

Teacher technological appropriation in urban educational institutions: A case study in The Colombian Caribbean

Rosa Margarita Murgas Canchano¹;
Leonar Javier Briceño Ariza²;
Carlos Alberto Severiche Sierra³; Luis Ernesto Paz Enrique⁴;
Iris María Cantillo-Velásquez⁵; Jesus David Iguaran Pinedo⁶

Abstract

This article analyzes the process of technological appropriation among teachers from educational institutions in Santa Marta, Colombia. Using a quantitative, descriptive, and cross-sectional approach, a five-point Likert-type questionnaire was administered to a probability sample of 80 teachers, evaluating reliable network access and infrastructure availability. Furthermore, a bibliometric method was employed to identify international trends in the field and contrast them with the institutional context of the Colombian Caribbean. The data, processed using frequencies and arithmetic means, reveal a high level of network access ($\bar{x} = 3.83$), with half of the teachers reporting being always connected and another third rarely lacking a connection. In contrast, technological infrastructure reached a medium level ($\bar{x} = 3.08$), as 38% reported rarely having adequate resources. Although the overall mean ($\bar{x} = 3.46$) places technological appropriation within a high range, the gap between connectivity and material provision evidences a heterogeneous adoption. The study concludes that consolidating ICT-mediated pedagogical practices requires balancing investment in equipment, software, and technical support with continuous teacher training, thereby transforming available access into effective digital competences.

Keywords: ICT appropriation, technological infrastructure, teacher training, educational institutions, Higher Secondary Education.

1. Universidad Politécnica de Valencia. Valencia, España.
rmurcan@upv.edu.es / <https://orcid.org/0009-0000-6429-6005>
2. Corporación Unificada Nacional de Educación Superior - CUN. Santa Marta, Colombia.
leobri2010@gmail.com / <https://orcid.org/0000-0002-0475-2870>
3. Corporación Unificada Nacional de Educación Superior - CUN. Bogotá, Colombia.
carlos_severiche@cun.edu.co / <https://orcid.org/0000-0001-7190-4849>
4. Universidad Nacional Autónoma de México. Ciudad de México, México.
Universidad de Granada. Granada, España.
luisernestopazenrique@gmail.com / <https://orcid.org/0000-0001-9214-3057>
5. Corporación Unificada Nacional de Educación Superior. Santa Marta, Colombia.
iris_cantillo@cun.edu.co - <https://orcid.org/0000-0002-4322-8131>
6. Universidad del Magdalena. Santa Marta, Colombia.
jiguaran@unimagdalena.edu.co - <https://orcid.org/0009-0009-1528-8389>

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Apropriação tecnológica dos professores em instituições educacionais urbanas: Estudo de caso no caribe colombiano

Resumo

Descreveu-se o processo de apropriação tecnológica de professores de instituições educacionais da cidade de Santa Marta, Colômbia. Sob uma abordagem predominantemente quantitativa, descritiva e de corte transversal, foi aplicado um questionário do tipo Likert de cinco pontos a uma amostra probabilística de 80 professores, tendo como eixos o acesso confiável à internet e a disponibilidade de infraestrutura tecnológica. O estudo foi apoiado pelo método bibliométrico com o objetivo de identificar as tendências internacionais sobre apropriação tecnológica. Tal procedimento foi desenvolvido com a finalidade de contrastar essas tendências com o contexto institucional urbano do Caribe colombiano. Os dados, processados por meio de frequências e médias aritméticas, revelam uma elevada presença no indicador de acesso à internet ($\bar{x} = 3,83$), uma vez que metade dos participantes declarou estar sempre conectada e outro terço afirmou quase nunca ficar sem conexão. Em contraste, a infraestrutura tecnológica alcança apenas uma presença média ($\bar{x} = 3,08$); 38% dos respondentes relataram dispor de recursos adequados apenas raramente. A média global ($\bar{x} = 3,46$) situa a apropriação tecnológica em um nível elevado, mas a diferença entre conectividade e disponibilidade de recursos materiais evidencia uma adoção heterogênea. Conclui-se que a consolidação de práticas pedagógicas mediadas pelas TIC dependerá do equilíbrio entre investimentos em equipamentos, software e suporte técnico, juntamente com a formação continuada dos professores, de modo que o acesso disponível se traduza em competências digitais efetivas e em aprendizagens de maior qualidade.

