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From flexibility to adaptive learning: a pre-COVID-19 perspective on distance education in Latin America

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At the time of this writing, emerging Generative Artificial Intelligence (GenAI) technologies, such as ChatGPT, Bard, and DALL-E, are shaping education. Despite their great potential for enhancing education, the discussion on the risks for the Society is an ongoing debate. Remote or distance education (DE) in developed countries has evolved in parallel to the permeation of Information and Communication Technologies (ICT). In Latin America (LATAM), a deep understanding of this interrelated evolution will encourage an efficient implementation of innovative policies, pedagogies, and technologies, including GenAI. This paper presents the historical development of DE in LATAM, drawing connections with milestones along the evolution of ICT in the region. This evolution is described across five generations: Correspondence, Audiovisual, ICTs-based, Web-based, and Interactive. Each generation offered incremental benefits to students, from flexibility and well-designed instructional materials to adaptive, interactive, and cost-effective education. This research encompassed a comprehensive search on Scopus, Web of Science, Google Scholar, ScienceDirect, Latindex, Dialnet, Redalyc, and SciELO with an historical approach. It yielded 97 peer-reviewed articles, books, and reports from recognized international organizations, published in Spanish or English and covering a period spanning from the end of the 19th century to the onset of COVID-19 lockdown. The analysis confirms the critical role of Higher Education Institutions (HEIs) in LATAM in supporting ICT integration, demonstrating a synergistic interplay with DE. Notwithstanding, the region's social inequality and digital divide have delayed the full deployment of DE's advantages, in comparison to USA and Europe. The paper exposes different scenarios and tech-educational requirements of DE, showcasing Mexico, Brazil, and Colombia, as well as other countries with smaller populations. Notably, by 2019, *Tecnológico de Monterrey* in Mexico, and *Universidade de São Paulo* and *Universidade Federal da Paraíba* in Brazil have pioneered the implementation of the Fifth Generation of DE in the region. The findings of this research highlight the value of DE as a cost-effective solution to traditional education, addressing social barriers and broadening educational access in LATAM, especially during emergencies. This research poses significant implications that can equip digital technology providers, HEIs, governments, and policymakers as they navigate the ongoing educational challenges.

KEYWORDS

distance education, Latin America, remote education, information and communication technologies, distance learning, higher education, educational innovation

1 Introduction

The COVID-19 pandemic created an adverse scenario for every nation around the World, including severe impacts on the educational sectors. The [World Bank \(2020\)](#) synthesized these affectations in two points: the economic recession sparked by pandemic-control measures and the near-universal closure of schools at all levels.

The COVID-19 pandemic profoundly disrupted education worldwide, prompting an unprecedented shift to remote or distance education (DE) and driving our attention toward policies and strategies for Emergency Remote Teaching (ERT). UNESCO defined in 1993, as cited in [Moreno and Maluche \(2017\)](#) that DE is the “education that is based on non-face-to-face communication, meaning that during the educational process the student is at a certain distance from the teacher, either for part, most, or even the entire duration of the process, depending on different circumstances.” Similar definitions have been stated underlining the following characteristics of DE: A formal education supported by an institution; the physical separation between the instructor and the student; different means of communication to connect students, learning resources, and instructors as well as a flexible learning ([García Aretio, 1999; Simonson, 2006; Cabral, 2022](#)). Flexibility in DE is understood in terms of, but not limited to, the timing and location of learning activities, the pace at which students progress through the curriculum, the choice of learning materials, the class size—massive or not, and the interaction available to learners. Throughout this work, DE will be assumed as formal education modalities with the mentioned characteristics.

ERT stems in DE, since it enables delivering education even under crises, such as pandemics, natural disasters, wars, or other circumstances that hinder traditional, face-to-face educational activities. ERT relies on providing a resilient, adaptable, and accessible educational system to ensure the delivery of high-quality education during disruptions to traditional inside-facilities teaching and learning environments ([Crompton et al., 2022](#)).

Implementing ERT has been particularly challenging in Latin America (LATAM), where access to Information and Communication Technologies (ICT) is limited. As countries like China and Japan rapidly deployed online courses ([MEXT, 2020; UNESCO, 2020](#)), LATAM responses were more conservative, reflecting the region’s unique challenges. For instance, Mexico adopted a television-based approach to deliver basic education, broadcasting recorded lessons to overcome connectivity issues.

Inequalities in LATAM limited the implementation and broadening of DE among the population, restricting the possibilities to provide quality education during COVID-19 pandemic. In general, Latin-American higher education institutions (HEI) and governments took several years to join the Network; and the general population has had limited access to ICT ([Rama, 2016](#)). In fact, since 2014, the *Organización de Estados Iberoamericanos* warned about the impact of digital divide on social and educative tendencies in LATAM.

The digital divide highlights the relevance of understanding the historical development of DE and ICT in LATAM. This knowledge can provide valuable insights for policymakers, educators, and researchers as they navigate the current challenges and plan for the future. Moreover, with the advent of AI technologies like ChatGPT and Bard, which are increasingly pervading the educational sector, understanding the historical context becomes even more critical.

These technologies hold great potential for enhancing DE, but their successful implementation will depend on a nuanced understanding of the region’s educational history and infrastructure.

This paper provides a historical review of DE and ICT in Latin America, focusing on the development of policies, technological infrastructure, and pedagogical approaches. We begin by examining the early development of DE prior to the advent of ICT, then explore the initial adoption of ICT by Higher Education Institutions (HEIs), and finally, discuss the integration of ICT with DE. The historical viewpoint recognizes five generations of DE in synergy with technological evolution: First Generation or Correspondence DE; Second Generation or Audiovisual DE; Third Generation or ICT-based DE; Fourth Generation or Web-based DE, and finally, Fifth Generation or Interactive DE. We conclude by analyzing the evolution of DE in some LATAM countries prior to the COVID-19 pandemic, to gain insights into the challenges and opportunities of DE in the region, as well as the different contexts and the required technological tools.

Our aim is to provide a grounded understanding of the capacities and infrastructure of educational institutions across Latin America at the onset of the COVID-19 crisis. This understanding will not only shed light on the current state of DE in the region but also inform the effective integration of emerging AI technologies in education. As such, this review is of critical relevance to today’s HEIs and will continue to be pertinent as we navigate the future of education in the Digital Age.

2 Methods

2.1 Procedures

This review aims to provide a historical perspective on the evolution of distance education (DE) in Latin America (LATAM), with a particular focus on the relationship with the adoption and evolution of Information and Communication Technologies (ICT). Following the route of previous historical literature reviews ([Chanock, 2011; Remenick, 2019; Georgiou, 2021](#)), this work assumes a “traditional” approach based on narrative. According to [Georgiou \(2021\)](#), the historical approach is more than a chronological description within a discipline. It not only situates the reader within an “historical context”; but also emphasizes a critic evaluation of a topic. Thus, it provides a historical perspective for engaging the body of the literature that is useful to identify and illustrate the issues of a given topic ([Georgiou, 2021](#)). For example, [Remenick \(2019\)](#), in her historical literature review, elucidated the development of nontraditional models of students during four different historical time periods.

The American Educational Research Association recognizes the historical approach together with theoretical, methodological, and integrative reviews as eligible for educational research ([Kennedy, 2007](#)). The historical narrative literature review is not necessarily enclosed within systematic or nonsystematic reviews. It employs a flexible approach to literature selection and analysis that aims for a qualitative understanding of the evolution of DE and ICT. In contrast, for example, the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) ([Page et al., 2021](#)) is designed toward systematic reviews and meta-analyses that synthesize empirical

research findings. To ensure transparency in the reporting process, though, we have detailed the sources consulted, the rationale for their inclusion, and the methodological approach to construct the narrative. See Sections 2.2 and 2.3.

In terms of time, we focus on the period prior to the COVID-19 pandemic, paying special attention to the most populated nations in LATAM: Mexico, Brazil, and Colombia to evidence the different contexts and tech-educational requirements in the region. Also, Argentina, Peru, Venezuela, and Puerto Rico were selected to complement the discussion.

Our methodology follows the procedures proposed by Petticrew and Roberts (2008), which include defining the research questions, determining the types of studies, conducting a comprehensive literature search, screening the search results, appraising the included studies, synthesizing the studies, and assessing heterogeneity among the studies.

After being actively involved in the process of shifting modality from face-to-face to online modality and vice versa, we posed the following research questions (RQ) to guide this work:

- RQ1: What were the key developments in distance education prior to the advent of Information and Communication Technologies?
- RQ2: What strategies did Higher Education Institutions employ in the initial adoption of Information and Communication Technologies and the Internet?
- RQ3: At what point and through what processes did Information and Communication Technologies integrate with distance education?
- RQ4: How has the implementation of Information and Communication Technologies in Latin American Education progressed over time?
- RQ5: What was the status of distance education in the three most populated Latin American countries prior to the COVID-19 pandemic?
- RQ6: How did the integration of Information and Communication Technologies influence the evolution of distance education in Latin America prior to the COVID-19 pandemic?

