

Specialized Educational Innovation in Latin American Universities for the Promotion of Science and Technology

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Abstract

A systematic review was carried out on the production and publication of research related to Educational Innovation, Higher Education, Educational Strategies, Science, Technology and Latin America, using the PRISMA approach (Preferred Reporting Items for Systematic Reviews and Meta-Analyses). The objective of this analysis was to identify the main characteristics of the publications registered in the Scopus and WoS databases, as well as their scope in the study of the proposed variables. The initial search identified a total of 35 publications. Subsequently, the results were refined by using keywords such as EDUCATIONAL INNOVATION, HIGHER EDUCATION, EDUCATIONAL STRATEGIES, SCIENCE, TECHNOLOGY, and LATIN AMERICA in both search engines, resulting in the final selection of 16 documents, after excluding duplicates and those that did not meet the analysis criteria. The selected scientific publications were analyzed with the aim of knowing the key characteristics in the execution of research projects on education, especially those that implement technological tools and promote the development of competencies in students through the use of ICT in their professional training. In this way, it seeks to understand the impact of research and the publication of works aimed at measuring academic performance, strengthening digital competencies and creating educational strategies aimed at promoting science and technology in higher education students in Latin America.

Keywords: Educational Innovation, Higher Education, Educational Strategies Science, Technology, Latin America.

1. Introduction

Educational innovation in Latin American universities is going through a process of profound transformation, driven mainly by the integration of Information and Communication Technologies (ICT) in teaching and learning processes. This change was accelerated by the

COVID-19 pandemic, which forced higher education institutions to rapidly adopt new digital teaching modalities, promoting a broad digitalization of their pedagogical processes and practices. In this context, universities have prioritized the development of digital skills in both teachers and students, adapting their teaching methods to current technological demands and preparing their graduates for a constantly evolving labor market. (Ramírez-Montoya, 2020) (Cateriano-Chavez, L., Patiño-Abrego, Araujo-Castillo, & Villalba-Condori, 2021)

Investments in teacher training have been instrumental in adapting teaching strategies to a digital environment, promoting the use of learning management platforms, virtual classrooms, and open educational resources. At the same time, students are expected to develop advanced skills in the use of software, data analysis and technological competencies that are increasingly valued in the labour market and in the knowledge society. This not only contributes to their professional development, but also empowers them to face the challenges of a digitalized and globalized economy. (Caldeiro-Pedreira, Sarceda-Gorgoso, & García-Ruiz, 2018)

In addition to digital training, universities in the region have increased their participation in applied research projects, aimed at solving local and regional problems. This trend has strengthened the link with the productive sector, promoting the creation of innovation laboratories, business incubators and strategic alliances with industry. These initiatives seek to bring students closer to the real challenges of the professional environment, fostering a culture of innovation and entrepreneurship that connects academia with the needs of the market and society.

The inclusion of ICT tools in higher education has been a catalyst for the development of scientific and technological competencies in students, facilitating access to up-to-date information and resources and encouraging research in multiple disciplines. Digital technologies promote active and autonomous learning, stimulate creativity through innovative projects, and encourage collaboration both locally and internationally. Through these tools, students can access virtual simulations and labs, enriching the understanding of complex concepts in areas such as science, engineering, and mathematics, providing immersive and hands-on learning experiences. (Rodríguez Izquierdo, 2010)

However, the promotion of science and technology in higher education in Latin America is not without challenges. Although significant progress has been made in the adoption of technological tools, the region faces significant inequalities in terms of access to connectivity and digital infrastructure. A lack of sustained investment in educational technologies limits the ability of many institutions to provide equitable digital learning opportunities, especially in rural areas and low-income communities, where connectivity gaps remain a significant obstacle. (Didriksson, 2012)

Despite these limitations, higher education institutions in Latin America continue to work to strengthen regional collaboration, promote academic mobility, and develop strategic alliances with companies and research centers. This joint effort seeks not only to reduce inequalities, but also to promote research and train professionals who are prepared to face the challenges of the digital economy. By effectively integrating ICTs, the region is positioned to become a relevant

player in the generation of knowledge and in the development of innovative solutions, contributing to the scientific and technological progress of its societies.

2. General objective

To analyze, from a bibliometric and bibliographic perspective, the production of research papers on the variables Educational Innovation, Higher Education, Educational Strategies, Science, Technology, Latin America, published in high-impact journals indexed in the Scopus and Wos databases during the period 2018-2023.