Palavras-chave: Apropriação das TIC; Infraestrutura tecnológica; Formação de professores; Instituições educacionais; Ensino Médio.

Apropiación tecnológica del profesorado en instituciones educativas urbanas: Estudio de Caso en El Caribe Colombiano

Resumen

Este artículo analiza el proceso de apropiación tecnológica en docentes de instituciones educativas de Santa Marta, Colombia. Mediante un enfoque cuantitativo, descriptivo y transversal, se aplicó un cuestionario tipo Likert de cinco puntos a una muestra probabilística de 80 docentes, evaluando el acceso fiable a la red y la disponibilidad de infraestructura. Asimismo, se empleó un método bibliométrico para identificar las tendencias internacionales en la materia y contrastarlas con el contexto institucional del Caribe colombiano. Los datos, procesados mediante frecuencias y medias aritméticas, revelan un nivel alto en el acceso a la red ($\bar{x} = 3,83$), donde la mitad de los docentes declaró estar siempre conectado y un tercio casi nunca carece de conexión. En contraste, la infraestructura tecnológica alcanzó un nivel medio ($\bar{x} = 3,08$), pues el 38 % refirió casi nunca disponer de recursos adecuados. Aunque la media global ($\bar{x} = 3,46$) sitúa la apropiación tecnológica en un rango alto, la brecha entre conectividad y dotación material evidencia una adopción heterogénea. Se concluye que la consolidación de prácticas pedagógicas mediadas por TIC requiere equilibrar la inversión en equipos, software y soporte técnico con la capacitación docente continua, transformando el acceso en competencias digitales efectivas.

Palabras Clave: Apropiación de las TIC, Infraestructura tecnológica, Formación del profesorado, Instituciones educativas, Enseñanza Media Superior.

Introduction

The integration of digital technologies in education has evolved from the mere provision of equipment toward complex processes of technological appropriation, wherein digital tools are resignified and deeply embedded into teaching culture (Ley et al., 2022; Mncube et al., 2021; Vargas et al., 2024). Empirical evidence demonstrates that simply having computers or internet connectivity is insufficient to transform teaching practices; the critical determinants remain the pedagogical beliefs, technical confidence, and institutional support experienced by the teaching staff (Boateng & Tindi, 2022; Cabello et al., 2020).

From a sociocultural, gradual, and situated perspective, technological appropriation is defined as the set of sociocultural processes involved in the use, socialization, and meaning-making of new technologies (Molina et al., 2015). This process is conditioned by social discourses that project representations and practices regarding their use, referring to values, interests, and objectives through which different social groups ascribe distinct meanings to technology and their specific relationship with it within their practical environments. Consequently, this is not merely a subjective act, but a phenomenon with material and objective dimensions that fosters the development of digital skills, encourages creativity, and enhances the exchange of ideas due to broad access to information (Kennedy & Cronjé, 2024; Turpo, 2018).

Under this approach, appropriating technology implies moving beyond a purely instrumental use of devices, platforms, or digital resources. Teachers must advance toward forms of integration where they adapt technology to their educational needs, articulating it with their knowledge, experiences, and the specific dynamics of the school context. Therefore, this phenomenon does not depend exclusively on infrastructure availability, but also on digital competences, pedagogical beliefs, received training, institutional support, and the actual opportunities for educational innovation offered by each environment (Cortés & Aguilar, 2025; Sandia et al., 2019).