2.2 Databases and search terms

To identify, assess, and synthesize relevant studies to answer our research questions we followed a similar procedure to that reported by Lee et al. (2019). It included searching selected terms in databases, using Boolean operators and snowball methods (Lee et al., 2019). We selected the following databases to ensure a broad coverage of both international and Latin American literature: Scopus, Web of Science, Google Scholar, ScienceDirect, Latindex, Dialnet, Redalyc, and SciELO. Since highly cited Latin American authors frequently publish in Spanish, the search was conducted in both English and Spanish using the keywords listed in Table 1. With respect to the search query, up to four different keywords of Table 1 were used to build additional strings through the Boolean operators AND as well as OR. All documents were retrieved through the library websites of Tecnológico de Monterrey and Universidad Pedagógica Nacional. The next subsection details the selection criteria used to curate the results of the searching procedure.

TABLE 1 Keywords used to carry out the literature search through search engines.

Focus of interest	Distance education and ICT concepts
<ul style="list-style-type: none"> • Latin America, LATAM • Mexico • Brazil • Colombia • Argentina • Peru • Venezuela • Puerto Rico • Higher education institutions 	<ul style="list-style-type: none"> • Distance education, DE • Correspondence-based education • Web-based education • Multimedia education • Interactive education • Audio-visual education • Information and communications technology, ICT • Epistolary education • Net-based education • Tele-education • Educational broadcasting • Radio in education • TV in education • Online education

2.3 Selection criteria

Initially, the literature included in this review was limited to peer-reviewed papers and books of recognized editorials, published in Spanish or English from January 2015 up to April 2020, while the search was conducted in December 2019. This time frame was strategically chosen due to the significant advancements in ICT that directly impacted the modalities and reach of DE, especially with the rise of Massive Open Online Courses (MOOCs) and the increased accessibility to high-speed internet in remote areas. This period encapsulates a transformative phase in DE, marked by technological innovations and global events, just before the onset of the COVID-19 lockdown, which accelerated DE adoption. It is also noteworthy that many of the included papers were comprehensive reviews on the development of DE at both a global scale and specifically within the LATAM region.

Initially, this search resulted in 92 publications. After a careful analysis of the abstracts and a screening of the whole documents, we excluded publications with similar topics, comparable strategies or approaches, and same authorship, resulting in 76 publications. The documents' topics to be included, i.e., the inclusion and exclusion criteria, are summarized in Table 2.

After exploration of the references in the selected publications and to obtain more recent statistics and official announcements, we consulted supranational organizations and governments' webpages and white papers. Therefore, 21 more publications were included for the sake of a complete overview of the historical development of DE in the global context. As a result, our review covers a period spanning from the end of the 19th century to the onset of COVID-19 lockdown, providing a rich historical context that underscores the evolution and significance of DE over time.

2.4 Analysis

After a detailed reading of the full texts, we identified patterns and themes related to the evolution of DE. We categorized them in two groups: those providing a global context and historical progression of

TABLE 2 Criteria to determine the studies included in this review on distance education (DE) in LATAM.

Inclusion criteria	Exclusion criteria
<ul style="list-style-type: none"> • Papers that reviewed the development of DE at a global scale. • Publications that report the development of DE in LATAM region. • Studies comparing, quantitatively, the enrolment in face-to-face programs with DE alternatives. • Publications that provide statistical data and correlations between DE and social indicators. 	<ul style="list-style-type: none"> • Empirical studies examining the impact of DE implementations on the learning-teaching process. • Reports of a certain implementation of DE. • Studies reporting similar approaches to other papers already analyzed and discussed.

DE, and those offering details on the adoption and current state of DE in LATAM. We synthesized the themes and compared across texts to build a comprehensive narrative of the general evolution of DE that simultaneously deepened on relevant experiences within this region, including those in the most populated countries in the region, i.e., Brazil, Mexico, and Colombia. We also build a coherent timeline of DE development and the integration of ICT within HEIs, to serve as a scaffold to our narrative. Since educational level is a key indicator of socio-economic development, this aimed to interweave the ICTs global trends with regional experiences in DE.

3 Results and discussion

To answer the research questions that were defined above, the contents of the selected articles are analyzed and discussed through the rest of the paper.

3.1 RQ1: what were the key developments in distance education (DE) prior to the advent of Information and Communication Technologies (ICT)?

Despite DE has evolved through five different generations (Castillo et al., 2017), only two generations emerged prior to the advent of ICT. After the advent of these technologies, DE had a rapid evolution linked to the ICT fast-evolving pace and its increasing pervasion in the different sectors of humanity. The timeline shown in Figure 1 illustrates an overview of the facts relevant to the DE history. The following paragraphs will answer RQ1 by correlating historical milestones with the development of the different generations of DE.

The first generation was based on printed media sent by postal services and was named Correspondence Education (Taylor, 1995; García Aretio, 1999). Although García Aretio marked the beginning of correspondence education at the end of the 19th century, currently exists certain controversy. Toro and Rama (2013) suggested the earliest implementations of DE could be the hieroglyphs found in priest schools from the ancient Egypt as well as the clay printed tablets sent the by the Mesopotamian king Ashurbanipal to educate his people.

The British University Correspondence College was one of the first HEIs to implement correspondence education (Kanwar and Daniel, 2010). This private institution provided courses for students enrolled in the University of London, which had no teaching functions and only conferred degrees after examinations (Kaye, 1981). Moreover, other well-established universities, as the Illinois Wesleyan University (1874), the Queen's University in Kingston, Canada (1889), and the University of Chicago, US (1891), initiated correspondence courses (Kanwar and Daniel, 2010). Also remarkable was the Centre National d'Enseignement à Distance, established by the French government in 1939, to provide correspondence education during World War II (Lecourt, 1988).

The second generation of DE was named Multi-media or Audio-visual Education; it integrated radio, telephone, television, video, and telegraph (García Aretio, 1999). It emerged from industrial inventions and global conflicts. Toward the middle of the 20th century, DE played a special role in the reconstruction of Europe. After the consecutive World Wars, audio-visual education pushed the formation of skilled workers for the re-emerging industry and the educational sector (Toro and Rama, 2013).

Audio-visual education reached a milestone through the creation of radio and television-based programs at the University of South Africa (UNISA) in 1946. UNISA became, in 1962, the first HEI in the World to deliver only DE programs (Yong et al., 2017). During the 1960s and 1970s, several DE institutions were created around the World. In 1963, *Centro Nacional de Enseñanza Media por Radio y Televisión*, a Spanish middle education institution, started to offer television- and radio-based courses. In 1969 in United Kingdom, the Open University was created as an autonomous and independent DE organization (Bell and Tight, 1993). Three years later, this entity inspired the creation of *Universidad Nacional de Educación a Distancia*, as well as a large list of other Spanish HEI (García Aretio, 1999). This progressive growth in Spain led, in 1977, to the association of DE institutions under the name *Asociación Nacional de Centros de Enseñanza a Distancia* (García Aretio, 1999).

Certainly, the contenders of the Cold War, US and USSR, pushed DE to increase their bases of skilled workers and educated people. Starting in 1920 from print-based educational systems, by the 1970s the USSR had enrolled around one million students in distance programs (Zawacki-Richter and Kourotchikina, 2012). As collected by García Aretio (1999), from data of Rumble and Keegan, in 1979 more than 2,200,000 university students enrolled in distance programs, although correspondence-based yet. In contrast, North American institutions took advantage of the most recent technologies. As Yong et al. (2017) synthesized, Wisconsin University offered telephone-based courses since 1965; while Stanford University created the Stanford Instructional Network Television in 1967. Even more, the National Technological University was created in 1985 to provide satellite-based courses for engineering degrees.

3.2 RQ2: what strategies did Higher Education Institutions (HEIs) employ in the initial adoption of Information and Communication Technologies (ICT) and the internet?