3. Methodology

The present research is qualitative, according to Hernández, et al., qualitative approaches correspond to research that carries out the procedure of obtaining information to review and interpret the results obtained in such studies; to do this, it searched for information in the Scopus and Wos databases using the words EDUCATIONAL INNOVATION, HIGHER EDUCATION, EDUCATIONAL STRATEGIES, SCIENCE, TECHNOLOGY, LATIN AMERICA. (2015)

3.1 Research design

The methodological design of this research was based on a Systematic Review, which follows a set of guidelines for the analysis of the data collected. This process ranged from initial coding to the visualization of theories, according to the approach of Strauss and Corbin (2016). In addition, the study is characterized by being a descriptive narrative, since it seeks to analyze how the levels of the investigated variable influence, and by being systematic, since academic material from scientific journals was reviewed, analyzed, and interpreted, focused on theories on knowledge management (Hernández, Baptista, & Fernández, 2015).

The results of the search were processed as shown in Figure 1, using the PRISMA technique for the identification and selection of documentary analysis material. Publications between 2018 and 2023 were considered, without restrictions in terms of country of origin, area of knowledge, or type of publication, including journal articles, reviews, book chapters, books, among others.

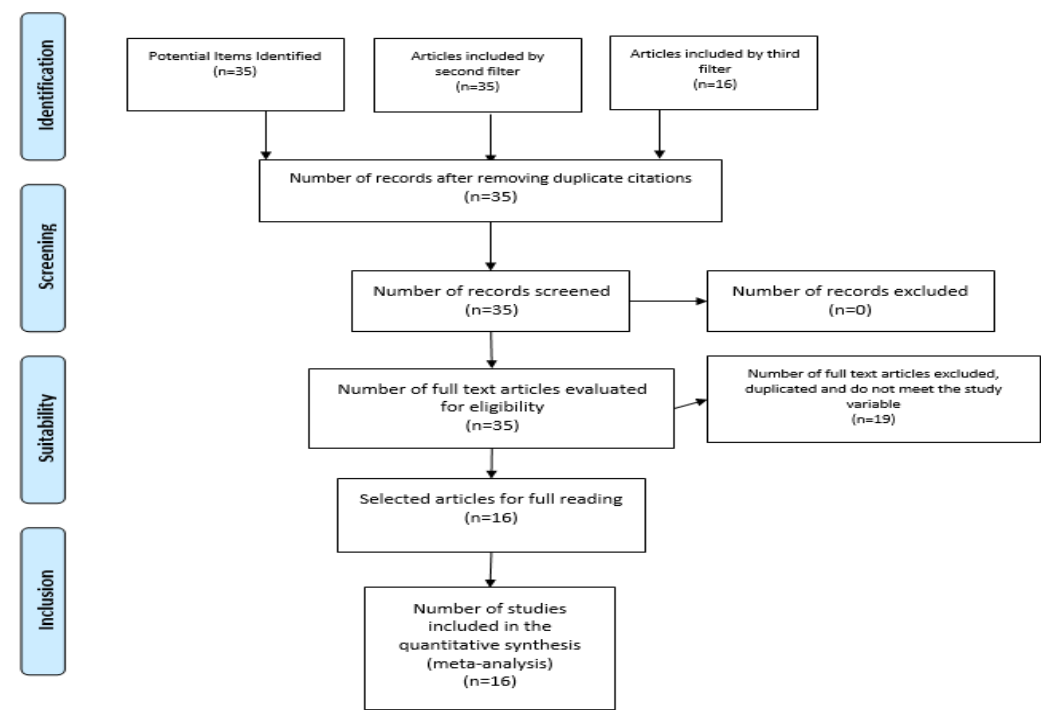


Figure 1. Flowchart of a systematic review carried out under the PRISMA technique (Moher, Liberati, Tetzlaff, Altman, & Group, 2009)

Source: Authors; Based on the proposal of the Prisma Group (Moher, Liberati, Tetzlaff, Altman, & Group, 2009)

4. Results

Table 1 shows the results after applying the search filters related to the methodology proposed for this research, after recognizing the relevance of each of the referenced works.

