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Abstract: The objective of the present systematic review aimed to analyze studies linked to online teaching-learning, digital competence tutoring, and technological tools in virtual education during COVID-19 in higher education. The suggested methodology by the PRISMA declaration was pursued; the information search was conducted in Scopus, EBSCO, Springer Open, ProQuest, and One File. The target period ranged from May 10, 2021, to July 4, 2021; the identification, screening, eligibility, and inclusion for its progress were performed. The search produced a total of 230 studies, with 45 remaining. The inclusion criteria included original peer-reviewed research articles and qualitative and quantitative studies in higher education, comprising

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teachers and students addressing the study objective. In contrast, the exclusion criteria covered bibliographic reviews with procedural deficiencies, studies not exposed to a peer review process, and those not depicting a relationship with parts of the study. The results reveal that online teaching-learning, digital competence tutoring, and technological tools have been affirmative features expected to persist in higher virtual education engendered by the COVID-19 pandemic.

Keywords: Online learning; distance learning; distance education; teaching digital competence; technological tools.

I. Introduction

Globally, the health crisis required the implementation of online teaching-learning to give continuity to the educational liaison: teacher-student-parent in simulated milieu, and the social distancing measure coerced the teacher to readapt to the new setting of teaching-learning processes, new pedagogical practices, needing a permanent transformation and conducive to the future.¹

Moreover, the pandemic caused by COVID-19 has brought radical changes in the financial, social, health, and educational spheres. Therefore, Latin American countries had to acclimatize to the changes engendered by the pandemic. It included modifications in their educational policies, technological and pedagogical revolution, reinforcement of digital competencies, and implementation of novel virtual teaching-learning practices in varied educational modalities.^{2,3,4}

Educational innovation demands the acquisition of new knowledge, procedures, products, and services to enhance teachers' pedagogical practices, infrastructure, and technological resources in line with changing times.⁵ Furthermore, it suggests innovation of educational resources, improved

¹ Enaidy Reynosa et al., "Adaptación docente educativa en el contexto COVID-19: Una revisión sistemática," *Revista Conrado*, 16(77) (2020): 141–149, <https://conrado.ucf.edu.cu/index.php/conrado/article/view/1580>.

² Julio Cabero-Almenara and Carmen Llorente-Cejudo, "COVID-19: transformación radical de la digitalización en las instituciones universitarias," *Campus Virtuales*, 9(2) (2020): 26, <http://www.uajournals.com/ojs/index.php/campusvirtuales/article/view/713>.

³ Lina Rosa Parra-Bernal et al., "Las prácticas pedagógicas. Una oportunidad para innovar en educación," *Revista Latinoamericana de Estudios Educativos*, 17(1) (2021): 70–94, <https://doi.org/10.17151/rlee.2021.17.1.5>.

⁴ María S. Ramírez-Montoya, "Transformación digital e innovación educativa en Latinoamérica en el marco del COVID-19," *Campus Virtuales*, 9(2) (2020): 123–139, <http://uajournals.com/ojs/index.php/campusvirtuales/article/view/744>.

⁵ María S. Ramírez-Montoya, "Transformación digital e innovación educativa en Latinoamérica en el marco del COVID-19," *Campus Virtuales*, 9(2) (2020): 123–139, <http://uajournals.com/ojs/index.php/campusvirtuales/article/view/744>.

literacy in computer media assisted by the virtual form of learning with ICT tools, the eradication of space-time relationship restricting the teaching and rendering the students build their knowledge independently in these contexts.⁶ To this end, Nuere and De Miguel⁷ note that distance learning can be simultaneous, in real-time, and asynchronous when the interaction between teacher and student ensues at different times and places.

Online teaching-learning can render university education more accessible, malleable to teach and learn anywhere, anytime, less costly, more interactive, and student-centered. Yet, it poses difficulties concerning the lack of equipment and access, restricted ICT skills, low-speed Internet connections, specifically among the poorest families.⁸ It causes deep concern among teachers as they experience hardships in developing synchronous teaching processes and asynchronous feedback. Thus, accentuating asynchronous feedback, a viable alternative to keep training professionals, is critical.^{9,10} The online teaching-learning process can occur in any place, environment, and time flexibly where the teacher is a facilitator, collaborator, mentor, and trainer having pronounced responsibility and pledge toward the students' learning.¹¹ Similarly, Crisol-Moya et al.¹² reported that in virtual education, the pedagogical and technological aspects of the teaching-learning process must have a specific quality to expedite communication with students and broaden the horizon of access.

Teachers must equip themselves with innovative didactic strategies and digital educational materials during the teaching-learning process, making

⁶ Carlos Zurita et al., "Análisis crítico de ambientes virtuales de aprendizaje. Utopía y Praxis Latinoamericana," *Revista Internacional de Filosofía y Teoría Social*, 25(Extra11) (2020): 33–47, <https://doi.org/http://doi.org/10.5281/zenodo.4278319>.

⁷ Silvia Nuere and Laura De Miguel, "The Digital/Technological Connection with COVID-19: An Unprecedented Challenge in University Teaching," *Technology, Knowledge and Learning*, (2020), <https://doi.org/10.1007/s10758-020-09454-6>.

⁸ José Luis Abreu, "Tiempos de Coronavirus: La Educación en Línea como Respuesta a la Crisis," *Daena: International Journal of Good Conscience*, 15(1) (2020): 1–15.

⁹ Siddhartha Dutta et al., "The satisfaction level of undergraduate medical and nursing students regarding distant preclinical and clinical teaching amidst COVID-19 across India," *Advances in Medical Education and Practice*, 12 (2021):113–122, <https://doi.org/10.2147/AMEP.S290142>.

¹⁰ José Martínez-Garcés and Jacqueline Garcés-Fuenmayor, "Competencias digitales docentes y el reto de la educación virtual derivado de la COVID-19," *Educación y Humanismo*, 22(39) J. (2020): 1–16, <https://doi.org/10.17081/eduhum.22.39.4114>.

¹¹ Unung Verawardina et al., "Journal of Talent Development and Excellence," 12(3) (2020):385–392, <https://www.iratde.com/index.php/jtde/article/view/281>.