Close to the beginning of the 21st Century, digital higher education was born from previous DE experiences (Yong et al., 2017) and it was developed in parallel with ICT, crystalized in

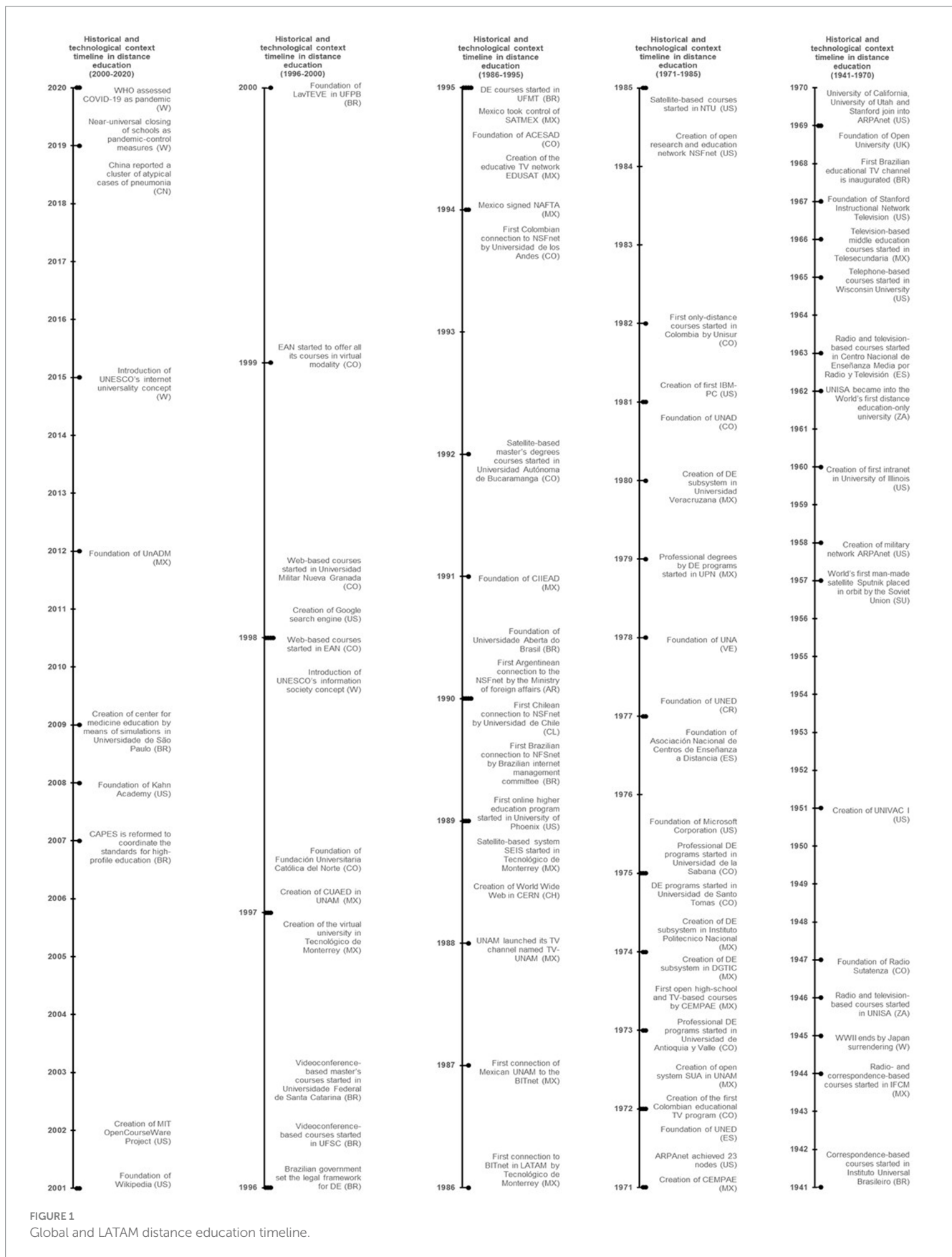


FIGURE 1 Global and LATAM distance education timeline.

the form of personal computers and the Internet. Historically, computers evolved from specific purpose military machines, as the British Turing-Welchman Bomb electro-mechanical

machine designed during the 1940's, to the general purpose commercial digital machines, such as UNIVAC I in 1951 (Tatnall, 2012).

In 1957, the launching of the World's first man-made satellite, Sputnik I, yielded developments in technology, global communications, and education; it was launched by the Soviet Union and triggered an arms race against the US. To fulfil the urgent necessity of high skilled scientists and engineers, positions recurrently covered by foreigners' refugees displaced after World War II, the US implemented a major scientific-technical oriented educational reform (Cha, 2015). Furthermore, due to the arms potential of artificial satellites and other orbital devices, the Global Network was born as a North American military project called ARPAnet. This was created by the Advanced Research Projects Agency (ARPA), in 1958, as a preventive measure against a possible orbital Soviet attack to the US wired and telephone network (Naughton, 2016).

Regarding educational institutions, in 1960, the University of Illinois created an internal network (intranet) to deliver recorded lectures and instructional materials to the students. This early form of computer-aided learning enhanced access to educational resources, facilitating a more flexible learning environment. By 1969, University of California, Stanford and University of Utah had adopted the ARPAnet to accelerate research processes and foster inter-institutional partnerships. With only 23 nodes in 1971, ARPAnet evolved up to the current internet, estimating 30 billion nodes by 2020 (Koenigsberger, 2014) and becoming a critical tool for academic collaboration, communication, and data sharing among HEI.

Countless private initiatives have contributed to shape the internet and other ICT; e.g. the creation of the first graphical user interfaces (GUI) by Xerox PARC, the foundation of the Microsoft Corporation in 1975 by Bill Gates and Paul Allen, or the introduction of the Personal Computer (PC) by International Business Machines (IBM) in 1981 (Koenigsberger, 2014). However, HEI increased their presence on the emerging Global Network establishing by 1985 the first open research and education network, called National Science Foundation Network (NSFnet) (NSFNET, 1990). By participating in global networks, HEI could access a wider array of resources, collaborate more effectively across geographic boundaries, and increase dissemination of knowledge. Besides, the World Wide Web was born, in 1989, with the World's first-ever website on the internet: <http://info.cern.ch/hypertext/WWW/TheProject.html>. This webpage was created at the *Conseil Européen pour la Recherche Nucléaire* (CERN) (Koenigsberger, 2014). These emerging ICT evidenced, for the first time, the relevance of faculty ICT skills to ensure effective integration of technology in knowledge generation as well as in teaching and learning processes.

3.3 RQ3: at what point and through what processes did Information and Communication Technologies (ICT) integrate with distance education (DE)?

ICT were integrated as support to the formative processes, giving the way to the third generation of DE, named ICT-based Education (Yong et al., 2017). It emerged after 1998, when the United Nations Educational Scientific and Cultural Organization (UNESCO) glimpsed the future role of ICT in teaching, leading to 'Knowledge Society' or 'Information Society' (Severin, 2013). This also contributed to the beginning of virtual education, "under principles of teacher-student cooperation and collaboration by means of ICT" (Torres,

2017). This generation witnessed the emergence of Google search engine, in 1998, and the foundation of Wikipedia, in 2001 (Koenigsberger, 2014). In addition, personal computers, office software, internet browsers, multimedia players, electronic encyclopedias and digital storage systems were massively implemented (Abdullahi, 2014).

The current century has seen the development of two more iterations of DE. The fourth generation of DE, web-based education, integrates a wide variety of tools from the Web 2.0. In words of Khan, "web-based programs can provide asynchronous communication to students and the instructor. Likewise, e-mail, listservs, newsgroups, conferencing tools, etc., can jointly contribute to the creation of a virtual community on the Web" (Khan, 1997, p. 6). Additionally, blogs, web conferences, learning platforms and wikis were continuously adopted as well (Yong and Bedoya, 2016). The relevant components in this distance modality, asynchronous electronic learning (e-learning), autonomy, coverage, and economy, represent advantages over face-to-face instruction (Moreno and Maluche, 2017). For instance, in 2001, the Massachusetts Institute of Technology (MIT) launched the OpenCourseWare Project, to provide free education (Abelson, 2008). In 2008, Salman Kahn founded the non-profit web-based educative institution named Kahn Academy; all its content is free and distributed throughout the Net under creative commons license (Bauer, 2013).

The fifth generation, Interactive Education, adopts virtual experiences for teaching. Virtual reality approaches "simulations of real and imagined worlds," through fully immersive and non-immersive modes (Freina and Ott, 2015). Augmented reality, consisting of layers of virtual information over real-life imaging, is also being used for learning purposes (Bower et al., 2014). In addition, artificial intelligence is being continuously implemented to create adaptative educational systems within e-learning platforms (Popenici and Kerr, 2017). Other technological elements have been created specifically for communication and educative purposes within interactive education. Learning management systems (LMS) have been developed to centralize and automate the course administration, to display self-guided e-learning services, to distribute contents, to consolidate web-based courses and beyond (Ellis, 2009). Blended learning (b-learning), mixing asynchronous e-learning content and face-to-face sessions, has been continuously incorporated (Garrison and Vaughan, 2008). Web-based seminars (webinars), personalized learning experiences and other tools from the Web 3.0 are expected to detonate novel learning strategies or even a different DE generation. For instance, personalized learning is promised to revolutionize the education systems through providing equitable outcomes for all learners, despite their learning skills or disabilities (Zhang et al., 2020).