No.	RESEARCH TITLE	AUTHOR/YEAR	COUNTRY	TYPE OF STUDY	INDEXING
1	New perspectives in teaching and learning with ICTs in global higher education systems	Armie, M., Asensio, G., de los Ríos, M. E. C., & Jordán Soriano, A. (Eds.). (2023).	SPAIN	QUALITATIVE	SCOPUS
2	Who, how and what is investigated in a commercialized educational system? A meta-analysis of research on educational policy in post-dictatorship Chile (1990-2019); [Who, how, and what is investigated in a commercialized educational system? A meta-analysis of research on educational policy in post-dictatorship Chile (1990-2019)];	Villalobos, C., & Pereira Mardones, S. (2022)	CHILE	QUALITATIVE	SCOPUS

3	Analysis of the virtualized teaching in a context of pandemic; [ANALYSIS OF VIRTUALIZED TEACHING IN THE CONTEXT OF THE PANDEMIC]	Sepúlveda-Irribarra, C., Villegas-Dianta, A., & Alcorta-Ramírez, I. (2022)	CHILE	QUALITATIVE	SCOPUS
4	Integration of Computational Thinking in Elementary and Secondary School in Latin America: A Systematic Literature Review; [Integration of Computational Thinking in Primary and Secondary Education in Latin America: A Systematic Review of the Literature]	Quiroz-Vallejo, D. A., Carmona-Mesa, J. A., Castrillón-Yepes, A., & Villa-Ochoa, J. A. (2021).	COLOMBIA	QUALITATIVE	SCOPUS
5	Digital communication and marketing: an emerging technological race in the context of COVID-19. Alternative in higher education in Ecuador,	PALADINES, F. Y., DUQUE-RENGEL, V. K., RODRÍGUEZ, J. F., & TANDAZO, M. F (2022)	ECUADOR	QUANTITATIVE	SCOPUS
6	Challenges and trends of the 21st century in higher education	Jayson Andrey, B., & Javier Andrés, V. G. (2020)	COLOMBIA	QUALITATIVE	SCOPUS
7	The Challenges of Augmented Reality for Higher Education in Spanish-speaking Countries	Rosell, R. D. L. C. A., Acosta, A. G. T., Manco, K. N. E., & Oriundo, J. L. Á. (2023, July).	PERU	QUALITATIVE	SCOPUS
8	Pedagogical experiences in the execution of research projects: Laica Eloy Alfaro University of Manabí-Ecuador; [Pedagogical experiences in the execution of research projects: Universidad Laica Eloy Alfaro de Manabí-Ecuador]	Quote Méndez, D. L. A., Arauz, M. J. E., & Cedeño, D. P. C. (2023).	ECUADOR	QUANTITATIVE/QUALITATIVE	SCOPUS
9	STEAM Approach in Colombian Higher Education in the Face of the Fourth Revolution1; [Status of STEAM approach in Colombian Higher Education in fourth revolution: a critical look]	Sanabria-Rangel, P. E., & Ospina-Díaz, M. R. (2023).	COLOMBIA	QUALITATIVE	SCOPUS
10	Transdisciplinary Cyber-systemic Design of Instruments to Measure Academic Performance in Middle and Higher Education Systems	Reséndiz-Castro, M., Zepeda-Bautista, R., & Peón-Escalante, I. E. (2022)	MEXICO	QUALITATIVE	SCOPUS
11	Impact of Information and Communication Technologies on Education in the 21st century: Bibliometric review; [Impact of Information and Communication Technologies on Education in the 21st Century: Bibliometric Review]	Bernate, J. A., & Fonseca, I. P. (2023).	COLOMBIA	QUALITATIVE	SCOPUS
12	Latin American professors' research culture in the digital age; [Investigative culture of the teacher in Latin America in the digital age],	Gonzalez-Diaz, R., Acevedo-Duque, Á., Martín-Fiorino, V., & Cachicatari-Vargas, E. (2022).	COLOMBIA, PERU, CHILE	QUALITATIVE	SCOPUS
13	Impact of digital technologies upon teaching and learning in higher education in Latin America: an outlook on the reach, barriers, and bottlenecks	Okoye, K., Hussein, H., Arrona-Palacios, A., Quintero, H. N., Ortega, L. O. P., Sanchez, A. L., ... & Hosseini, S. (2023).	MEXICO, UNITED STATES, COLOMBIA	QUALITATIVE	WOS
14	Teaching STEM: A Systematic Mapping of Literature	Esquer Zárate, M. D. P., & Fernández Morales, K. (2021)	MEXICO	QUALITATIVE	WOS

15	FROM A REGIONAL PERSPECTIVE ON THE FUTURE OF HIGHER EDUCATION	Santana, A and Villavicencio, MV (2022)	CUBA	QUALITATIVE/QUANTITATIVE	WOS
16	Digital disruption of optimal co-innovation configurations	Lafuente, E., Vaillant, Y., & Rabetino, R. (2023).	SPAIN, FRANCE, FINLAND	QUALITATIVE	WOS

Table 1. List of articles analyzed

Source: Own elaboration

4.1 Co-occurrence of words

Figure 2 shows the relationship between the keywords used to search for the study material for the elaboration of the systematic analysis proposed for this research.