¹² Emilio Crisol-Moya, Liliana Herrera-Nieves, and Rosana Montes-Soldado, "Educación virtual para todos: una revisión sistemática." *Education in the Knowledge Society*, (21) (2020):1–13, <https://doi.org/10.14201/eks.20327>.

classes more engaging and motivating along with the needs and preferences of students.¹³ On top of that, Liesa-Orús et al.¹⁴ suggested a methodological revitalization of the teacher to undertake a superintendent role in the teaching-learning process. It included active methodologies, concentrating on the students to improve their participation. Also, it prioritized collaborative work, encouraged learning autonomy, and nurtured the acquisition of competencies and skills, crucial in the 21st century.

The paradigm shift in the educational system asks teachers to adapt to digitalized models using technological tools and digital competencies to get optimal results in meeting students' needs. It, reformed to the current reality, increasingly centers on "telework" and "working with ICTs," allowing the skills and abilities for effective technology deployment in many sources and channels in the educational setting¹⁵. Thus, the teachers' digital competence is a priority for online education, providing continuous training and covering the software use, online platforms, digital resources, and online assessment during the teaching-learning process.^{16,17}

Information technology tools have altered and affected the pedagogical practice, ignoring the traditional teaching-learning methodology, posing opportunities for more efficient communication between students and teachers, incredible in the past. Today, a student must socialize before being exposed to the online teaching-learning process.^{18,19} Thus, adequate utilization of

¹³ Unung Verawardina et al., "Reviewing online learning facing the COVID-19 outbreak," *Journal of Talent Development and Excellence*, 12(3) (2020):385–392, <https://www.iratde.com/index.php/jtde/article/view/281>.

¹⁴ Marta Liesa-Orús et al., "The technological challenge facing higher education professors: Perceptions of ICT tools for developing 21st Century skills." *Sustainability (Switzerland)*, 12(13) (2020):1–14, <https://doi.org/10.3390/su12135339>.

¹⁵ Aída López et al., "Un nuevo paradigma en la enseñanza universitaria basado en competencias digitales para profesores," *Campus Virtuales*, 9(2) (2020):71–82, <http://www.uajournals.com/ojs/index.php/campusvirtuales/article/view/737>.

¹⁶ A. D Olofsson, G. Fransson, and J.O Lindberg, "A study of the use of digital technology and its conditions with a view to understanding what 'adequate digital competence' may mean in a national policy initiative." *Educational Studies*, 46(6) (2020):727–743, <https://doi.org/10.1080/03055698.2019.1651694>.

¹⁷ Amiya Kumar Mohapatra, "Impact of COVID-19 on Higher Education," *Journal of Management & Public Policy*, 11(2) (2020): 4–6, <http://search.ebscohost.com/login.aspx?direct=true&db=bth&AN=144532553&lang=es&site=eds-live>.

¹⁸ Atul Bamrara, "Examining the status of ICT usage in teaching – Learning Process," *International Journal for Environmental Rehabilitation and Conservation*, 10(1) (2019):59–63, <https://www.doi.org/10.31786/09756272.19.10.1.108>.

¹⁹ Enaidy Reynosa et al., "Adaptación docente educativa en el contexto COVID-19: Una revisión sistemática", *Revista Conrado*, 16(77) (2020): 141–149, <https://conrado.ucf.edu.cu/index.php/conrado/article/view/1580>.

technological tools demands initial and permanent training in teaching practice. It targets to adapt to the technology abundance in education, incorporating them commendably and competently in the teaching-learning process.²⁰

Therefore, the objective of this systematic review was to review studies on online teaching-learning, digital competence tutoring, and technological tools in virtual education during COVID-19 in higher education.

II. Methodology

The systematic literature review was performed using a qualitative approach.²¹ To this end, the documentary analysis of scientific articles was utilized, entailing the discovery and examination, with relevant knowledge and information for research.²² It charted the methodology recognized in the PRISMA declaration, enabling a solid process of methods and results, enriching the studies of systematic reviews and meta-analyses.²³ The information search was in English and Spanish, with the databases of Scopus, EBSCO, Springer Open, ProQuest, and One File having the following keywords' combination: "Online teaching-learning and virtual education and COVID-19," "Digital competence in teaching and virtual education and COVID-19," and "Technological tools and virtual education and COVID-19," considered from the subcategories presented in Table 1.

The target period was from May 10, 2021 to July 4, 2021, where the identification, screening, eligibility and inclusion were carried out. The search for articles in the database consulted yielded a total of 230, of which 45 studies remained, establishing as inclusion criteria: peer-reviewed original research articles, qualitative, quantitative and mixed studies in higher education involving teachers and students addressing the study objective; exclusion criteria: literature reviews, with methodological deficiencies, studies that were not subjected to a peer review process and those that did not demonstrate a relationship with the categories that are part of the study (see Figure 1).

²⁰ Marta Liesa-Orús et al., "The technological challenge facing higher education professors: Perceptions of ICT tools for developing 21st Century skills" *Sustainability* (Switzerland), 12(13) (2020):1–14, <https://doi.org/10.3390/su12135339>.

²¹ Roberto Hernández-Sampieri and Cristina Paulina Mendoza, "Metodología de la Investigación. Las rutas Cuantitativa Cualitativa y Mixta. In Metodología de la investigación. Las rutas cuantitativa, cualitativa y mixta", (2019), <https://virtual.cuautitlan.unam.mx/rudics/?p=2612>.

²² M., Tamayo, "El proceso de la investigación científica," (2003), <https://doi.org/10.1007/s13398-014-0173-7.2>.

²³ G., Urrutia, and X. Bonfill, PRISMA_Spanish.pdf. *Medicina Clínica*, 135(11) (2010): 507–511.