Beyond history and ITC development, Society has shaped new DE learning models and tools. For instance, as a response to the high cost of formal education institutions, governments limitations and borders, Massive Online Open Courses (MOOC) emerged with the aim of providing education to many students for free (Rizzardini et al., 2014). Additionally, a milestone that will mark the future development of DE was the introduction, in 2015, of UNESCO's internet universality concept. Under a human rights-based approach, the level of development of internet universality is evaluated through UNESCO's indicators or ROAM principles, an acronym for: Rights, Openness, Accessibility to all and Multistakeholder participation (Weber, 2015).

Not only asynchronous experiences have been reported. [Watts \(2016\)](#) collected dozens of synchronous implementations of DE, being mostly perceived as positive and even more favorable than the asynchronous alternative. For instance, [Rockinson-Szapkiw and Wendt \(2015\)](#) reported that students enrolled in synchronous courses increased the number of inquiries over those in asynchronous experiences. Also, an improvement in the social cohesion in workgroups in high school courses imparted via videoconference was reported by [Mayer et al. \(2017\)](#). Even though, blended synchronous experiences, with a group split into remote as well as face-to-face modalities, provided insights on complex implementations merging different generations of DE ([Wang et al., 2017](#)).

3.4 RQ4: how has the implementation of Information and Communication Technologies (ICT) in Latin American Education progressed over time?

In comparison with North America and Europe, LATAM has adopted internet, ICT, and DE at its own rhythm. The 20th century was characterized by the advent of globalization and the adoption of new technologies, both irrupting in every human activity. In words of [Avenidaño Castro and Guacaneme Pineda \(2016\)](#), “it is possible to talk about financial, technological, environmental, economic, cultural, and social globalization.” This close and global-scale interconnection has consequences in all levels of our society. As [Severin \(2013\)](#) accurately synthesizes, “for better or for worse, good and bad news come early than before: science findings, new cures and solutions, discoveries and innovations; but economic crisis, infections, new weapons and control mechanisms too.” Education in LATAM is not an exception. ICT emerged as natural tools to face this new reality, to adapt teaching practice to the global context.

The first connection to the Internet in LATAM took place in Mexico in 1986, only one year after the creation of NSFnet. It joined the main campus of *Tecnologico de Monterrey*, the most recognized private HEI in Mexico, and the School of Medicine of the University of Texas at Austin through the Because It's Time network (BITnet). A year later, the largest Mexican university, *Universidad Nacional Autónoma de México* (UNAM), was connected to the BITnet through the link established previously by *Tecnologico de Monterrey* ([Koenigsberger, 2014](#)), obtaining access to NSFnet afterwards. Other Mexican universities obtained temporary connections to the NSFnet, through agreements with these pioneers.

Other countries in LATAM accessed the NSFnet by means of their own national HEI and governmental entities. In 1990, Chile established its first connection to the NSFnet through the *Universidad de Chile*; meanwhile, Brazil did it through the *Comite Gestor da Internet no Brasil*. The same year, Argentina established its first connection to the NSFnet by the management of *Ministerio de Relaciones Exteriores, Comercio Internacional y Culto*. However, other nations took longer to connect to the global network. For instance, Colombia joined the NSFnet until 1994, by the *Universidad de los Andes* ([Islas, 2011](#)).

The introduction of the internet during the 1990s revolutionized the education in LATAM, until then dominated by face-to-face models, through the continuous adoption of distance and semi-presential programs. In words of [Rama \(2016\)](#), virtual components

opened the gate to offer a new modality totally virtual, encouraging the intensive use of ICT and novel strategies within the learning and teaching process. ICT promoted the institutional evolution toward the distance modality and eased the entry of new higher-education suppliers, commonly international entities ([Vincent-Lacrin, 2011](#)).

By '90s, LATAM nations already had remarkable experiences in terms of higher education under the distance model. For example: *Sistema Universidad Abierta* in Mexico, established in 1972 by UNAM; *Universidad Nacional Abierta* in Venezuela, established in 1978; *Universidad Nacional de Educación a Distancia* (UNED) in Costa Rica, established in 1977; *Unidad Universitaria del Sur* in Colombia, founded in 1982 as the first only-distance programs institution; *Universidad Nacional Abierta y a Distancia*, created in 1981 in Colombia; and *Sistema de Educación Interactiva por Satélite* (SEIS), a satellite-based system introduced in 1989 by *Tecnologico de Monterrey* ([Zubieta-García and Rama-Vilate, 2015](#)). These experiences proved the efficient use of ICT in education, motivating other universities to generate DE experiences, like *Universidade Federal de Santa Catarina* in Brazil that started offering videoconference-based master's degrees toward 1996 or UNED in Costa Rica that used e-mail as main support to tutored campaigns by 1995 ([Torres and Rama, 2010](#)).

3.5 RQ5: what was the status of distance education (DE) in the three most populated Latin American countries prior to the COVID-19 pandemic?

The adoption of DE in LATAM countries was completely irregular ([Rama, 2016](#)), and describing such heterogeneity in deep is outside the scope of this work. Therefore, to understand the characteristics of educational institutions before the outbreak of Covid-19 the following sections cover DE development in the three most populated countries in this region. By analyzing the history of DE in Mexico, Brazil, and Colombia, we aim to gain insights into the challenges and opportunities of distance learning in LATAM, as well as the diversity of contexts and needs that require different pedagogical and technological solutions ([Statista, 2023](#)). [Table 3](#) synthesizes the evolution of DE in these countries by the pioneering institutions through successive generations.

3.5.1 Mexico

DE in Mexico was born in 1944, with the *Instituto Federal de Capacitación del Magisterio* (IFCM). Its aim was to train basic education teachers through a radio- and correspondence-based platforms ([Zubieta-García and Rama-Vilate, 2015](#)). Up to that moment, as [Navarrete-Cazales and Manzanilla-Granados \(2017\)](#) said with information of Torres-Bodet, 76% of the federal teachers and 86% of the rural ones did not have a professional instruction. In 1966, DE evolved to a closed-circuit television project, broadcasted by microwave, named *Telesecundaria*; it delivered middle education live lessons taught by a remote teacher and a face-to-face mentor ([Navarrete-Cazales and Manzanilla-Granados, 2017](#)). With this approach, the Mexican government tried to educate rural population. Even nowadays, *Telesecundaria* is a current strategy of DE implemented, with experiences about history and geography recently reported ([Gordillo Fuentes, 2018](#)).

TABLE 3 Milestones achieved by Mexican, Brazilian, and Colombian pioneers in distance education.