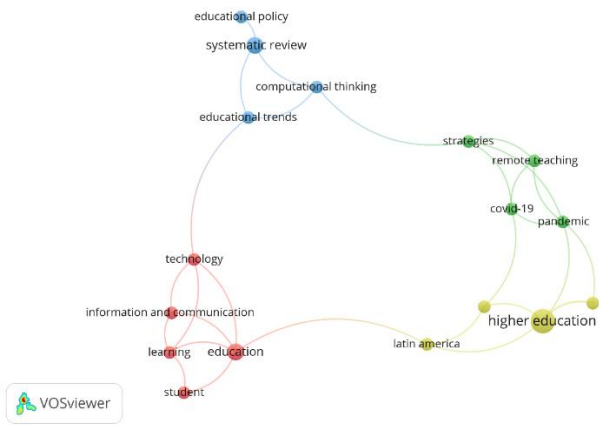


Figure 2. Co-occurrence of keywords.

Source: Own elaboration

The graph shows an analysis of the co-occurrence of key terms related to EDUCATION and EDUCATIONAL INNOVATION in the context of LATIN AMERICA, with a focus on the transformation that has taken place in HIGHER EDUCATION. Through different colors, groupings of terms that are interconnected are visualized, which indicates how certain concepts are most frequently associated in the analyzed literature. The strongest connections are observed between terms such as TECHNOLOGY, INFORMATION AND COMMUNICATION, and LEARNING, which highlights the importance of ICT in teaching and learning processes.

In the upper right part of the graph, a group of terms associated with the PANDEMIC, COVID-19 and REMOTE TEACHING stands out. This reflects the significant impact of the pandemic on the adoption of distance learning strategies, which was an abrupt and necessary change for the continuity of HIGHER EDUCATION during the health crisis. The links between these terms and STRATEGIES indicate that the adaptation to remote teaching required the implementation of various educational strategies to maintain the quality of the training process.

Another important group of terms, located in the middle and top of the graph, includes words such as **SYSTEMATIC REVIEW**, **EDUCATIONAL TRENDS**, and **COMPUTATIONAL THINKING**. This suggests an interest in meticulous research on emerging trends in education, especially those related to the development of skills such as computational thinking. The connection to **EDUCATIONAL POLICY** implies that, in order to take advantage of these trends, education policies play a crucial role in integrating new teaching methodologies and approaches.

Finally, the group of terms at the bottom of the graph, where **EDUCATION**, **STUDENT**, and **TECHNOLOGY** stand out, highlights the close relationship between technological adoption and the learning process of students. The presence of **LATIN AMERICA** as a term linked to **HIGHER EDUCATION** indicates a particular interest in how universities in the region have adapted to these changes, seeking to improve educational quality through the incorporation of technological tools and the strengthening of student training to face the challenges of a digitalized environment. This analysis highlights both the opportunities and challenges faced by educational institutions in the region in the context of technological innovation and digital learning.

4.2 Discussion

The integration of information and communication technologies (ICT) in higher education has proven to be a key factor in the promotion of science and technology in Latin America. Studies such as that of Armie et al. (2023) and Bernate and Fonseca (2023) highlight that digitalization has facilitated access to educational resources and promoted the development of technological skills in students, generating an environment conducive to scientific research and the development of digital skills. ICTs not only enable access to up-to-date information, but also create more interactive and adaptive learning environments, preparing students to face the challenges of an increasingly digitized world.

The focus on teaching digital skills from an early stage is essential to strengthen science and technology education. Quiroz-Vallejo et al. (2021) underscore the importance of integrating computational thinking into primary and secondary education, which lays the groundwork for a smooth transition to higher education. This process is complemented by the STEAM approach in higher education, as Sanabria-Rangel and Ospina-Díaz (2023) point out, which integrates science, technology, engineering, arts, and mathematics to promote comprehensive education. These innovative methodologies not only prepare students for the job market, but also train them to be agents of change and innovation in their respective areas of study.

The COVID-19 pandemic accelerated the adoption of digital tools and the virtualization of teaching, as reflected in the studies by Sepúlveda-Irribarra et al. (2022) and Paladines et al. (2022). The health crisis forced higher education institutions to quickly adapt to distance education, using technologies that allowed the continuity of training processes. However, this shift also exposed inequalities in access to technology, especially in rural areas and communities with less access to digital infrastructure. Despite these challenges, the pandemic demonstrated the resilience of the education system in the region and the ability of teachers and students to adapt to new challenges.

Collaboration between academia and the productive sector is essential to promote applied research and promote innovation in the region. Méndez et al. (2023) and Reséndiz-Castro et al. (2022) highlight the importance of involving students in projects that address local and regional problems, allowing them to apply their knowledge in a practical way and contribute to the development of innovative solutions. This connection strengthens research competencies and promotes a culture of innovation within universities, which is essential for scientific and technological progress in Latin America.