However, the appropriate and didactic use of these tools remains complex, as it requires the teaching staff to possess both an advanced command of technical ICT skills and the pedagogical competencies necessary for classroom mediation (Ferreira et al., 2020; Jiménez et al., 2024). Diverse investigations confirm that, even within educational systems with optimal material endowments, variability in the didactic use of technologies stems from the level of teacher preparedness and continuous technical support (Almerich et al., 2024; Fernández et al., 2022; Flores et al., 2021). Conversely, an imbalance between network access and material equipment reduces pedagogical exploitation to low-cognitive-level tasks, such as passive information retrieval or purely administrative management (Gonzales & Castro, 2024; Mesfin et al., 2018).

Within the educational field, teachers' technological appropriation is of paramount relevance because it conditions how ICTs are integrated into the teaching and learning process. Teacher technology adoption does not occur uniformly; disparities persist between technology use inside and outside the classroom, as well as between resource availability and effective pedagogical implementation. Consequently, network access and technological infrastructure constitute necessary but insufficient conditions unless accompanied by teacher training, technical support, instructional planning, and institutional strategies aimed at transforming educational practices. In this manner, technological appropriation is configured as a multidimensional category that orchestrates material, cognitive, pedagogical, and sociocultural aspects. This framework allows for an understanding of why certain teachers successfully transform their practices through digital technologies, while others employ them in a limited, instrumental, or predominantly administrative fashion (Freixas et al., 2022; Ramírez et al., 2025; Vargas et al., 2024).

In Latin America, mass-scale implementation programs have narrowed the connectivity gap; however, device obsolescence and irregular technical assistance persist as barriers to innovation (Avendaño et al., 2021). Even so, there remains a scarcity of studies that simultaneously measure the perception of access and the sufficiency of infrastructure, particularly in mid-sized cities characterized by high bandwidth alongside fragmented maintenance (Muñoz et al., 2023).

The sustained expansion of national public policies aimed at digital inclusion in education—particularly *Computadores para Educar* and *Vive Digital*—has positioned Colombia among the Latin American countries with significant progress in school connectivity coverage (Velasco, 2024). Nevertheless, empirical studies warn that the pedagogical integration of these technologies remains uneven. Faculty appropriation of ICTs relies on the convergence of pedagogical-technological training, institutional support, and resource availability, rather than the mere delivery of devices. Despite infrastructural advances, the gap between access and effective use persists, as many teachers utilize tools primarily for administrative tasks or basic information retrieval, far removed from strategies that foster critical thinking or collaborative learning (Revelo et al., 2018; Sosa, 2024).

Within this national reality, the Colombian Caribbean exhibits unique characteristics that warrant closer examination. While the region displays high connectivity indices resulting from both public and private investments, its educational institutions are characterized by heterogeneous resource endowments and intermittent technical support frameworks



(Ayala et al., 2017). Santa Marta, a major urban core in the zone, exemplifies this tension: widespread network coverage coexists with schools where hardware obsolescence and a lack of continuous professional development limit the transformative potential of ICTs (Correa & Parra, 2019).

Concurrently, the sociocultural diversity of the region demands appropriation strategies that recognize local practices and favor the resignification of technology in the classroom. In light of this scenario, the present study describes the process of technological appropriation among teachers in educational institutions in the city of Santa Marta, Colombia, by contrasting two key dimensions: network access and technological infrastructure.

Methodology

This research was conducted from a predominantly quantitative perspective rooted in the positivist paradigm, aiming to detail and describe phenomena through the objective measurement of variables, guided by the principles of objectivity, control, and replicability (García & Sánchez, 2020). The study was configured as a descriptive, non-experimental, and cross-sectional field research design, as data were gathered directly from the participants' natural environment without intentional intervention or manipulation of the variables (Falcón & Serpa, 2021).