	Description	Mexican pioneers	Brazilian pioneers	Columbian pioneers
1st. Generation. Correspondence education	Institutions delivered, periodically, lessons and contents in printed media through the postal services. It offered the students flexibility (in time, place and pace) to learn with refined instructional material (Taylor, 1995).	IFCM was created by the Mexican government, in 1944, to train teachers of basic education by radio- and correspondence-based programs.	Correspondence-based courses were offered to the Brazilian population since the late years of 19th century. By 1941, Instituto Universal Brasileiro offered correspondence-based courses.	The North American institution Hemphill Schools offered training for radio technicians through printed media and kits with practice materials, during 1930s.
2nd. Generation. Audio-visual education	Institutions used several communication technologies, such as television, radio, telephone, video, and telegraph. Main contents were broadcasted, and students were tutored through regular sessions. It allowed the students flexibility to learn with refined and audio-visual instructional material (Taylor, 1995).	In 1966, Telesecundaria offered a hybrid education model through TV. IFCM radio-broadcasted the courses that were previously provided by printed media. CEMPAE was founded, in 1971, to encourage and manage extracurricular programs. In 1973, CEMPAE and Tecnológico de Monterrey, created a TV-based open high-school. During the 1970s, UNAM, IPN, Colegio de Bachilleres and others created their own open systems. By 1979, UPN had offered DE undergraduate programs. UNAM launched TV-UNAM in 1988.	Radio Sociedade do Rio de Janeiro broadcasted educational contents since 1922. In 1937, the Brazilian government launched Radio Mec, an educational radio station. During 1940s, the Capanema reform flexibilized the Brazilian educational system. Commercial television channels broadcasted programs to take Madureza tests during the 1960s. The first educational TV channel was launched in 1967.	Since 1947, Radio Sutatenza broadcasted radio contents for basic education. Open University of Universidad Javeriana offered TV-based courses, since 1972, to train teachers. In 1973, Universidad de Antioquia y Valle already provided professional DE programs.
3rd Generation. ICTs-based education	HEI implemented virtual programs through ICT Web 1.0 or “read-only web”; such as instant messaging, web pages, office software, virtual books, and encyclopedias. It allowed the students flexibility to learn with refined instructional material. Interaction was still very limited.	In 1997, Tecnológico de Monterrey created its virtual university and UNAM, formalized DE just with the creation of CUAED. UDG, IPN, BUAP, UV, UAEH and TecNM created their virtual and distance programs.	Universidade Aberta do Brasil was founded in 1990. In 1996, the Brazilian government set the legal framework for DE. The same year, Universidade Federal de Santa Catarina gave the first videoconference-based course.	Universidad Autónoma de Bucaramanga gave master’s degrees, since 1992, by satellite-based courses. In 1998, Universidad Militar Nueva Granada started to offer undergraduate ICT-based programs. Universitaria Católica del Norte, a totally virtual HEI, was founded in 1997.
4th Generation. Web-based education	Institutions incorporated platforms and tools from Web 2.0 or “read-write web”; for instance, e-mail, listservs, newsgroups, conferencing tools, web browsers and web pages. Students had flexibility to learn with highly refined instructional material and they are in continuous communication with instructors.	Completely web-based and virtual universities such as UMEL, UVEG, UNIVIM, Instituto Consorcio Clavijero, UnADM were created	Online courses were included in several HEI, such as Universidade Federal de Pernambuco, Universidade Federal de Minas Gerais, Universidade Federal do Rio Grande do Sul, Universidade Federal de São Paulo, Universidade Anhembi Morumbi, Pontifícia Universidade Católica de Campinas and Centro Universitário Carioca.	In 1998, Escuela de Administración de Negocios implemented the first Colombian web-based course. One year later, all EAN’s were converted to virtual modality. Toward 2017, Sistema Nacional de Información de la Educación Superior reported more than 1,191 DE programs for higher levels.
5th Generation. Interactive education	Institutions implement Web 3.0 (“read-write-execute”) tools and artificial intelligence solutions to provide adaptative contents. Also, virtual and augmented realities provide different learning experiences. Besides flexibility, it offers the students tailor-made courses delivered with high interactivity.	Tecnológico de Monterrey reported virtual reality implementations for learning purposes.	Tecnológico de Monterrey reported virtual reality implementations for learning purposes.	Prior to the COVID-19 pandemic, none Colombian institution has been known to implement interactive DE programs.

By 1970s, several institutions had implemented DE programs in Mexico. The *Centro para el Estudio de Medios y Procedimientos Avanzados de la Educación* (CEMPAE) was created in 1971 to encourage, coordinate and control extracurricular programs. Two years later, CEMPAE in collaboration with *Tecnológico de Monterrey* created the first open high-school through TV-based courses. As previously mentioned, in 1972, UNAM, created the open system *Sistema Universidad Abierta*, as an alternative to the traditional modality (Zubieta-García and Rama-Vilate, 2015). Numerous Mexican secondary and HEI started their own open or DE subsystems during the following years; *Instituto Politécnico Nacional* (IPN) and *Dirección General de Institutos Tecnológicos* in 1974, *Colegio de Bachilleres* in 1976, *Universidad Pedagógica Nacional* (UPN) in 1979 and *Universidad Veracruzana* by 1980 (Navarrete-Cazales and Manzanilla-Granados, 2017).

Toward 1987, up to 28 public and private Mexican institutions accounted with their own open or DE programs. In 1988, UNAM launched its TV channel named *TV-UNAM*. Three years later, the Mexican government created *Comisión Interinstitucional e Interdisciplinaria de Educación Abierta y a Distancia*, as a linking mechanism among the national suppliers of open and distance programs (Bosco and Barrón, 2008). Several educational and technological reforms took place during the 1990s, after Mexico signed the North American Free Trade Agreement (NAFTA) and entered globalization. NAFTA motivated the adoption of novel learning models to fulfill the requirements of a more skilled workforce (Torres and Rama, 2010). Concerning communications, in 1995 the Mexican government created *Sistema de Satélites Mexicanos* (SATMEX) to control the satellite system Morelos launched during the 1980s. The same year, *Red de Televisión Educativa* (EDUSAT) was created as an educative TV network.

UNAM formalized DE by 1997 with the creation of *Coordinación de Universidad Abierta y Educación a Distancia* (CUAED) (Navarrete-Cazales and Manzanilla-Granados, 2017). *Tecnológico de Monterrey* has promoted DE with remarkable experiences, like achieving the first connection to the Internet in LATAM and getting its satellite-based system SEIS. In 1997, this institution created its virtual campus, in which, according to its official website, more than 460,000 high-school and undergraduate students have taken online courses.

Nowadays almost every large HEI in Mexico offers distance modalities. Some of them with special relevance are: *Universidad de Guadalajara* (UDG), *Universidad Veracruzana* (UV), *Benemérita Universidad Autónoma de Puebla* (BUAP) and IPN (García Aretio and Ruiz Corbella, 2015). Although only few are completely virtual, this is the case of *Universidad Mexicana en Línea* (UMEL), *Universidad Virtual del Estado de Guanajuato* (UVEG), *Universidad Virtual del Estado de Michoacán* (UNIVIM), *Instituto Consorcio Clavijero* (Rama, 2014). Also, *Universidad Autónoma del Estado de Hidalgo* (UAEH) and *Tecnológico Nacional de México* (TecNM Virtual) offered graduate and postgraduate degrees through virtual models. Recently, in 2012, the Mexican government established the *Universidad Abierta y a Distancia de México* (UnADM) as a completely virtual institution (Sosa Silva and Infante Mendoza, 2017).

The fifth generation or interactive DE is being slowly adopted by some Mexican institutions. For instance, *Tecnológico de Monterrey* has used virtual reality for teaching abstract and complex concepts, such as those in physics and mathematics, in undergraduate programs

(Calderon and Ruiz, 2019; Acosta et al., 2020). Thus, several immersive learning experiences have been reported in recent years by academics of this HEI (Alvarez et al., 2020). Mostly these projects are supported by the NOVUS Fund, an internal initiative to encourage educational innovation.

Currently, about 200,000 students in Mexico take e-learning courses. These represent only 7.0% of the enrolment in higher education and advanced technical studies in Mexico (Aguilar, 2018). The small number of students in the distance model is intimately related to the digital divide and social inequality. As Gómez (2018) reported, based on statistical data from the Mexican government, two of three houses lack economic resources to get internet services and even lack of interest on it. In terms of academic supply, according to official information from *Dirección General de Acreditación, Incorporación y Revalidación* of the Mexican Ministry of Education (SEP), among 22,994 registered and valid degrees in Mexico, only 7.8% of them implement DE, although up to 28.7% apply hybrid models. Most of these programs correspond to graduate and postgraduate levels, with a participation of 60.2 and 27.1%, respectively. Despite the delocalized nature of DE, these programs are highly concentrated in the central region of Mexico, implemented by institutions in Mexico City and neighboring states. By 2019, 37.4% of them were related to management and business (Secretaría de Educación Pública, 2020).

3.5.2 Brazil

Following trends from foreign international institutions, in the late 19th century, Brazil implemented DE through correspondence courses (da Silva et al., 2019). By 1922, Radio Sociedade do Rio de Janeiro broadcasted educative programs on the Brazilian radio (Reifschneider, 2006). During the 1930s, a school radio channel also was visualized as an educational vehicle (Torres, 2019). Formally, Brazilian DE began until 1937 when the government launched the educative radio station named Radio Mec. The next decade, the dictatorship of Getúlio Vargas set the Capanema Reform to ease the promotion through different educational levels. In 1941, Instituto Universal Brasileiro started offering correspondence-based courses. By 1960s, commercial television channels broadcasted programs to take *Madureza* tests, a set of exams to get elementary and middle education diplomas. In 1967, the first educational TV channel was inaugurated in Recife, followed by several other similar initiatives (Oliveira, 1980), like *TV-Cultura* in São Paulo and *Fundação Maranhense de Televisão Educativa* (Young et al., 2010). Also, during the 1970s, the Brazilian Tele-education Association was created as a non-government institution (Oliveira, 1980). Notable is the case of *Sistema Educativo Radiofônico de Bragança*, in the Brazilian state of Pará, as a broadcast system focused on youth and adult people (Maciel, 2015).

In words of Lupion Torres and Rama (2018), in the 1940–1970 period, “the legal advances were limited to the legalization of the supplementary model of learning.” The adoption of a national policy marked the end of the 1980s decade, but its deployment within the university context was stopped by pressure of the federal administration, with centralizer legislations. In contrast, private institutions and non-government organizations delivered supplementary education courses for elementary and middle levels either through printed-, TV- or satellite- based media (Torres and

Rama, 2010). Even in our days, radio education has been implemented as a DE option. For instance, Patricio reported the experience of 21 schools in the Fortaleza region (Patricio, 2016).