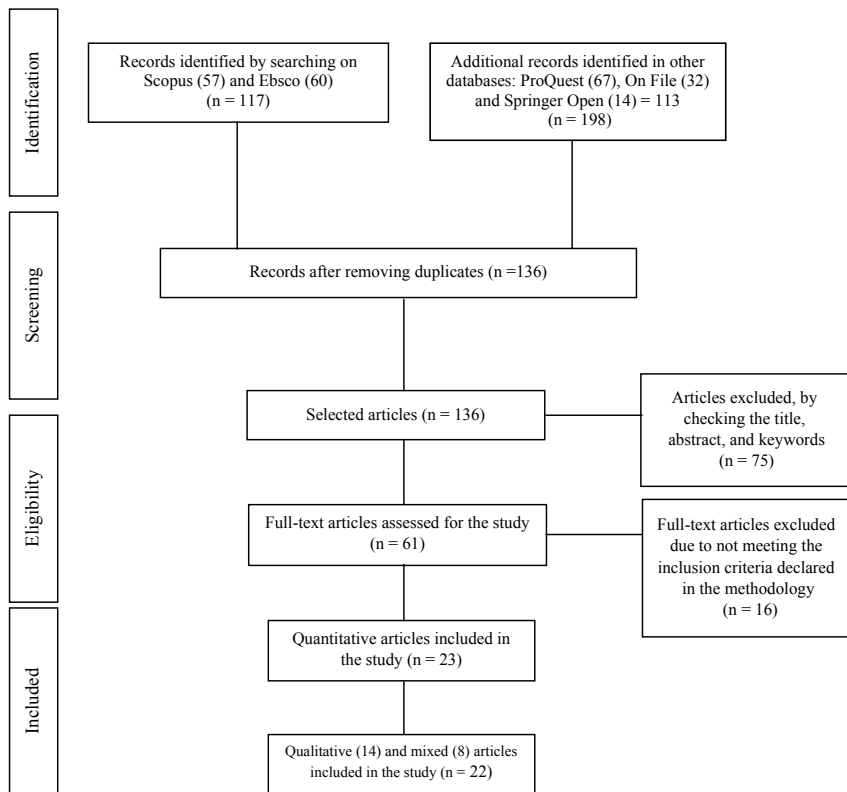


Figure 1
Adaptation of PRISMA, flowchart

III. Results and discussion

While performing the initial search in the above Databases, 230 qualitative, quantitative, and mixed scientific articles in higher education were retrieved. They encompassed teachers and students, contending with the objective of the study. The 136 articles were debarred due to duplicates; similarly, 75 were disqualified by checking title, abstract, and keywords. Eventually, 16 articles did not meet the inclusion criteria indicated in the methodology, thus excluded. The remaining was 45 articles for an extensive review and investigation as detailed below:

Table 1
Investigations included in the systematic review

N°	Author	Methodology		Subcategories		
		Research type	Instrument, technique or method	Online teaching-learning	Teaching digital competence	Technological tools
1	(García-de-paz and Santana, 2021)	Qualitative	Interview Documentary analysis	X		
2	(Ramírez-Montoya, 2020)	Qualitative	Questionnaire		X	
3	(Martínez-Garcés and Garcés-Fuenmayor, 2020)	Quantitative	Questionnaire		X	
4	(Fernández-Regueira et al., 2020)	Mixed	Questionnaire and Documentary analysis	X		
5	(Zacarias and Salgado, 2020)	Qualitative	Questionnaire		X	
6	(Arántzazu de las Morenas, 2020)	Mixed	Questionnaire Interview	X		X
7	(Zurita et al., 2020)	Mixed	Descriptive Documentary Analysis			X
8	(Amaya et al., 2021)	Quantitative	T-Pack test	X		
9	(Alamer and Alharbi, 2021)	Quantitative	Questionnaire			X
10	(Drake et al., 2021)	Quantitative	FAST exam			X
11	(Hew et al., 2020)	Mixed	Online assessment	X		
12	(Ashry et al., 2020)	Quantitative	Questionnaire	X		
13	(Venera et al., 2020)	Quantitative	Questionnaire	X		
14	(Ferri et al., 2020)	Qualitative	Case Study	X		
15	(Amir et al., 2020)	Quantitative	Questionnaire	X		

N°	Author	Methodology		Subcategories		
		Research type	Instrument, technique or method	Online teaching-learning	Teaching digital competence	Technological tools
16	(Pozo-Rico et al., 2020)	Mixed	Questionnaire Inventory (stress)		X	
17	(Portillo et al., 2020)	Quantitative	Questionnaire		X	
18	(Kara et al., 2020)	Qualitative	Virtual Environment			X
19	(Robles and Fernández, 2021)	Quantitative	ABP Intervention Program	X	X	X
20	(Sangeeta and Tandon, 2020)	Quantitative	Questionnaire			X
21	(Torres et al., 2021)	Quantitative	Questionnaire		X	
22	(König et al., 2020)	Quantitative	Questionnaire	X	X	
23	(Tejedor et al., 2020)	Quantitative	Questionnaire		X	
24	(Molise and Dube, 2020)	Qualitative	Interview	X	X	
25	(Hortigüela-Alcalá et al., 2020)	Quantitative	Questionnaire	X		
26	(Palau et al., 2020)	Qualitative	Interview	X		
27	(Montenegro et al., 2020)	Quantitative	Questionnaire	X		
28	(Sales et al., 2020)	Qualitative	Interview		X	X
29	(Ruiz-Ramirez et al., 2020)	Qualitative	Interview		X	
30	(Schina et al., 2020)	Quantitative	Questionnaire	X	X	
31	(Acevedo-Duque et al., 2020)	Quantitative	Questionnaire		X	
32	(Albó et al., 2020)	Quantitative	Questionnaire	X	X	

N°	Author	Methodology		Subcategories		
		Research type	Instrument, technique or method	Online teaching-learning	Teaching digital competence	Technological tools
33	(Pérez-Jorge et al., 2020)	Quantitative	Questionnaire		X	X
34	(Lie et al., 2020)	Qualitative	Interview	X	X	
35	(Dutta et al., 2021)	Quantitative	Questionnaire	X		X
36	(Naidoo, 2020)	Qualitative	Interactive Qorkshops			X
37	(Hossain, 2021)	Mixed	Open Questionnaires	X		X
38	(Sepasgozar, 2020)	Qualitative	Interview			X
39	(Fernandez et al., 2021)	Mixed	Open Questionnaires		X	
40	(Zhang, 2020)	Qualitative Ethnographic	Personal Narration	X		
41	(Fathima and Savitha, 2021)	Quantitative	Questionnaire	X		
42	(Ożadowicz, 2020)	Quantitative	Questionnaire	X		X
43	(Yan and Batako, 2020)	Quantitative	Questionnaire	X		
44	(Noor et al., 2020)	Qualitative	Interview	X		X
45	(Zambrano, 2020)	Mixed	Open Questionnaires		X	