The study focused on district educational institutions located in Comuna 6 of Santa Marta, Magdalena, Colombia. The units of analysis comprised the teaching staff working at these schools. To guarantee case representativeness, a randomized sampling method with proportional allocation was employed, a procedure that initially selected 112 teachers distributed across eight educational centers. However, the questionnaire was ultimately administered to 80 teachers, who constituted the final effective sample of the study.

The instrument comprised two key indicators (network access and technological infrastructure), evaluated through a five-point Likert scale. For the descriptive analysis, absolute and relative frequencies of the responses provided by the 80 teachers were calculated for each indicator, alongside their respective arithmetic means. Each item required the participants to indicate their level of agreement or the frequency with which they experienced the described situation using a five-category Likert scale: Always (5), Almost always (4), Sometimes (3), Rarely (2), and Never (1)—a widely recognized tool for measuring perceptions within the social sciences (Hernández & Duana, 2020).

The collected data were processed using Microsoft Excel, where an analysis matrix was constructed to compute absolute and percentage frequencies, as well as the corresponding arithmetic means; this procedure is broadly supported in descriptive quantitative research (Rojas, 2021). Descriptive statistics were utilized for data treatment, enabling the synthesis and interpretation of the results for each of the examined indicators (Espinoza & Calva, 2020).

A bibliometric method was employed as a pathway to identify international trends within technological appropriation. The steps followed were:

- **Objective of the bibliometric analysis:** To analyze the patterns of international scientific production regarding technological appropriation, with an emphasis on the educational teaching process from 2015 to 2024 within the Web of Science (WoS) database.
- **Information source:** WoS was selected because it is a premier information source that serves as an international benchmark for knowledge generation and scientific production.
- **Spatial and temporal dimension:** The period spanning from 2015 to 2024 was chosen to cover the last decade of research concerning technological appropriation, focusing specifically on the teaching and learning process.
- **Search strategy:** Refine results for “technological appropriation” (Topic) AND “Technology Appropriation” (OR – Search within topic) AND “Use Of Technologies” (OR – Search within topic) AND “Tct Appropriation” (OR – Search within topic) AND 2024 or 2022 or 2023 or 2021 or 2020 or 2018 or 2017 or 2019 or 2016 or 2015 (Publication Years).
- **Applied indicators:**
 - 1) annual productivity,
 - 2) annual citation counts,
 - 3) Single Country Publications (SCP) versus Multiple Country Publications (MCP),
 - 4) most productive countries,
 - 5) word cloud/map to reflect the most frequent terms in abstracts,
 - 6) international collaboration networks, and
 - 7) keyword co-occurrence analysis.

Results and Discussion

Technological Appropriation as a Field of Study Within the Teaching and Learning Process

The descriptive analysis of international scientific production on technological appropriation—with a specific emphasis on the educational teaching process during the 2015–2024 period—evidences a notable expansion of the field. The examined corpus comprises 2,284 documents published across 1,585 sources indexed in Web of Science, denoting a significant diversification of scientific communication channels and a growing interdisciplinary interest. The annual growth rate of 15.32% confirms the sustained consolidation of this topic over the last decade, driven by the boom in educational digitalization and the incorporation of emerging technologies in formative contexts.

The average age of the documents (4.34 years) shows that this is a recently evolving field with a constantly renewing theoretical foundation and an active production flow in recent years. Furthermore, the average of 11.9 citations per document indicates a moderate-to-high reception within the scientific community, reinforcing the academic relevance and impact of the topic across different domains of knowledge.

From an authorship perspective, 7,444 authors were identified, which showcases broad research participation and the existence of diverse collaboration networks. However, the proportion of single-authored documents (393) represents only 17.2% of the total, suggesting a clear predominance of collaborative research. This pattern is further supported by an average of 3.42 co-authors per document and an international co-authorship rate of 21.28%. These indicators evidence a considerable level of transnational cooperation, though still leaving room for growth compared to other, more internationalized scientific fields.