In 1990, the Brazilian government founded the *Universidade Aberta do Brasil* (UAB), establishing guidelines to subsequently implement other DE programs (Aguilar, 2018). By 1994, *Universidade Federal de Mato Grosso* gave the first admission test for a DE program that initiated a year later. In 1996, two events promoted a fast adoption of the Net and the broadening of online education. The first event was the delivering of the internet to the public access, reserved to HEI and governments until then (Aguilar, 2018). The second event was the creation of the Brazilian legal framework for DE, recognizing it as legal, valid, and equivalent to the face-to-face modality (da Silva et al., 2019). 1996 also marked the beginning of videoconference-based courses given by *Universidade Federal de Santa Catarina* (Torres and Rama, 2010).

In the following years, online courses were included in several Brazilian HEI, such as *Universidade Federal de Pernambuco*, *Universidade Federal de Minas Gerais*, *Universidade Federal do Rio Grande do Sul*, *Universidade Federal de São Paulo*, *Universidade Anhembi Morumbi*, *Pontifícia Universidade Católica de Campinas* and *Centro Universitário Carioca* (Torres and Rama, 2010). However, DE did not include elementary education, due to resistance from many educators, politicians, and society (Nobrega and Rozenfeld, 2019). Consequently, the most important implementations of DE remained in higher education. Toward 2002, four HEI supported by interactive media were registered at the Brazilian Ministry of Education (Torres and Rama, 2010).

The first decade of the 21st century witnessed an increment in the supply and enrolment in distance higher education, making Brazil a main actor in the scene of DE in LATAM. For example, UAB covered the whole Brazilian territory with centers dedicated to DE and face-to-face courses. Other Brazilian HEI with remarkable DE modalities are: *Universidade de Brasília*, *Universidade Federal do Rio de Janeiro* (UFRJ) and *Universidade Católica de Brasília*. Moreover, the enrolment in DE institutions increased from 1,682 in 2000, to 369,766 in 2007 (Lupion and Marques, 2013). In the last 15 years, pushed by middle and middle-upper classes, the access of the Brazilian people to higher education has increased substantially. According to Marta Ferreyra et al. (2017), one potential explanation is the expansion in the supply of private institutions over the last few years; from 2007 to 2018, private initiatives offered over 90% of DE programs (Da Silva et al., 2019). In this period, the enrolment in DE programs doubled, from 15.4% of the total students in 2007, to about 33.0% ten years later (da Educação Superior, 2018).

Finally, the current decade glimpses the implementation of the fifth DE generation in Brazil using novel ICT and the introduction of interactive education. In 2007, the Brazilian government reformed the *Coordenação de Aperfeiçoamento de Pessoal de nível superior* (CAPES) to coordinate the standards of the high-profile education. Currently, CAPES promotes DE and innovative experiences with technological resources and ICT. As a result, Brazilian HEI have implemented immersive learning experiences into distance programs. For instance, in 2009, *Faculdade de Medicina da Universidade de São Paulo* inaugurated a center for simulation-based medicine education (Mariani and Pêgo-Fernandes, 2011). Several experiences implementing virtual reality have been reported as well. *Universidade Federal da Paraíba* (UFPB) opened in 2000 the Laboratory of

Technologies for Virtual Teaching and Statistics to develop medical simulators, interactive visualization applications and other interdisciplinary research (Machado and Moraes, 2011).

3.5.3 Colombia

Education in Colombia ventured into distance modalities since the first generation; however, the first Colombian DE experience consolidated until the second generation. During the 1930s, North American institutions offered correspondence training for technical formation; for instance, Hemphill Schools programs to train radio technicians (Alvarez et al., 2000). In 1947, Colombian DE emerged with *Radio Sutatenza*, a radio-broadcasted program for farmers in Sutatenza, Boyacá (Yong et al., 2017); it transmitted until 1994 (Bernal Alarcón, 2012) basic calculus, health, sickness prevention and agricultural production content. Another milestone was achieved in 1972 when *Universidad Javeriana* created a TV program named *Teaching for the New Man*; it trained basic education teachers through the TV network *Inravisión* which belonged to Instituto Nacional de Radio y Televisión (Toro and Rama, 2013). The first Colombian HEI to provide DE degrees was *Universidad de Antioquia y Valle* toward 1973; it focused on the formation of teachers as well, avoiding the daily transportation of the students in the Colombian roads not suitable by then. Two years later, *Universidad de Santo Tomas* and Instituto de *Educación a Distancia de la Universidad de la Sabana* started their own DE programs for administration, fine arts and physics. Another relevant antecedent of distance higher education in Colombia is the establishment of *Universidad Nacional a Distancia de Colombia* in 1981 (Verdún, 2016).

The government has used DE as a strategy to increase the professional formation of the Colombian people. During the Belisario Betancur's presidency, from 1982 to 1986, DE was officially established as a national policy (Moreno, 2007). Consequently, relevant institutions were created to encourage DE in Colombia; for instance, *Sistema de Educación a Distancia* (SED) (Aguilar, 2018) and *Unidad Universitaria del Sur de Bogotá* (UNISUR), which later became *Universidad Nacional Abierta y a Distancia* (UNAD). Toro and Rama (2013) said "this novel modality departs as a historic opportunity to revamp the national apparatus of education, in its flexibility, organization, financing, administration and pedagogic innovation."

The first implementations of ICT in HEI emerged by 1990s, promoting the Colombian DE evolution toward the third generation. In 1992, *Universidad Autónoma de Bucaramanga* in collaboration with the Mexican institution *Tecnológico de Monterrey* offered satellite-based courses for master's degrees (Aguilar, 2018). In 1995, *Asociación Colombiana de Instituciones de Educación Superior con Programas a Distancia y Virtual* was created. In 1997, *Fundación Universitaria Católica del Norte*, a completely virtual HEI was established, followed by *Universitaria Virtual Internacional* and *Corporación Universitaria de Asturias*, both located in Bogota (Toro and Rama, 2013). Virtual education emerged from all these experiences, and it was defined by the Colombian Ministry of Education as the development of formation programs with the cyberspace as scenery for teaching and learning (Moreno and Maluche, 2017).

Concerning the fourth generation of DE in Colombia, by 1998, the business school *Escuela de Administración de Negocios* (EAN) designed web-based training for teachers using ICT. The same year, the official military institution, *Universidad Militar Nueva Granada*, developed web-based programs. A year later, EAN implemented all its

classes in virtual modality (Yong et al., 2017). Also, was reported the national radio strategy Acción Cultural Popular (ACPO) along the Colombia-Venezuela border. This strategy was based on multimedia, teaching materials, speakers or newspapers (Pérez Pinzón, 2015).

The current century has evidenced the increment in the availability of DE and virtual programs in Colombia, mostly encouraged by the Ministry of Education. Such modality has been favored over face-to-face programs due to reduced cost, intensive use of ICT, larger territorial coverage, student's autonomy, and teacher-student relationship. This last characteristic implies that teachers and professors become guides and advisors through the learning processes. In numbers, the adoption of DE in HEI has increased significantly, passing from 184,136 students in 2010, to 405,218 in 2016 (Tovar et al., n.d.). Another significant effort to incorporate ICT into the Colombian educational system was the governmental initiative *Colombia Aprende* (Severin, 2013). Also, didactic materials for teaching based on audiovisual ICT have been reported (Forero Sandoval and Díaz Buitrago, 2018). Radio, streaming services and social media also have been merged to be used as strategy for international collaboration between HEIs and collaborative radios (Rendón López and Ortega Carrillo, 2015). Toward 2017, according to the information *Sistema Nacional de Información de la Educación Superior* (SNIES), more than 1,191 programs have been registered as distance or virtual ones. Among them, 552 corresponded to undergraduates and 639 to postgraduates (Moreno and Maluche, 2017).

3.6 RQ6: how did the integration of Information and Communication Technologies (ICT) influence the evolution of distance education (DE) in Latin America prior to the COVID-19 pandemic?

Notwithstanding historically the adoption of DE in LATAM countries was completely irregular, technological milestones have propelled DE as mentioned previously for the global context. In Brazil, DE initiatives started in the late 19th century through correspondence courses. Colombia consolidated DE around the 1930s with North American correspondence courses, while Mexico began DE a decade later with radio- and correspondence-based platforms. Technology advances equipped Brazil to advance toward second DE generation as early as the 1920s; Mexico transitioned to television-based DE in the 1960s, while Colombia evolve to radio-based DE in the 1940s and TV-based in the 1970s (see Table 3).

