulation of the research question; selection of appropriate databases; identification of terms that facilitate and enhance the search; application of filters and search delimitations; organization of findings; and consolidation and production of the final review. Each phase recommended in this model was carried out according to the proposed procedure (see Table 1).

The search yielded several results: 148 documents were initially reviewed, and 89 were selected, including articles, studies, and theses related to methods of scientific knowledge synthesis. Additional references were also identified through citation tracking of the selected materials for further reading and analysis.

The distribution of the sources identified was as follows: Google Scholar (93), Scopus (40), and Scielo (15). The selection process involved abstracting, which consists of reviewing the titles, abstracts, and keywords in order to filter the most suitable documents for inclusion in the review.

The article selection was recorded in a spreadsheet, where articles were included based on the subject and keywords. A final sample of 44 articles was selected, read, reviewed, and analyzed as follows: 22 from Google Scholar, 14 from Scopus, and 8 from Scielo (see Table 2).

DEVELOPMENT AND DISCUSSION

With a documentary corpus of 60 identified articles, we proceeded to build an explanatory unit using the qualitative data analysis software ATLAS.ti. All the analyzed articles were registered as primary documents, and categories and subcategories were created *a priori*, based on the guiding research question. This process helped identify repeated terms that served as an initial insight into the emerging

Table 1

Phases and description of the procedure

Phase	Description
Research question	What digital capabilities do students possess for receiving virtual classes?
Selection of databases	Initial search conducted in Google Scholar (yielding most articles), followed by Scopus and Scielo.
Selection of search terms	Search terms used in the three databases included: *online education, virtual education, blended learning*. Boolean operators OR and AND were used.
Application of filters and limits	Filters were applied by field of knowledge (education, social sciences), language (Spanish and English), and publication date (from 2018 onward).
Synthesizing results	Articles were reviewed by reading abstracts, keywords, and conclusions; the most relevant were selected.
Consolidating and producing the review	After reviewing all selected results, the review article was drafted using an organized structure.

Table 2
Article selection

Author and year	Title
Linne (2022)	Secondary schooling and digital technologies in pandemic times. *Espacios en blanco. Serie indagaciones.*
Espina-Romero (2022)	Virtual Teaching-Learning Processes during COVID-19: A Bibliometric Review.
Rivera & Ponce (2022)	Knowledge assessment during remote learning caused by the Coronavirus disease.
Vivar & Dominici (2022)	The Great Mistake: Rethinking Education and Virtual Training for the "Hypercomplex Society" of the Global World.
Huacac & Ramos (2022)	Relevance of virtual education during COVID-19 and meaningful learning in students of the Fortunato Luciano Herrera School – Cusco 2021.
Urrea et al. (2022)	Digital competencies in Ibero-America during COVID-19: A bibliometric analysis.
Correa et al. (2022)	Implementation and evaluation of virtual teaching during COVID-19. Intercambios. Dilemas y transiciones de la Educación Superior
Salguero et al. (2022)	Effective digital competencies for meaningful virtual classes during COVID-19.
Pinedo (2022)	Digital competencies management among teachers mediated by ICT during COVID-19
Cárcamo et al. (2022)	Virtual education during the COVID-19 pandemic: A bibliometric review.
Jaramillo & Eras (2022)	Restructuring the educational context during the pandemic, from face-to-face to virtual modernity.
Hasbún (2021)	360-degree Educommunication and RICT in virtual learning-teaching environments.
Rodríguez (2021)	COVID-19 and its impact on education in Guatemala.
Vargas-Murrillo (2021)	Design and management of virtual learning environments.
Gervacio & Castillo (2021)	Impacts of the COVID-19 pandemic on academic performance during the transition to virtual education.
Bellolio (2021)	Systematization of the "Learning from Home" Project Experience: Highlighting Educational Experiences and Socioemotional Needs of 12–15-Year-Old Students During the 2020–2021 School Year Amid the COVID-19 Pandemic in the Northern Sector of Guayaquil City — Building a More Inclusive Education Through Teacher Collaboration
Rodríguez & Cabell (2021)	Importance of teachers' digital competencies during social confinement. *Polo del conocimiento.*
Hernández et al. (2021)	Teachers' Digital Competence: A systematic review of the most used models.
Holguín et al. (2021)	Digital competencies of school leaders and teachers during remote education in 2020.
A. Martínez (2021)	Teachers' digital competencies and their status in virtual contexts.
J. Martínez (2021)	Virtual learning: The e-learning era. *Con-Ciencia Serrana.*
Estrada & Mamani (2021)	Digital competence and sociodemographic variables in Peruvian basic education teachers.
González (2021)	High school teachers' digital competencies for emergency remote teaching.
Bautista et al. (2021)	Achievement of competencies during the learning process in COVID-19 times. *Propósitos y Representaciones.*
Díaz & Loyola (2021)	Digital competencies in the COVID-19 context: A view from education.
Asenjo & Asenjo (2021)	Teachers' self-perception of digital competence: Changes after confinement.
Ferrada et al. (2021)	Teacher training in ICT and its relevance during COVID-19.
Larrea (2021)	Teachers' digital competencies during the health emergency: Needs and opportunities for secondary education students in Lambayeque.
Pantoja et al. (2021)	Education and the pandemic: A challenge for upper basic and high school teachers in Ibarra.
Pesántez et al. (2021)	ICT in the educational transformation process: From face-to-face to distance learning. *Polo del conocimiento*
Centeno (2021)	Technological Training and Teachers' Digital Competencies.
Vargas-Murrillo (2021)	Design and Management of Virtual Learning Environments
Cóndor (2020)	Teaching in times of COVID-19.
Cedeño et al. (2020)	*Classroom* and *Google Meet* as tools to strengthen the teaching-learning process.
Macías et al. (2020)	Virtual environments as new learning settings: Managing online platforms in academia.
Aretio (2020)	Semantic forest: Distance, virtual, online, digital, e-learning education...
Sánchez et al. (2020)	Teaching physical education during the pandemic.
García (2020)	Education during the pandemic: Technology and its role in learning beyond the classroom.
Mangui et al. (2020)	Virtual Learning Environments (VLEs) as resources in asynchronous classes in higher education.
Asanov et al. (2020)	Remote learning, time use, and mental health of Ecuadorian high school students during COVID-19 quarantine.
Florián et al. (2018)	Training strategy for integrating educational technology in Altagracia Henríquez Perdomo Basic School, Vicente Noble District 01-05 (2018–2019).