Regarding the document types, journal articles predominate (1,519), followed by conference proceedings (513) and reviews (168), thereby demonstrating a balance between the dissemination of empirical results and theoretical reflection. The presence of blended document types—such as book chapters or early access articles—confirms the breadth of publication formats surrounding the topic. Conversely, the negligible number of retracted publications or editorial materials does not represent a significant bias. The scientific production and citations per year are shown in Figure 1.

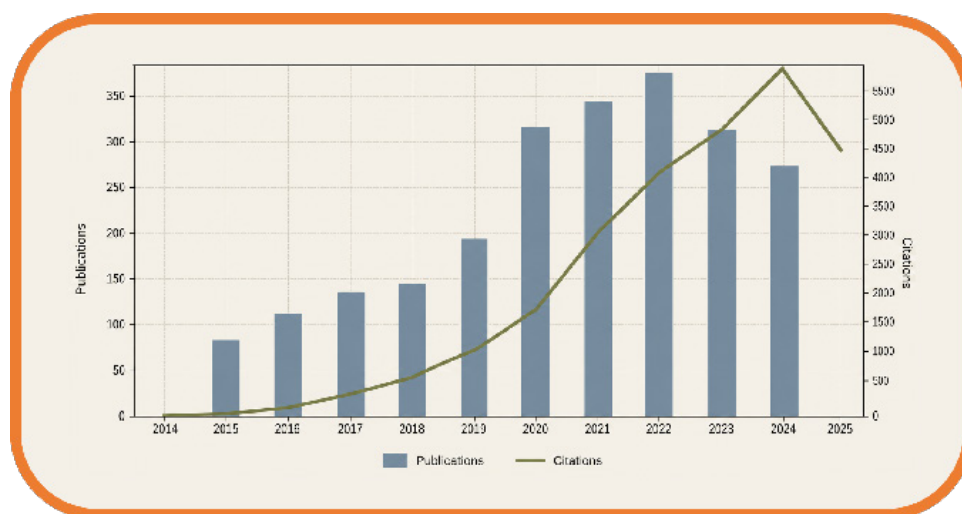


Figure 1.
Scientific production and citation counts per year.

The annual evolution of scientific production on technological appropriation—with an emphasis on the educational teaching process between 2015 and 2024—shows a sustained trend toward quantitative growth, accompanied by a progressive decrease in the mean citation impact. During the initial years of the period (2015–2017), production was comparatively low, with 84, 112, and 136 documents, respectively; however, these papers maintained a high average number of citations per article (29.08 in 2015 and 17.68 in 2017). This behavior illustrates that pioneering research in the field was highly referenced, likely establishing the foundational conceptual and methodological frameworks for subsequent studies.

From 2018 onward, a steady increase in the volume of publications is observed, peaking in 2022 with 391 documents. This surge coincides with the consolidation phase of digital education and the accelerated incorporation of educational



technologies driven by the COVID-19 pandemic. Nevertheless, this thematic expansion was accompanied by a reduction in the mean citations per article, which dropped from 17.12 in 2018 to 7.24 in 2022, and reached 3.24 in 2024. This pattern reflects the dispersion effect characteristic of expanding fields, where the volume of publications grows faster than its capacity to generate short-term citation accumulation.

The analysis of the mean total citations per year (MeanTCperYear) reinforces this interpretation: although values remain stable between 1.6 and 2.8 annual citations, the discrepancies between the earlier and later years are explained by the shorter exposure time of recent publications (CitableYears). Consequently, the apparent decline in impact does not necessarily imply a loss of scientific relevance, but rather a temporal inertia in the visibility of newer works that have not yet reached citation maturity. These results evidence a field undergoing expansion and diversification, where the increasing number of studies responds to the growing centrality of technological appropriation in contemporary educational processes. The collaboration patterns are shown in Figure 2.