Table 2 depicts the broad distribution of the 45 analyzed scientific articles: 51.1% (23) studies were quantitative; 8 corresponded to the subcategory online teaching-learning, 5 to the subcategory teaching digital competence, 3 to the subcategory technological tools, and seven studies exhibited interrelation between subcategories. However, 31.1% (14) were qualitative research, with four conforming to the subcategory online teaching-learning, three to teaching digital competence, and three to the technological tools. Four studies displayed interrelation between subcategories. Ultimately, 17.8% (8) articles were the mixed type, with two

belonging to the online teaching-learning, three to teaching digital competence, and one to the technological tools. Two studies showed interrelation between subcategories.

Table 2
Number of scientific articles reviewed and analyzed

Research type	Related subcategory				Frequency	%
	Online teaching-learning	Teaching digital competence	Technological tools	Interrelationship between Subcategories		
Quantitative	8	5	3	7	23	51.1
Qualitative	4	3	3	4	14	31.1
Mixed	2	3	1	2	8	17.8
Total	14	11	7	13	45	100

Subcategory online teaching-learning

The findings of the analyzes of the articles reviewed revealed that that online teaching-learning during the pandemic has had new methodologies, strategies, pedagogical approaches, and platforms explicitly engineered for virtual settings during the teaching-learning process and will be increasingly efficient and pose a prospect for a more viable educational system.^{24,25,26,27} Also, online teaching-learning is flexible and diverges, enabling active interaction between teachers and students and expediting communication with “free discussion and debate” through virtual platforms to apply language skills. Moreover, it increases the virtual methods’ acquaintances,

²⁴ Lisa R. Amir et al., “Student perspective of classroom and distance learning during COVID-19 pandemic in the undergraduate dental study program Universitas Indonesia”, *Medical Education*, 20(1) (2020):2–8, <https://doi.org/10.1186/s12909-020-02312-0>.

²⁵ Fernando Ferri, Patrizia Grifoni, and Tiziana Guzzo, “Online Learning and Emergency Remote Teaching: Opportunities and Challenges in Emergency Situations”, *Societies*, 10(86) (2020):2–18, <https://doi.org/10.3390/soc10040086>.

²⁶ Sergio García-de-paz and Pablo Joel Santana Bonilla, “La transición a entornos de educación virtual en un contexto de emergencia sanitaria: estudio de caso de un equipo docente en Formación Profesional Básica,” *Revista de Educación a Distancia*, 21(9) (2021):1–25, <https://revistas.um.es/red/article/view/450791>.

²⁷ Despoina Schina et al., “The integration of sustainable development goals in educational robotics: A teacher education experience”, *Sustainability*, 12(23) (2020):1–15, <https://doi.org/10.3390/su122310085>.

saving time and resources in synchronous relations in webinars and teleconferences.^{28,29}

Accordingly, the studies disclose that the novel online teaching modality presents teachers the opportunity to urge the autonomy and self-regulation of students, test varying styles of synchronous and asynchronous teaching, implement advanced collaborative formats to form tasks, provide feedback and check multiple communication modes with students and their parents recognizing that communication with teachers has been constructive.^{30,31} With a change in online teaching methodology, teachers have quickly undertaken their digitized pedagogical practices, despite specific difficulties using technological tools. It is due to their limited experience causing them to contract a slow work pace.^{32,33,34}

Yet, some studies have noted that in online teaching, teachers confront many challenges: inadequate student participation due to not possessing the needed electronic devices for online classes, low or no internet connection, deprived supervision of virtual educational settings by parents. There also exist difficulties in holding students' attention, deficiency of social interaction with the students, monumental time devoted to class preparation and

²⁸ Andrzej Ożadowicz, "Modified blended learning in engineering higher education during the COVID-19 lockdown-building automation courses case study," *Education Sciences*, 10(10) (2020):1–20, <https://doi.org/10.3390/educsci10100292>.

²⁹ Ning Yan and Andre DL Batako, "Online Teaching: A Relational Study of Perception and Satisfaction," *International Journal of TESOL Studies*, 2(4) (2020):128–145, <https://doi.org/10.46451/ijts.2020.12.12>.

³⁰ David Hortigüela-Alcalá et al., "Familias y Docentes: Garantes del Aprendizaje durante el Confinamiento," "Revista Internacional de Educación Para La Justicia Social," 9(3) (2020):353–370, <https://doi.org/10.15366/RIEJS2020.9.3.019>.

³¹ Johannes König, Daniela J. Jäger-Biela, and Nina Glutsch, "Adapting to online teaching during COVID-19 school closure: teacher education and teacher competence effects among early career teachers in Germany," *European Journal of Teacher Education*, 43(4) (2020):608–622, <https://doi.org/10.1080/02619768.2020.1809650>.

³² Laia Albó et al., "Emergency remote teaching: Capturing teacher experiences in Spain with selfie," *Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*, Vol. 12315 LNCS (2020), https://doi.org/10.1007/978-3-030-57717-9_23.

³³ Martín Arántzazu de las Morenas, "Percepciones de alumnos y docentes de 5º y 6º de educación primaria sobre la modalidad de educación a distancia implantada temporalmente en España por COVID-19," *Enseñanza & Teaching*, 38(2) (2020): 157–175, <https://doi.org/10.14201/et2020382157175>.