Table 3
Categories and descriptions

Category	Description
Capabilities	Refers to the knowledge or skills a person has or must have to perform a given task. In this context, it refers to digital competencies.
Digital, virtual, or online	Refers to learning or teaching that takes place entirely through technological means, without requiring physical presence (i.e., remote learning).
ICT, LKT, and EPT	Acronyms for Information and Communication Technologies (ICT), Learning and Knowledge Technologies (LKT), and Empowerment and Participation Technologies (EPT), which support technological use in education and society.

themes in the data. These recurring elements allowed for the formulation of initial connections between categories and subcategories, which would later be explored more deeply (see Table 3).

Grounded theory was proposed as the analytical approach for interpreting the data, with the aim of ensuring transparency in the analytical procedures and enabling a systematic exegesis of the findings. Strauss and Corbin (2002) advocate for this type of method through *open coding*, which is understood as a process that allows each text to be examined in depth in order to understand the phenomenon according to existing categories and subcategories, while also identifying new categories that may emerge from the data.

In the initial phase, a list of new subcategories was obtained, enriching the depth of the analysis. In the subsequent phase, following the proposed methodology, we carried out axial coding, during which relationships between categories and subcategories began to emerge. To illustrate these connections, several semantic networks were created for each category, as well as a general semantic network that allowed for the identification of broader interrelations (see Figure 1).

In these two phases, the process was based exclusively on comparison, during which the documents were coded until data saturation was achieved based on reliability (Cantero, 2014). Following this, selective coding was carried out, enabling a coherent response to the research question and other related inquiries. After completing the analysis process, the findings were organized by category, followed by triangulation among them—this allowed for a robust