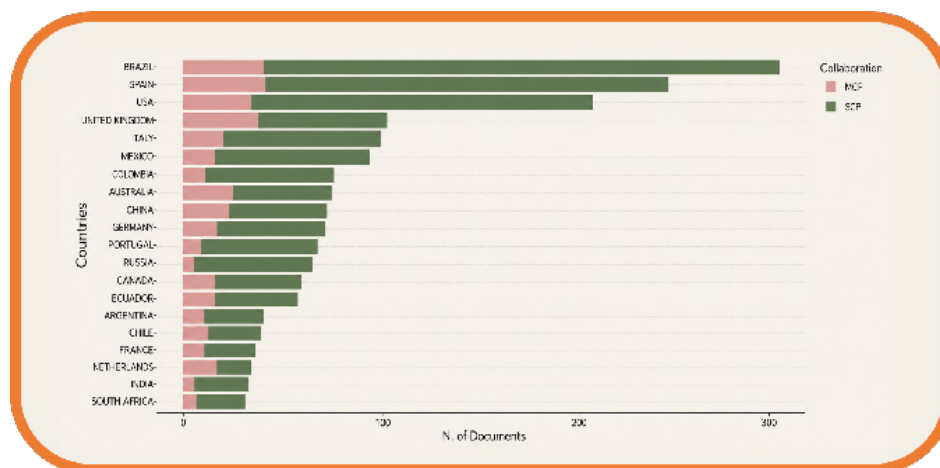


Figure 2.
Scientific production based on authors' corresponding country.

The scientific production on technological appropriation within the educational teaching process, analyzed through the corresponding author's country, reveals a notable geographical concentration alongside a growing diversity in international participation. Within the corpus of 2,284 documents, Brazil, Spain, and the United States emerge as the leading nations with 305, 241, and 205 publications, respectively, collectively accounting for approximately 33% of the total output. This leadership highlights the consolidation of the field within both Latin American contexts and educational systems heavily oriented toward technological innovation and learning digitalization policies.

Brazil stands out not only for its absolute volume but also for its predominantly domestic nature, with 87.2% of Single Country Publications (SCP) and 12.8% of Multiple Country Publications (MCP). This pattern points to a robust domestic research ecosystem capable of sustaining its own research agenda around technological appropriation. In contrast, Spain and the United States, with international collaboration rates of 16.6% and 16.1% respectively, exhibit greater openness to global networks, reflecting their integration into transnational scientific communities tied to digital education and pedagogical innovation.

Furthermore, the United Kingdom, Australia, China, and Germany display higher levels of internationalization, with multiple co-authorship rates (MCP %) exceeding 30%. In certain cases, such as Switzerland (57.1%), more than half of the publications involve international collaboration. This trend underscores the global orientation of research in Anglo-Saxon and European contexts, where technological appropriation is addressed through interdisciplinary and comparative frameworks. The cases of the Netherlands (48.5%) and Austria (50.0%) are particularly noteworthy; despite their smaller production volumes, they maintain intense international cooperation, suggesting a strategic focus on high-impact networks.

Within the Latin American context, alongside Brazil, nations such as Mexico, Colombia, Ecuador, Argentina, Chile, and Peru contribute significantly, jointly representing over 15% of the total output. Among these, Ecuador (26.8%) and Argentina (25.6%) demonstrate prominent levels of international collaboration, reflecting their increasing insertion into cross-border academic consortia and interinstitutional projects. This pattern indicates a regional maturation of educational research that balances national agendas with strategic global alliances aimed at strengthening the pedagogical use of technology. The most frequent terms in the abstracts are presented in Figure 3.



Figure 3.
Word cloud of the most frequent terms in the abstracts.

The analysis of the most frequent terms in the abstracts demonstrates a clear relationship between technological appropriation and the social changes derived from educational digitalization. The terms “digital technologies” (210), “COVID-19 pandemic” (180), and “communication technologies” (142) are the most common, indicating that the global health crisis acted as a catalyst for the use and study of technology in educational processes. Furthermore, the presence of “social networks” (137) and “mental health” (85) evidences an academic interest in the psychological and social effects of learning mediated by digital environments.