³⁴ Uxia Fernández-Regueira, Adriana Gewerc, and Martín Llamas-Nistal, "El profesorado universitario de Galicia y la enseñanza remota de emergencia: condiciones y contradicciones," *Campus Virtuales*, 9(2) (2020): 9–24, <http://www.ua-journals.com/ojs/index.php/campusvirtuales/article/view/731>.

homework assessment, changes in students' learning behavior, and families' precincts to attend virtual tasks.^{35,36,37,38,39,40,41}

However, most students readily adapted to modifications in the combined intervention and assessment procedures through a synchronous and asynchronous connection. It helps them search for novel things and didactic material supplied by their teachers during virtual classes, positively impacting the educational progression.^{42,43,44} Yet, students deal with challenges such as instability in the internet connection, extra financial burden, time management, scanty concentration in virtual classes at home during this acclimatization. Moreover, situational issues

³⁵ Ahmed Hamdy Ashry, Hussein Mohammed Soffar, and Mohamed Fathalla Alsawy, "Neurosurgical education during COVID-19: challenges and lessons learned in Egypt," *Egyptian Journal of Neurology, Psychiatry and Neurosurgery*, 56(1) (2020):110, <https://doi.org/10.1186/s41983-020-00242-8>.

³⁶ Fernandez CSP et al., "Training 'Pivots' from the Pandemic: Lessons Learned Transitioning from In-Person to Virtual Synchronous Training in the Clinical Scholars Leadership Program," *Journal of Healthcare Leadership*, 13 (2020):63–75, <https://doi.org/10.2147/jhl.s282881>.

³⁷ David Hortigüela-Alcalá et al., "Familias y Docentes: Garantes del Aprendizaje durante el Confinamiento," *Revista Internacional de Educación Para La Justicia Social*, 9(3) (2020):353–370, <https://doi.org/10.15366/RIEJS2020.9.3.019>.

³⁸ Shaista Noor, Filzah Md. Isa, and Faizan Farid Mazhar, "Online Teaching Practices During the COVID-19 Pandemic," *Educational Process: International Journal*, 9(3) (2020):169–184, <https://doi.org/10.22521/edupij.2020.9.3.4>.

³⁹ Ramon Palau, Jordi Mogas, and María José Ucar, "¿Cómo han gestionado los conservatorios de música españoles los procesos de enseñanza-aprendizaje durante el confinamiento del COVID-19?," *Revista Electronica de LEEME*, 46 (2020):108–124, <https://doi.org/10.7203/LEEME.46.18110>.

⁴⁰ Luis Leonardo Zambrano Vacacla, "Uso de la Tecnología de la Información y Comunicación en educación virtual y su correlación con la Inteligencia Emocional de docentes en el Ecuador en contexto COVID-19," *Revista Ibérica de Sistemas e Tecnologías de Información*, 40(12) (2020):31–44, <https://doi.org/10.17013/risti.40.31.44>.

⁴¹ Chun Zhang, "From Face-to-Face to Screen-to-Screen: CFL Teachers' Beliefs about Digital Teaching Competence during the Pandemic," *International Journal of Chinese Language Teaching*, 1(1) (2020):35–52, <https://doi.org/10.46451/ijclt.2020.06.03>.

⁴² Fathima, E. V. and Savitha, E., "Gendered Inequalities of Access: Online Classes in the Times of the Pandemic" *Journal of Comparative Literature and Aesthetics*, 44(1) (2020):68–78, <https://link.gale.com/apps/doc/A655258324/AONE?u=univalle&sid=AONE&xid=6bd15512>.

⁴³ Francisco Javier Robles Moral and Manuel Fernández Díaz, "Future Primary School Teachers' Digital Competence in Teaching Science through the Use of Social Media," *Sustainability*, 13(5) (2021):1–13, <https://doi.org/10.3390/su13052816>.

⁴⁴ Cristina Venera Tartavulea et al., "Online teaching practices and the effectiveness of the educational process in the wake of the COVID-19Pandemic," *Amfiteatru Economic*, 22(55) (2020):920–936, <https://doi.org/10.24818/EA/2020/55/920>.

increase the social need directly or indirectly, impacting their academic performance.^{45,46,47}

Like so, many studies disclose that students favor face-to-face classes as they provide them with an actual study environment, face-to-face learning, continual discussion, audiovisual interaction on texts associated with the study, and a blackboard for sharing questions and answers. Moreover, these classes offer adequate comprehension and the likelihood of facing a real communication setting between students and teachers. Yet, students consider that with online teaching, teachers are more considerate, solve uncertainties, learning is engaging and inspiring to partake in debates, time is properly used. On top of that, the content quality is comparable to conventional education, and the topics and ideas are exchanged appropriately and help students acquire technical knowledge, rendering them technically capable.^{48,49,50}

Subcategory digital competence

The research reveals digital transformations' necessitated changes in culture, knowledge management, and open education. It has caused the enhancement and innovation of the teacher's pedagogical practices of⁵¹

⁴⁵ Lisa R. Amir et al., "Student perspective of classroom and distance learning during COVID-19 pandemic in the undergraduate dental study program Universitas Indonesia," *Medical Education*, 20(1) (2020):2–8, <https://doi.org/10.1186/s12909-020-02312-0>.

⁴⁶ Mozaffor Hossain, "English Language Teaching through Virtual Classroom during COVID-19 Lockdown in Bangladesh: Challenges and Propositions," *Journal of English Education and Teaching (JEET)*, 5(1) (2021):41–60, <https://ejournal.unib.ac.id/index.php/JEET/article/view/13724>.

⁴⁷ Sofia Montenegro, Esther Raya, and Fermín Navaridas, "Percepciones Docentes sobre los Efectos de la Brecha Digital en la Educación Básica durante el COVID-19," *Revista Internacional de Educacion Para La Justicia Social*, 9(3) (2020):317–333, <https://doi.org/10.15366/RIEJS2020.9.3.017>.

⁴⁸ Siddhartha Dutta et al., "The satisfaction level of undergraduate medical and nursing students regarding distant preclinical and clinical teaching amidst COVID-19 across India," *Advances in Medical Education and Practice*, 12 (2021):113–122, <https://doi.org/10.2147/AMEP.S290142>.