The creation of new careers oriented to the technological and digital needs of the labor market is another relevant strategy. Paladines et al. (2022) highlight how the emergence of academic programs related to digital communication and technological marketing in Ecuador has been a response to the demands of the post-pandemic context. These new training offers allow students to develop key skills for an increasingly digitalised work environment, facilitating both entrepreneurship and adaptation to new professional scenarios. This shows how higher education is adapting to global changes and preparing its graduates to actively participate in the digital economy.

However, significant challenges remain in terms of equity in access to technologies and the quality of digital training. Okoye et al. (2023) identify that, despite the advances, there are significant gaps in the technological infrastructure available in different regions of Latin America, which limits the potential to develop inclusive higher education. However, international collaboration initiatives and the exchange of good practices, as Rosell et al. (2023) and González-Díaz et al. (2022) point out, can be key to overcoming these barriers. Cooperation between universities and countries can contribute to leveling opportunities for access to technology, strengthening the region's capacity to position itself as a relevant actor in the generation of scientific knowledge and technological advancement.

This set of studies demonstrates that the region has made significant progress in the integration of ICT in higher education, but also faces structural challenges that must be addressed to achieve a more equitable and sustainable impact. The adoption of educational strategies that promote science and technology, coupled with greater investment in infrastructure and regional cooperation, will be essential to enhance Latin America's role in the global digital economy.

5. Conclusions

The incorporation of Information and Communication Technologies (ICT) in higher education has established itself as a fundamental pillar to promote educational innovation in Latin America. This process has transformed the way information is accessed, allowing students and teachers to have up-to-date and high-quality resources, which has enriched the learning environment. ICTs not only facilitate access to teaching and scientific materials, but also create interactive and collaborative learning spaces that respond to the needs of an increasingly digitized world. In this way, universities are in a better position to prepare their students to face today's technological challenges and awaken in them a genuine interest in scientific research and technological development, crucial aspects for the growth of the region.

The promotion of digital skills and computational thinking has become a central axis in both basic and higher education, recognizing that these competencies are essential for science and technology training. Developing these skills not only allows students to understand technical concepts, but also gives them the tools necessary to apply them creatively and innovatively. This includes complex problem solving, data analysis, scheduling, and process automation, which are critical in fields such as artificial intelligence, cybersecurity, and software engineering. In the long term, these competencies strengthen the region's capacity to generate its own knowledge and contribute significantly to the global knowledge economy.

The COVID-19 pandemic acted as a catalyst for the accelerated digitalization of higher education, forcing institutions to quickly adapt to remote teaching modalities. This change evidenced the ability of the region's education system to adapt, demonstrating that it is possible to maintain the continuity of training processes through digital platforms, despite the difficulties. However, it also highlighted the urgent need to improve technological infrastructure to ensure that all students, regardless of their geographical location, have equitable access to education. This is crucial to ensure that science and technology education is not limited by disparities in access to the internet and devices, which are critical to maintaining educational quality in an increasingly digitalised context.

Collaboration between universities and the productive sector has proven to be a key strategy for connecting higher education with the real needs of society and the economy. Through this collaboration, students have the opportunity to participate in applied research projects that focus on solving local problems, from developing technological solutions for industry to creating sustainability strategies in vulnerable communities. This type of experience not only enriches the professional profile of students, but also promotes a culture of open innovation, in which creativity and scientific knowledge become engines for social and economic development.

The creation of new academic programs focused on technological areas, such as digital communication, cybersecurity, artificial intelligence and technological marketing, responds to the transformations of the contemporary labor market. These careers allow students to acquire specialized skills that are increasingly in demand in an environment of rapid technological evolution. In this way, higher education institutions not only contribute to improving the employability of their graduates, but also play an active role in strengthening the region's digital economy. This ability to adapt to global trends is essential for Latin America to be competitively integrated into the global digital economy.

However, despite the progress made, significant challenges related to inequalities in access to technology remain. These gaps affect different countries and regions within Latin America unequally, generating disparities in opportunities for access to quality technological training. Regional cooperation, through the creation of strategic alliances between universities, the exchange of good practices and participation in international research networks, emerges as an indispensable strategy to overcome these obstacles. Strengthening collaboration between institutions and promoting the development of joint projects will allow the region to better take advantage of its potential in the generation of scientific and technological knowledge. This will not only contribute to greater equity in access to education, but will also position Latin America as a relevant player in the global field of science and technology.

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