Other terms, such as “healthcare” (86) and “digital health” (34), expand the scope of technological appropriation into the medical field, where professional training and education play a decisive role. This demonstrates that educational technology is also analyzed through its social and formative impact beyond the traditional classroom. Concurrently, the frequency of expressions such as “artificial intelligence” (106), “augmented reality” (66), “virtual reality” (49), and “machine learning” (38) reveals the incorporation of emerging technologies into the teaching process. This set of terms confirms a trend toward a more personalized, interactive, and data-driven education.

Likewise, the recurrence of “digital competence” (58), “teacher training” (56), and “digital literacy” (47) highlights the pedagogical dimension of the phenomenon, framing technological appropriation as a process that fundamentally requires teacher preparedness and skill development. On the other hand, the emergence of methodological terms such as “systematic review” (71), “semi-structured interviews” (52), and “content analysis” (63) indicates scientific maturity within the field, as researchers apply more rigorous and diverse approaches to strengthen its consolidation.

The presence of concepts like “smart cities” (47), “sustainable development” (46), and “digital divide” (33) evidences a comprehensive vision of the topic. Technological appropriation is perceived as an integral social process linked to sustainability, equity, and the digital transformation of educational institutions and society as a whole. Finally, the high volume of author keywords (7,085) and Keywords Plus (2,989) suggests a great thematic and conceptual diversity, consistent with the mainstreamed nature of technological appropriation in education. This characteristic anticipates the existence of multiple emerging research lines that can be characterized with greater precision through co-occurrence and thematic network analyses. Figure 4 shows the keyword co-occurrence network.

The keyword co-occurrence analysis reveals a thematic structure articulated around three major clusters that define the primary research lines on technological appropriation within the educational domain. The **first cluster** groups terms such as technology, covid-19, internet, communication, and social media, exhibiting high betweenness and closeness centrality values. This group represents the social and communication dimension of technology, where the term technology acts as the central node of the subsystem (centrality = 311.44). The prominent presence of covid-19 and internet underscores the influence of the pandemic context on the expansion of digital learning and the redefinition of educational interaction processes through virtual environments. Furthermore, the weight of social media and communication technologies evidences a strong academic interest in collaborative environments and digital platforms as spaces for knowledge socialization.

The scientific production in this field features a clear concentration in countries with consolidated higher education systems and active educational innovation policies. Brazil, the United States, and Spain lead the index with 689, 598, and 548 documents, respectively, shaping a geographical axis that bridges Latin American and Global North contexts. In the case of Brazil, this high volume is a response to strong institutional momentum toward digital inclusion and technology-mediated teacher training, backed by national educational research programs and wide-reaching public university networks. The United States, conversely, maintains a long-standing trajectory in studies on educational technology, digital learning, and data-driven pedagogies, positioning it at the core of theoretical and methodological framework generation. Spain demonstrates a growing European leadership in educational research, influenced by digital transformation policies driven by the European Union and the integration of its universities into Ibero-American networks, which explains its high productivity and close connection to Latin America.

The second tier of nations—comprising the United Kingdom, Italy, Canada, Australia, Portugal, Mexico, China, and Germany—reflects the global diversification of interest in technological appropriation, linked to educational modernization processes, university internationalization, and the adaptation of teaching to digital environments. In these contexts, technological appropriation is conceived not merely as the instrumental incorporation of resources, but as a cultural and pedagogical process that redefines teaching practices and equitable access to knowledge. Within Latin America, nations such as Colombia, Ecuador, and Argentina stand out for their increasing production over the last decade, a trend associated with public policies aimed at digital literacy and the strengthening of virtual higher education. These results evidence that academic interest in this subject respond both to the technical adaptation needs of educational systems and to the recognition of technology as a central mediator of twenty-first-century teaching and learning processes.