⁴⁹ Mozaffor Hossain, "English Language Teaching through Virtual Classroom during COVID-19 Lockdown in Bangladesh: Challenges and Propositions," *Journal of English Education and Teaching (JEET)*, 5(1) (2021):41–60, <https://ejournal.unib.ac.id/index.php/JEET/article/view/13724>.

⁵⁰ Ning Yan and Andre DL Batako, "Online Teaching: A Relational Study of Perception and Satisfaction," *International Journal of TESOL Studies*, 2(4) (2020):128–145, <https://doi.org/10.46451/ijts.2020.12.12>.

⁵¹ María S. Ramírez-Montoya, "Transformación digital e innovación educativa en Latinoamérica en el marco del COVID-19," *Campus Virtuales*, 9(2) (2020): 123–139, <http://uajournals.com/ojs/index.php/campusvirtuales/article/view/744>.

allowing teachers and students to progressively get used to these new educational demands in the virtual environment. The updated fundamental modality replying emphatically to the current reality has coerced teachers to acquire high-quality technological equipment, internet connectivity, and reinforcing digital skills for developing online teaching-learning.^{52,53,54,55}

Notwithstanding, the use of technologies embodies a didactic resource for sustenance, communication, and observing during the teachers' online pedagogical practices compelling them to employ some digital implements, including WhatsApp, Google Drive, email, Zoom, Khan Academy, WhatsApp Web, Google Classroom, Facebook, Microsoft Team, and others, securing the continuation of classes through an application.⁵⁶ Nevertheless, many teachers endure hardships and limitations in their digital skills while editing extant digital material. They include specifying and managing information, limited by their digital literacy and usage of technological tools. This is especially true for teachers having higher age and employed in public schools, causing a heavier workload and aggravating stress and anxiety.^{57,58,59}

⁵² José Martínez-Garcés and Jacqueline Garcés-Fuenmayor, "Competencias digitales docentes y el reto de la educación virtual derivado de la COVID-19," *Educación y Humanismo*, 22(39) J. (2020): 1–16, <https://doi.org/10.17081/eduhum.22.39.4114>.

⁵³ Teresa Pozo-Rico, Raquel Gilar-Corbí, Andrea Izquierdo, and Juan-Luis Castejón, "Teacher Training Can Make a Difference: Tools to Overcome the Impact of COVID-19 on Primary Schools. An Experimental Study," *Environmental Research and Public Health*, 17(22) (2020):1–22, <https://doi.org/10.3390/ijerph17228633>.

⁵⁴ María S. Ramírez-Montoya, "Transformación digital e innovación educativa en Latinoamérica en el marco del COVID-19," *Campus Virtuales*, 9(2) (2020): 123–139, <http://uajournals.com/ojs/index.php/campusvirtuales/article/view/744>.

⁵⁵ Johannes König, Daniela J. Jäger-Biela, and Nina Glutsch, "Adapting to online teaching during COVID-19 school closure: teacher education and teacher competence effects among early career teachers in Germany," *European Journal of Teacher Education*, 43(4) (2020):608–622, <https://doi.org/10.1080/02619768.2020.1809650>.

⁵⁶ José D. Zacarias and Gladys D. Salgado, "Estudio de la preparación del profesorado en México ante la pandemia del COVID-19 en la transición de enseñanza presencial a virtual o en línea," *Revista Paradigma*, XLI(2) (2020):795–819, <https://doi.org/10.37618/paradigma.1011-2251.0.p795-819.id925>.

⁵⁷ Uxia Fernández-Regueira, Adriana Gewerc, and Martín Llamas-Nistal, "El profesorado universitario de Galicia y la enseñanza remota de emergencia: condiciones y contradicciones," *Campus Virtuales*, 9(2) (2020): 9–24, <http://www.uajournals.com/ojs/index.php/campusvirtuales/article/view/731>.

⁵⁸ José Martínez-Garcés and Jacqueline Garcés-Fuenmayor, "Competencias digitales docentes y el reto de la educación virtual derivado de la COVID-19," *Educación y Humanismo*, 22(39) J. (2020): 1–16, <https://doi.org/10.17081/eduhum.22.39.4114>.

⁵⁹ Javier Portillo et al., "Self-Perception of the Digital Competence of Educators during the COVID-19 Pandemic: A Cross-Analysis of Different Educational Stages," *Sustainability*, 12(23) (2020):1–13, <https://doi.org/10.3390/su122310128>.

Therefore, it is critical to keep developing technological competencies to enhance their online teaching practice in distance education; a must, more manifest in teachers from rural areas.^{60,61,62,63}

Moreover, teachers disclose that adaptation to the unexpected change in the online class format has favored the growth of digital skills through an emerging process of reinforcing and self-training. It has helped enrich their high-tech knowledge and has enabled the continuity of education. Fortunately, they have displayed solid spirit and compliance to the new world educational scenario, advancing the quality of response.^{64,65,66,67} Additionally, the strategic use of ICT in converting virtual teaching-learning is crucial in the communication and elevation of critical-reflective thinking in students. Hence, developing their digital skills competently and tellingly with a critical vision is critical for their training and helps them grow into productive learners and liable citizens in the

⁶⁰ Arturo Amaya, Daniel Cantú, and José Marreros, “Análisis de las competencias didácticas virtuales en la impartición de clases universitarias en línea, durante contingencia del COVID-19,” *Revista de Educación a Distancia*, 21(5) (2021):1–20, <https://doi.org/http://dx.doi.org/10.6018/red.426371>.

⁶¹ Khe Foon Hew et al., “Transitioning to the “new normal” of learning in unpredictable times: pedagogical practices and learning performance in fully online flipped classrooms,” *International Journal of Educational Technology in Higher Education*, 17(1) (2020):57, <https://doi.org/10.1186/s41239-020-00234-x>.

⁶² Anita – Lie et al., “Secondary School Language Teachers’ Online Learning Engagement During The COVID-19 Pandemic in Indonesia,” *Journal of Information Technology Education: Research*, 19 (2020):803–832, <https://doi.org/10.28945/4626>.

⁶³ Habasisa Molise and Bekithemba Dube, “Emergency online teaching in economic and management sciences necessitated by the covid-19 pandemic: The need for healthy relations in a rural schooling context,” *International Journal of Learning, Teaching and Educational Research*, 19(6) (2020):387–400, <https://doi.org/10.26803/IJLTER.19.6.23>.