Figure 1
Semantic graph and axial coding

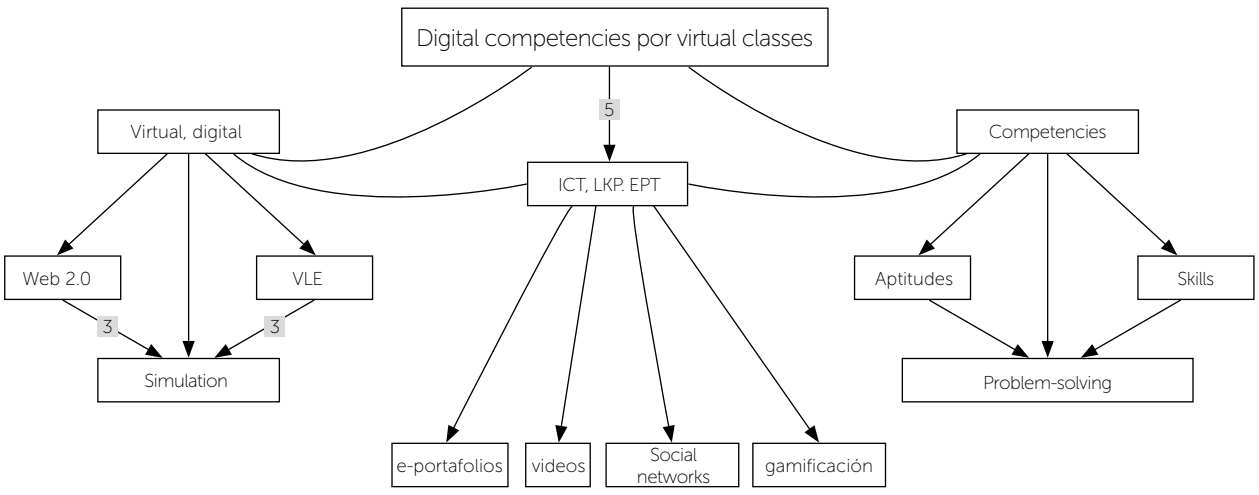

Figure 2
Category Frequencies

Name	Grounded	Date
Social networks	20	01/05/2023
Videos	18	11/10/2022
Problem solving	16	11/10/2022
Web 2.0	15	11/15/2022
Virtual learning environments	14	11/16/2022
Skills	14	12/08/2022
Gamification	13	11/26/2022
Simulation	12	12/13/2022
Aptitudes	12	11/10/2022
E-portfolios	05	12/01/2022

answer to the central research question, which will be further elaborated in the discussion section. Figure 2 presents the frequency of categories and subcategories as analyzed using ATLAS.ti.

Competencies

These refer to the essential preparations an individual possesses to solve situations in a globalized world. When the pandemic struck unexpectedly, teachers were forced to refine their existing skills to adapt lesson planning to digital tools within a virtual environment (Jaramillo & Eras, 2022)—a reality that was entirely new for most teachers accustomed to traditional face-to-face instruction.

The competencies developed through in-person teaching differ significantly from those required in remote learning. This is due to changes in planning, evaluation, feedback, class timing, and teaching dynamics. Moreover, the enhancement of digital competencies is closely related to factors such as the teacher's institutional affiliation or age (González, 2021).

Competency achievement may be limited by factors such as feedback and portfolio evaluation, which often show significance values exceeding theoretical expectations (Bautista et al., 2021). Since the onset of virtual education, the study of digital skills has progressively gained interest (Urrea et al., 2022).

Teaching competencies are influenced by various factors, including age, gender, socioeconomic status, academic level, and ongoing professional development. These are directly associated with the level of digital competence among teachers (Estrada & Mamani, 2021).

Digital / Virtual competencies

The digital or virtual competencies referenced in this review are supported by existing literature across various educational levels, with a particular focus on secondary education. These competencies may not always be explicitly stated, so it is necessary to infer them from the methods or methodologies described in each study.

Digital competencies are increasingly essential in today's globalized society. According to Díaz and Loyola (2021), such skills are crucial for achieving a true information and knowledge society. However, teachers often focus more on access to and management of digital tools rather than pedagogical application (Correa et al., 2022), despite being stronger in the latter and less so in the former.

Pinedo (2022) notes that this was largely caused by the abrupt transition from face-to-face to online or virtual teaching, which directly impacted the management of digital skills among both teachers and students. It also affected how these competencies relate to remote work and virtual classes.

Starting to teach electronically without adequate training in digital competencies led to several issues within the education system. Among the most significant were prolonged student demotivation, increased dropout rates, and insufficient development of skills and performance (Salguero et al., 2022).

This shift pushed the educational process to adopt digital methodologies, forcing teachers to adapt in real time (Asenjo & Asenjo, 2021). Although only 36% of teachers reported feeling truly prepared to educate

their students through ICTs (Ferrada et al., 2021), some educators quickly displayed signs of innovation, albeit accompanied by frustration and concern in this new educational context (Larrea, 2021).

Information and Communication Technologies (ICT), Learning and Knowledge Technologies (LKT), and Empowerment and Participation Technologies (EPT)

With the emergence of new education-oriented technologies, the focus has expanded beyond ICTs to include Learning and Knowledge Technologies (LKT), Empowerment and Participation Technologies (EPT), and more recently, the integration of all three into Relationship, Information, and Communication Technologies (RICT) (Hasbún, 2021).