DE has enabled the positive interrelation between larger dissemination of the use of ICTs and the Internet, and better socio-economic conditions. DE in LATAM has usually being delivered at a cost that is substantially lower than that associated with traditional methods (Oliveira et al., 1992); even more, distance higher education in LATAM has steadily increased enrollment since the 1970s (Lupion Torres and Rama, 2018). DE has risen educational level and facilitated training, which in turn improves the quality of human capital, enhances productivity, and contributes to economic development (Balboni et al., 2011; Hanushek and Woessmann, 2012). Balboni et al. (2011) demonstrated that, in synergy, household income and education positively influence Internet usage.

Governments and institutions in LATAM have tried to take advantage of this positive interrelation and have supported DE and connectivity through different public policies. As mentioned previously, the Mexican government tried to educate the rural population through DE; in Brazil, DE began formally with the launch of an educational radio station and, Colombia's government used DE as a strategy to deliver more professional training.

In LATAM, multiple aspects have limited DE dissemination from being considered for decades as a second-class education (Lupion Torres and Rama, 2018) to the appropriation of the Internet, ICT, and electricity (UNESCO Institute for Statistics, 2012). The situation in the three most populated countries in this region has been described; however, other countries show many weaknesses in this aspect (Chan-Núñez, 2016). Fainholc (2016) identified several problems in the region, from professors without technological skills to areas without connectivity. Similarly, Chávez Maciel (2016) synthesized diverse indicators to trace the adverse scenario in a quantitative manner and to continuously evaluate the adoption and evolution of DE in LATAM.

Digital transformation of education in LATAM was led by supranational organizations, through blended or mixed learning programs in both, the private and the public sector (Lupion Torres and Rama, 2018). Its popularity raised with a smaller costs and dissemination of communication and digital information infrastructure accompanied by an increase in low-income families and professional job market demands. Several Latin-American nations have been incorporating DE under the guidelines of supranational organizations, such as UNESCO (Silvio, 2010) and, even before the COVID-19 outbreak, they proposed new pedagogical models, based on virtual approaches. In general, DE in LATAM evolved since the beginning of the 21st century due to greater innovation, standardization, complexity, assessments options and increased regulation and accreditation (Lupion Torres and Rama, 2018). Argentina, for instance, recently proposed a digital educational system (Rivas, 2018). Moreover, technologies have been tested and adopted in the DE context (Méndez-Ortega et al., 2020). Virtual learning environments, LMS and MOOCs are being designed and adapted to the local context through different initiatives. HEI in Mexico, Brazil, Argentina, Chile, Colombia, El Salvador, Peru and Dominican Republic have participated in MOOCs (Zubieta-García and Rama-Vilate, 2015). Other examples are multinational collaborative workshops, (Amado-Salvatierra et al., 2014), polls-based analyses on the efficiency of learning models, strengths, and weaknesses analyses of e-learning models (Basantes et al., 2018), and new virtual mobility initiatives (Ruiz-Corbella and Álvarez-González, 2014).

Prior to the COVID-19 outbreak, in Mexico nearly every large HEI already offered distance modalities; in Brazil, DE enrolment significantly grew driven by private institutions, while in Colombia, governmental initiatives promoted the incorporation of ICT and DE was widely adopted. To complement an interpretative and explanatory discussion on the impact of ICTs on the development of DE in LATAM, we have introduced other case studies to get further insights into the achievements and challenges faced. For this purpose, we selected Argentina, Peru, Venezuela, and Puerto Rico (see Table 4). We include the latter to expand the sociocultural context to a Caribbean country that is intimately related to the most developed United States of America.

3.6.1 Argentina

The first experiences in DE in Argentina were through correspondence courses. The oldest record data from 1940, considered within the first generation of DE, with the issuance of diplomas for courses for adult training provided by *Escuela Panamericana de Arte* (Cabral, 2022). The second generation was adopted in 1975, with the arrival of radio, television, audiocassettes, and the telephone, which served as mediators in the DE process, making *Universidad de Buenos Aires* the most prominent pioneer (Cabral, 2022). In the 1990s, as responses to policies established by UNESCO and the World Bank, Argentina started to implement ICT into DE and classrooms (OECD, 2015). In the second half of the 1990s, the expansion of coverage and the growth bandwidth of the Argentinian net, along with international policies such as “*Educación para todos*,” led to the inclusion of ICT in DE. *Universidad Nacional de Quilmes* implemented the first virtual classroom (OECD, 2015). Also, *Red Universitaria de Educación a Distancia de Argentina* (RUEDA) was founded to promote and develop the appropriate use of DE resources (Cabral, 2022). By 2015, a significant number of postgraduate and extension programs were recorded as complements to face-to-face lessons. The most representative were the courses recorded by *Universidad Nacional de Quilmes*, targeted to undergraduate programs (OECD, 2015). Similarly, *Universidad Tecnológica Nacional*, through its “*Campus Virtual Global*” platform, provided ICT-based resources to implement distance and blended courses (OECD, 2015). In contrast with the benefic scenario described above, in 2015, only 18% of public institutions had internet access in their DE classrooms, a figure that increased to 33% in 2019 (INDEC, 2019). Up to 2019, according to this research, no fifth generation DE implementation was reported.

3.6.2 Peru

In a dissimilar manner, there are no records of DE in Peru through correspondence courses, i.e., no evidence about the first generation of DE. Additionally, there are no records of educational programs implemented in the DE mode using television, radio, or telephone as tools, as there was no regulatory framework in Peru. The law entitled “*Ley de Educación Superior*,” published in 1983, did not include remote learning as an educational modality (Rama, 2017). The absence of regulatory guidelines discouraged the advancement of DE in Peru. In principle, one of the limitations to implement it was the lack of a regulatory framework that would establish it as a legal and valid modality in the country. Additionally, there was disinterest due to the perception that this type of education was of low quality.

In the 1990s, all LATAM countries began incorporating ICT into education in response to policies established by UNESCO and the World Bank. This move was also driven by the high demand for higher education and competition among universities (OECD, 2015). *Pontificia Universidad Católica del Perú* (PUCP) pioneered online DE projects in 2011, launching its virtual platform, and incorporating postgraduate programs and diplomas (OECD, 2015). Also, *Centro de Investigaciones y Servicios Educativos* and *Facultad de Educación* launched remote programs within PUCP (OECD, 2015). A second DE project was launched by *Sistema de Universidad Abierta* (SUA) in 2014. Thus, various undergraduate programs such as education, law, accounting, business administration, and tourism have been offered in a blended modality (OECD, 2015). By 2015, only two among 75 institutionalized universities in Peru had DE programs, whereas only 12 reported virtual platforms

(OECD, 2015). As in the previous case, no fifth generation of DE experience was reported prior to the COVID-19 pandemic.

3.6.3 Venezuela

Similarly, to the Argentinean case, DE experiences in Venezuela date back to 1960 with correspondence courses offered by the *Instituto de Mejoramiento Profesional del Magisterio y el Instituto Nacional de Cooperación Educativa* (OECD, 2015). There are no records of remote educational programs implemented using television, radio, or telephone as tools. Venezuela started in 1997 with the implementation of ICT as a support resource in face-to-face programs and, in some cases, as a didactic tool in blended education environments. In 2007, the *Proyecto Nacional de Educación Superior a Distancia* was created to establish a regulatory framework that would ensure the quality of DE (OECD, 2015). None fifth generation of DE implementation was reported until 2019.

3.6.4 Puerto Rico

Puerto Rico was chosen as a particular country within LATAM due to its close relationship with the United States of America. As in the previously discussed countries, there are no records of correspondence DE. In 1936, DE made its debut in Puerto Rico with the first radio broadcast of the program “*Escuela al Aire*,” sponsored by the *Departamento de Instrucción Pública* (DIP). This educational program continued until the end of World War II. In 1949, the DIP, through its *Educación Comunal* agency, launched a comprehensive program in this form of DE study, which gained international renown (Robles, 2014). In the 1950s, state radio and television stations emerged, and the DIP started integrating these novel communication media with the educational curriculum. In 1970, “*Abriendo Caminos*” program allowed students to take courses through television and then validate them, obtaining official certificates (Robles, 2014). In the 1990s, the introduction of ICT in Puerto Rico was reflected in the online programs offered by the *Universidad Interamericana*, with over 44 programs up to master’s degrees. Moreover, another HEIs from Puerto Rico, such as *Fundación Ana G. Méndez*, *Universidad de Puerto Rico*, *Universidad del Sagrado Corazón*, *Universidad Politécnica*, *Colegio Universitario Nacional*, among others, encourage online courses as complement to the face-to-face modality (Robles, 2014). Also, *Universidad Internacional Iberoamericana* was introduced to Puerto Rico as a completely online university, i.e., without the option of face-to-face lessons. Similarly, to the other LATAM countries discussed in this subsection, Puerto Rico did not report any fifth generation of DE experience prior to the COVID-19 pandemic (Robles, 2014).