⁶⁴ Acevedo-Duque, Á. et al., “Teacher competences in online education in time of COVID-19: Public Universities of Honduras,” *Revista de Ciencias Sociales*, 26 (2020):206–224, <https://repositorio.uaautonoma.cl/handle/20.500.12728/7898>.

⁶⁵ Anita – Lie et al. “Secondary School Language Teachers’ Online Learning Engagement During The COVID-19 Pandemic in Indonesia,” *Journal of Information Technology Education: Research*, 19 (2020):803–832, <https://doi.org/10.28945/4626>.

⁶⁶ David Pérez-Jorge et al., “Training in Digital Skills in Early Childhood Education Teachers: The Case of the University of La Laguna,” *International Journal of Interactive Mobile Technologies*, 14(20) (2020):35–49, <https://doi.org/10.3991/IJIM.V14I20.17339>.

⁶⁷ Jessica A. Ruiz-Ramirez, Dayannis Tamayo-Preval, and Hugo Montiel-Cabello, “Competências digitais de professoras na modalidade de aulas online: Estudo de caso no contexto da crise sanitária”, *Texto Livre*, 13(3) (2020):47–62, <https://doi.org/10.35699/1983-3652.2020.25592>.

virtual world with continuous teacher training as a permanent state educational policy.^{68,69,70,71}

Yet, students, albeit belonging to a new generation; have not advanced their digital skills in online education and spun classroom methodology. They gather that virtual work engenders an increased academic burden relative to face-to-face work.^{72,73} Equally, they mention that teachers can implement virtual active methodologies but do not possess adequate knowledge of image editors, videos, infographics, synchronous response systems, and anti-plagiarism tools.⁷⁴

Subcategory technological tools

Zurita et al.⁷⁵ have noted that currently, the knowledge society goes through an immense advancement about technological tools' use because it has succeeded in connecting to virtual educational platforms as an alternative space of knowledge, compliant to the current prerequisites of globalized societies. Similarly, it has attained a crucial impact on educational work settings. Accordingly, the teachers declare that technological tools and their

⁶⁸ Habasisa Molise and Bekithemba Dube, "Emergency online teaching in economic and management sciences necessitated by the COVID-19 pandemic: The need for healthy relations in a rural schooling context," *International Journal of Learning, Teaching and Educational Research*, 19(6) (2020):387–400, <https://doi.org/10.26803/IJLTER.19.6.23>.

⁶⁹ Dora Sales, Aurora Cuevas-Cerveró, and José-Antonio Gómez-Hernández, "Perspectives on the information and digital competence of social sciences students and faculty before and during lockdown due to COVID-19," *Profesional de La Informacion*, 29(4) (2020):1–20, <https://doi.org/10.3145/epi.2020.jul.23>.

⁷⁰ Despoina Schina et al. "The integration of sustainable development goals in educational robotics: A teacher education experience2, *Sustainability*, 12(23) (2020):1–15, <https://doi.org/10.3390/su122310085>.

⁷¹ Santiago Tejedor et al., "Education in times of pandemic: reflections of students and teachers on virtual university education in Spain, Italy, and Ecuador," *Revista Latina de Comunicacion Social*, 78 (2020):1–21, <https://doi.org/10.4185/RLCS-2020-1466>.

⁷² Francisco Javier Robles Moral and Manuel Fernández Díaz, "Future Primary School Teachers' Digital Competence in Teaching Science through the Use of Social Media," *Sustainability*, 13(5) (2021):1–13, <https://doi.org/10.3390/su13052816>.

⁷³ Santiago Tejedor et al., "Education in times of pandemic: reflections of students and teachers on virtual university education in Spain, Italy, and Ecuador", *Revista Latina de Comunicacion Social*, 78 (2020):1–21, <https://doi.org/10.4185/RLCS-2020-1466>.

⁷⁴ César Torres Martín et al., "Impact on the Virtual Learning Environment Due to COVID-19," *Sustainability*, 13(2) (2021):1–16, <https://doi.org/10.3390/su13020582>.

⁷⁵ Carlos Zurita et al., "Análisis crítico de ambientes virtuales de aprendizaje. Utopia y Praxis Latinoamericana," *Revista Internacional de Filosofía y Teoría Social*, 25(Extra11) (2020): 33–47, <https://doi.org/http://doi.org/10.5281/zenodo.4278319>.

use are critical for developing high-quality educational practice. That is why they teach virtual classes employing their means, including technology and Internet support. The most used devices for online teaching include the mobile, laptop, tablet, and desktop computer with apps such as the Zoom, Cloud Meeting, and Google classroom. Also, they record their classes on their mobile phones; then upload the videos to their Facebook pages. They claim to have selected the tools, best fitting to their situation, as an enabler of the platforms or possessions, continue with the classes from home.^{76,77,78}

Concerning the students, most utilize personal computers, despite their mastery in technological implements and the broader use of mobile devices. They have access to virtual platforms such as Blackboard Collaborate, enabling better resolution images, radiology, and ultrasound for medical training during virtual sessions. Furthermore, they feel that webinars and sessions with recorded demonstrations are invaluable sources of knowledge acquisition and answer to the technical hardships arising during virtual classes. They can deepen the assessment methods and systems in current practice.^{79,80,81,82,83} The virtual learning environments, supplied by social

⁷⁶ Martín Arántzazu de las Morenas, “Percepciones de alumnos y docentes de 5° y 6° de educación primaria sobre la modalidad de educación a distancia implantada temporalmente en España por COVID-19,” *Enseñanza & Teaching*, 38(2) (2020): 157–175, <https://doi.org/10.14201/et2020382157175>.

⁷⁷ Siddhartha Dutta et al., “The satisfaction level of undergraduate medical and nursing students regarding distant preclinical and clinical teaching amidst COVID-19 across India,” *Advances in Medical Education and Practice*, 12 (2021):113–122, <https://doi.org/10.2147/AMEP.S290142>.