Although these technologies had already facilitated meaningful learning in traditional education settings, school closures forced their integration to become mandatory in order to mitigate the effects of the shutdown and ensure continuity in teaching. Both students and teachers adapted to this new way of delivering and receiving information. In fact, even students without home internet access managed to participate in some form of remote learning (Asanov et al., 2020). The primary challenge for pedagogy has been the shift in teaching and learning methodologies. According to modern pedagogical models such as constructivism, technology was already playing a role in instruction through the use of ICTs (Pantoja et al., 2021). Nonetheless, J. Martínez (2021) states that a significant percentage of teachers have a low level of proficiency in digital competencies, highlighting the urgent need to achieve at least a basic level of ICT literacy.

The use of ICTs in everyday human life has had an exponential impact on various systems, with the educational sector standing out. It has increasingly promoted online, virtual, or distance education (Pesántez et al., 2021). When the educational modality shifted unexpectedly from in-person to remote or distance learning, educational systems responded by relying on the almost improvised use of tools such as ICTs, which were uncommon for many teachers (Cárcamo et al., 2022), as they were either unaccustomed to using them or employed them solely as supplementary tools.

Centeno (2021) emphasizes that, to ensure the effective use of ICTs, it is urgent to restructure teacher training through the design of a methodological and permanent guide that addresses their specific needs, aiming to optimize pedagogical practice.

Based on the present review and the findings obtained, it is reasonable to infer that the competencies achieved by students through the implementation of virtual education due to the COVID-19 pandemic were, in most cases, insufficient. This is largely because the transition from one educational modality to another was compulsory, abrupt, untimely, and sporadic, which at times led to stress among teachers and dropout among students.

Furthermore, the incorporation of technologies without proper educational planning, defined and achievable objectives, or a suitable contextual framework for their implementation, became a double-edged sword. In many cases, they turned into distractions that hindered the teaching-learning process and the final goals intended by teachers and educational systems, while also failing to develop the desired competencies.

The strategies aimed at fostering competencies largely revolved around the use of social media platforms (such as WhatsApp) as indispensable tools. While these could serve as supporting resources, they should never be used as the primary means of educational delivery. A more effective and appropriate strategy would have been the implementation of virtual learning environments (VLEs), which, according to Álvarez et al. (2020), have secured a strong foothold in contemporary education. Nevertheless, the online teaching-learning process remains a practice mediated by the internet and virtual spaces—an educational modality that continues to gain traction and is governed by ICTs (Espina-Romero, 2022).

In addition to the technological strategies described in the reviewed studies, there is a clear relationship between the educational outcomes sought and the methods employed. This correlation is often conditioned by the learning environment. According to Vargas-Murrillo (2021), distance education possesses characteristics distinct from face-to-face learning, offering students greater autonomy and independence in their learning processes and work rhythms.

Finally, feedback and application timing are essential factors that significantly affect the implementation of virtual education. Unlike face-to-face education, where feedback is immediate, virtual learning often lacks real-time interaction. This delay can become a disadvantage (Linne, 2022), especially in pre-university education, where the "human warmth" of direct contact plays a vital role.

As outlined above, technology makes substantial contributions to the virtual education process.

It enriches study, inquiry, and assessment tools, and allows students to learn at their own pace. Nevertheless, a fundamental challenge remains: many teachers still lack the competencies required to effectively implement this mode of education. Ongoing preparation and practical experience are essential to achieving the expected teaching standards and to educating individuals who are better aligned with the demands of contemporary society.

CONCLUSIONS

The findings of this review reveal significant progress in the preparation of teachers to operate effectively within virtual environments. These capabilities are reflected in the gradual transformation of teaching practices, support for the student population, adaptation to the digital context, and the development of competencies related to the use of RICT. However, a generational gap remains: older teachers tend to maintain a basic use of ICTs, remaining within their traditional pedagogical comfort zone, despite occasionally incorporating technological resources such as audiovisual materials or social media. Nevertheless, the integration of online, blended, or technology-mediated face-to-face modalities (such as the flipped classroom) represents a substantial step toward a more innovative educational model.

Recommendations

Local and regional educational systems should, in one way or another, enforce the mandatory integration of RICT in the teaching-learning process. This could be achieved by offering incentives to those who implement these tools—whether at a basic, intermediate, or advanced level—and by implementing corrective measures or even suspensions to those who fail to do so. Such measures would lead to significantly improved competency outcomes among recent graduates, while also ensuring the development of citizens who are well-prepared for the demands of both the present and the future. Currently, due to the widespread lack of teacher training in this area, the expected competencies are often not being met.

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