3.7 Limitations

While this work provides valuable insights on remote or distance education (DE) in Latin America (LATAM) for institutions, governments, and policy makers, it is important to acknowledge its limitations.

Firstly, we limited our search to peer-reviewed and indexed literature, primarily cited using Digital Object Identifiers (DOIs). As a result, non-indexed and non-peer-reviewed literature, such as conference proceedings and newspaper reports, were excluded. Additionally, publications without DOIs may have been inadvertently

TABLE 4 Milestones achieved by Argentinian, Peruvian, Venezuelan, and Puerto Rican pioneers in distance education.

	Argentina	Perú	Venezuela	Puerto Rico
1st Generation. Correspondence education	In 1940 was created the adult-targeted distance courses by Escuela Panamericana de Arte (Cabral, 2022).	None registry found.	In 1960, correspondence-based courses, given by Instituto de Mejoramiento Profesional del Magisterio y el Instituto Nacional de Cooperación Educativa, was introduced (OECD, 2015).	None registry found.
2nd. Generation. Audio-visual education	In 1975, Universidad de Buenos Aires started to use radio, TV and cassettes to delivery lessons (Cabral, 2022).	None registry found.	None registry found.	In 1936, the radio program Escuela al Aire from Departamento de Instrucción Pública, through Educación a la Comunidad organism, was launched (Robles, 2014). During the 1950s, Departamento de Instrucción integrated radio, and TV to the study plans. From 1970, it was created the program “Abriendo Caminos” to give TV-based courses (Robles, 2014)
3rd Generation. ICTs-based education	During the 1990s, Universidad Nacional de Quilmes, created the first virtual classroom. It was founded the Red Universitaria de Educación a Distancia de Argentina (Cabral, 2022).	Pontificia Universidad Católica del Perú started the first DE courses (OECD, 2015). In 2014, Sistema de Universidad Abierta started courses for several programs in blended format (OECD, 2015).	In 1997, HEIs started the usage of ICTs in lessons imparted in fase-to-face and blended formats.	ICTs were introduced for up to 44 programs. Fundación Ana G. Méndez, Universidad de Puerto Rico, Universidad del Sagrado Corazón, Pontificia Universidad Católica de Puerto Rico, Universidad Politécnica, and Colegio Nacional Universitario, implemented extension on-line courses (Robles, 2014).
4th Generation. Web-based education	In 2015, posgraduate and extension programs adopted DE. Also, Universidad Nacional de Quilmes offered undergraduate virtual programs (OECD, 2015). Universidad Tecnológica Nacional implemented blended as well as distance courses (OECD, 2015). By 2015, only 18% of public education institutions reported internet connections, increasing this value was increased to 33% to 2019 (INDEC, 2019).	In 2011, HEIs adopted the DE platform known as PUCP, for posgraduate and undergraduate levels (OECD, 2015). By 2015, only 2 HEIs accounted with DE programs, 12 more reported virtual platforms (OECD, 2015).	In 2007 was created the Proyecto Nacional de Educación Superior a Distancia, with the aim to stablish a regulatory framework for DE (OECD, 2015).	Universidad Internacional Iberoamericana was certified, in 2014, as a completely virtual HEI (Robles, 2014).

omitted. Secondly, we conducted the search in English and Spanish only, which may have resulted in the omission of relevant studies published in other languages, particularly from Asia. Thirdly, while this work bases on published literature and offers a comprehensive understanding, firsthand data such as surveys or interviews with

educators, policymakers, or students might have provided deeper and more localized insights. Lastly, while we correlated major historical events and technological advances with the development of DE, detailed discussions about the sociopolitical, economic, and cultural context of every LATAM country were beyond the scope of this paper.

In this sense, a more explanatory and interpretative perspective of the development of DE in LATAM is limited, and there is a risk of drawing overly generalized conclusions, especially when comparing the state of DE in LATAM with that in Europe and the USA.

Beyond this work focus on improvements and innovations of DE in LATAM, we must also recognize DE's multiple associated risks, from mental health issues to data privacy and security concerns. The implementation of ERT amid the COVID-19 lockdown evidenced that the lack of personal interaction and the increasing screen time associated can affect students' mental health and well-being (Hosseini et al., 2023). In turn, this can affect graduates' social and interpersonal skills, mandatory for a successful professional performance (Ehlers, 2020). Most importantly, DE challenges the teaching-learning-evaluation process from multiple perspectives. The absence of physical cues and conducive learning environment does not favor the emotional component for learning, including engagement and motivation (Ferrer et al., 2022). Despite the vast sources of online learning, unreliable sources lead to misinformation and a diminished quality of education. For DE, fairness and efficacy of assessment still represent a challenge (Camacho-Zuñiga et al., 2023), particularly with the broader use of generative artificial intelligence. DE tools do not always fulfill a Universal Instructional Design adding barriers to students with disabilities. Furthermore, DE, delivered through digital platforms, exacerbates risks to the security of personal data and vulnerability against cyber threats (Terry and Rivera Vargas, 2020).

These limitations also highlight potential areas for future research, including the examination of DE evolution in LATAM from alternative perspectives and the exploration of DE in the rest Latin American countries and in other regions of the World.

3.8 Implications

As these lines are written, generative artificial intelligence technologies, such as ChatGPT and other large language models, are rapidly pervading multiple aspects of human activity (Eloundou et al., 2023). Education is not an exception, triggering a discussion on its potential benefits and risks (Allam et al., 2023). Understanding the historical context and current state of DE and ICT in LATAM can provide experiences and study cases for more informed decision-making on the integration and impact of these technologies for a better trained and educated workforce.

These findings pose several implications for practice and policy:

- Governments and institutions in LATAM should prioritize the development and promotion of DE as a viable means to improve social indicators and well-being. This is particularly relevant given the proven efficiency and cost-effectiveness of DE compared to traditional education and the interdependence of educational level with the economic development.
- Policymakers in LATAM must address the digital divide and promote the adoption of ICT, and other general-purpose technologies, in line with ROAM's principles (A framework established by UNESCO and based on Rights, Openness, Accessibility, and Multistakeholder participation). This will enhance the universal right to education and leverage the benefits of remote learning.
- The experience with Emergency Remote Teaching during the pandemic underscores the need to include DE into the emergency policies of every country. This approach has proven effective in ensuring the continuity of education during natural disasters and political and economic crises.

4 Conclusion

Remote or distance education (DE) is a tool for advancing inclusivity, diversity, equity, and accessibility (IDEA) in education, by making learning more accessible, flexible, diverse, and equitable. It leverages technology to remove traditional barriers to education, thus contributing significantly to creating more inclusive educational environments.

This work traced the evolution of DE in Latin America (LATAM) prior to the COVID-19 outbreak, through the case study of some countries for a broad perspective. It contrasted the development of DE in LATAM with global trends, providing a comprehensive overview of the capacities and experiences of educational institutions in the region.

While North America and Europe have led the adoption of DE since the 19th century, LATAM began embracing DE a century later. Higher Education Institutions (HEI) have headed this adoption, driven by public policies and globalization. HEI have also played a crucial role in implementing Information and Communication Technologies (ICT), verifying the synergy between education and technological development observed in the rest of the Globe.

However, the emergence of ICT-based DE programs in LATAM occurred later than in other regions, a delay that can be attributed to the digital divide and social inequality prevalent in these territories. Despite these challenges, DE in LATAM has proven to be an efficient and cost-effective alternative to traditional education increasing the population's educational level. This parameter correlates with economic development; therefore, DE offers a means to combat poverty and improve well-being.

The COVID-19 pandemic, which hit LATAM particularly hard, bolstered emergency remote teaching (ERT) with DE as the primary mode of education delivery. ERT indeed accelerated the evolution of DE worldwide but, at the same time, worsen the disparity between developed and developing regions. Within the Latin American society, ERT also exacerbated other problematics due to the limited connectivity and lack of access to technological devices required to deliver DE in its digital or online modality.

A clear understanding of DE's evolution, status, and future potential is pivotal for the political governance of educational strategies in LATAM. HEIs, governments, and even supranational entities, need a detailed study of cases from several national contexts in paired with an analysis of DE's impact on other societal factors. This knowledge will equip them to establish effective policies and strategies to overcome the long-term educational impact of the COVID-19 pandemic and to integrate artificial intelligence into education in a beneficial manner.

This work provides a historical perspective that is crucial for navigating the current educational challenges in LATAM and planning for a better future in this volatile, uncertain, complex, and ambiguous World toward the Digital Era.

Author contributions

AM and JM-V contributed to conception, design of the study, and organized the database. AM, JM-V, and CC-Z performed the analysis. AM wrote the first draft of the manuscript. JM-V and CC-Z wrote sections of the manuscript. All authors contributed to manuscript revision, read, and approved the submitted version.

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