⁷⁸ Mozaffor Hossain, “English Language Teaching through Virtual Classroom during COVID-19 Lockdown in Bangladesh: Challenges and Propositions,” *Journal of English Education and Teaching (JEET)*, 5(1) (2021):41–60, <https://ejournal.unib.ac.id/index.php/JEET/article/view/13724>.

⁷⁹ Ali Alamer and Fawaz Alharbi, “Synchronous distance teaching of radiology clerkship promotes medical students’ learning and engagement,” *Insights into Imaging*, 12(1) (2021):1–11, <https://doi.org/10.1186/s13244-021-00984-w>.

⁸⁰ Anne E. Drake et al., “Innovations with tele-ultrasound in education sonography: the use of tele-ultrasound to train novice scanners,” *The Ultrasound Journal*, 13(1) (2021):6, <https://doi.org/10.1186/s13089-021-00210-0>.

⁸¹ Andrzej Ozadowicz, “Modified blended learning in engineering higher education during the COVID-19 lockdown-building automation courses case study,” *Education Sciences*, 10(10) (2020):1–20, <https://doi.org/10.3390/educsci10100292>.

⁸² David Pérez-Jorge et al., “Training in Digital Skills in Early Childhood Education Teachers: The Case of the University of La Laguna,” *International Journal of Interactive Mobile Technologies*, 14(20) (2020):35–49, <https://doi.org/10.3991/IJIM.V14I20.17339>.

⁸³ Dora Sales, Aurora Cuevas-Cerveró, and José-Antonio Gómez-Hernández, “Perspectives on the information and digital competence of social sciences students and faculty

networks, are message platforms essentially utilized by this century's young generation, keeping them excited. This is due to the self-assured interaction conducted with their peers, boosting their participation and intercommunication apart from providing critical benefits and esteeming learning achievements.^{84,85}

Teachers have had to espouse a positive assertiveness toward the technology used to present their classes online. Nonetheless, there exist teachers, not appreciate the digital platforms' expediency. It prevents them from implementing it and steering their online classes optimally.⁸⁶ Similarly, they must secure that the utilized resources are readily available with no extra cost to themselves and students. Accordingly, it is compulsory to propound them orientation sessions on the usage of digital platforms. Only then are they better prepared for their effective and satisfactory utilization to teach several distance courses encouraging higher student participation in online classes.^{87,88,89}

IV. Conclusions

Distance education has claimed that teachers devise online teaching-learning, implying a transformation in strategies and pedagogical approaches utilized in virtual milieus. It is critical to acknowledge that this process has first been convoluted as they only have fundamental training in technological tools. Yet, teachers could acclimate and assimilate their pedagogical skills in

before and during lockdown due to COVID-19," *Profesional de La Informacion*, 29(4) (2020):1–20, <https://doi.org/10.3145/epi.2020.jul.23>.

⁸⁴ Nurten Kara, Begum Çubukçuoğlu, and Alev Elçi, "Using social media to support teaching and learning in higher education: an analysis of personal narratives," *Association for Learning Technology*, 28 (2020). <https://doi.org/10.25304/rlt.v28.2410>.

⁸⁵ Francisco Javier Robles Moral, and Manuel Fernández Díaz, "Future Primary School Teachers' Digital Competence in Teaching Science through the Use of Social Media," *Sustainability*, 13(5) (2021):1–13, <https://doi.org/10.3390/su13052816>.

⁸⁶ Sangeeta and Urvashi Tandon, "Factors influencing adoption of online teaching by school teachers: A study during COVID-19 pandemic," *Journal of Public Affairs*, (2020):1–11, <https://doi.org/10.1002/pa.2503>.

⁸⁷ Jayaluxmi Naidoo, "Postgraduate mathematics education students' experiences of using digital platforms for learning within the COVID-19 pandemic era," *Pythagoras*, 41(1) (2020):1–11, <https://doi.org/10.4102/PYTHAGORAS.V41I1.568>.

⁸⁸ Shaista Noor, Filzah Md. Isa, and Faizan Farid Mazhar, "Online Teaching Practices During the COVID-19 Pandemic," *Educational Process: International Journal*, 9(3) (2020):169–184, <https://doi.org/10.22521/edupij.2020.93.4>.

⁸⁹ Samad M.E. Sepasgozar, "Digital twin and web-based virtual gaming technologies for online education: A case of construction management and engineering," *Applied Sciences (Switzerland)*, 10(13) (2020):1–32, <https://doi.org/10.3390/app10134678>.

this novel form of online teaching covering a synchronous and asynchronous link, rendering classes more vigorous and inspiring for the student.

Concerning the teachers' digital competencies, the studies have underlined that teachers should accommodate virtual teaching during the pandemic, implying classifying digital information, sharing it through digital media, editing content and texts, guarding personal data, and devising abstract proficiencies.

Therefore, digital literacy and computerization are the most sought competencies teachers should develop, not all achieving a progressive level. The need to secure the efficiency of the educational service provision has become essential for all learning institutions during the COVID. This unusual health emergency has had devastating ramifications throughout the Earth, bringing future repercussions modifying the way of making and consuming products and services, above all on the life itself.

The education sector, an essential constituent of society, has had to conform to this new form of teaching-learning. It has brought digitalization, first as an option, but has turned into compulsory later. To that end, the digital skills' practice and reinforcement for all teachers are indispensable and commanding.

Technological tools in pandemic times have received increased attention because knowledge always plays a preeminent role in society. Technology allows conducting many human activities and even more critically in the educational field. Thus, teachers confronted with the cold reality engendered by the COVID-19 have had to readily adapt to the increased technology use in varied educational platforms and integrate it into their pedagogical work. It has included teaching their virtual classes optimally favoring students, judging that education is a fundamental right beyond the privilege. Nonetheless, a group of teachers, reluctant to change themselves and find it challenging to undertake new and unexpected challenges, should gather that adopting technology as a valuable resource in their teaching process can help them meet current educational demands. Yet, the students, the indispensable learning actors, have favorably undertaken this new modality. Attending their virtual classes, they have remained motivated as ever because they can interact, partake, sustain intercommunication with their peers and attain the anticipated learning.

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