The analysis of international collaboration within the scientific production on technological appropriation in the educational process highlights dense, multifocal networks, with a select group of countries serving as cooperative anchors. The United States positions itself as the primary collaboration node, maintaining significant ties with Australia (16), the United Kingdom (15), China (13), and Canada (10). This position reflects its role as a leader in technological and educational research, as well as its capacity to coordinate transnational networks that integrate both the Global North and emerging economies. The diversity of its connections indicates a cooperation strategy oriented toward knowledge dissemination and technology adoption across highly diverse contexts.

Spain also plays a prominent role in the international network, featuring substantial collaborations with Mexico (11), Ecuador (10), the United Kingdom (10), Portugal (9), and France (7). This underscores an active Ibero-American and European integration in educational and technological research, consolidating Spain as a geopolitical bridge between Latin America and Europe. Meanwhile, Brazil maintains relevant ties with the United States (8), the United Kingdom (7), and Portugal (11); this reveals a gradual opening toward global networks, albeit through a more selective international cooperation framework compared to Anglo-Saxon nations.

Other countries, such as the United Kingdom, Germany, and Italy, stand out for their balanced participation in European and global networks, engaging in multiple collaborations that strengthen interdisciplinarity and knowledge transfer. The United Kingdom's links with the United States (15), Australia (10), and China (8) reflect its strategic role in articulating international educational networks. Similarly, the connections of France, the Netherlands, and India, though fewer in number, demonstrate the expansion of scientific cooperation toward Asia and continental Europe. Collectively, these networks evidence that technological appropriation in education is a highly globalized field, where local leadership pairs with strategic collaboration to maximize scientific visibility and impact.

Teacher Technological Appropriation in Upper Secondary Education Institutions within the Colombian Caribbean

Table 1 presents the indicators for technological appropriation, which comprise: (1) network access, and (2) technological infrastructure. Each of these indicators obtained a weighting resulting from the arithmetic mean analysis. Accordingly, the results for the Network Access indicator show that the highest recorded valuation was the “Always” option, accounting for 50.0% of the responses; followed by 33.3% for “Rarely [lacking access]”; and the remaining 16.7% for “Almost always.” No responses were recorded for the “Sometimes” and “Never” options. These results place the indicator at a weighted mean of 3.83, corresponding to the High Presence (HP) category.

According to Tacca et al. (2022) and Matamala (2018), it is argued that merely being connected does not translate into benefits for individuals or institutions if they lack the capacity to actively engage with the available digital media and information; consequently, education holds the primary responsibility for fostering these competencies in children and adolescents.

Regarding technological infrastructure, the highest recorded valuation was for the “Rarely” alternative, capturing 58.3% of the responses, followed by “Always” with 33.3%, and “Sometimes” with 8.3%. No responses were registered for the



“Almost always” and “Never” options. The analysis places this indicator within the Medium Presence (MP) category, with an arithmetic mean of 3.08.

In turn, Casanova and Calderón (2020) and Levano et al. (2019) conceptualize infrastructure as the devices that enable signal transmission and transport, alongside the computing devices and software programs involved in carrying the information that reaches the user. This occurs either through personal access devices or shared equipment within a telecenter with internet availability, allowing information to be communicated to achieve learning outcomes.

Overall, a favorable perception is exhibited within the analyzed context, as evidenced by an overall arithmetic mean of 3.46, which represents a High Presence (HP) status. According to Vergara and Rey (2025) and Santiago and Garvich (2024), digital competencies do not develop solely through access to and use of technology; thus, the role played by schools in guaranteeing educational experiences aimed at developing these skills appears indispensable if equitable access to technology is to effectively translate into a more egalitarian society.

Accordingly, educational institutions are directing their efforts toward responding to technological advancements through more efficient teaching-learning processes. Consequently, gaining knowledge on how technological appropriation takes place within individuals would allow institutions to design communication and innovation-implementation strategies within their social structure, backed by a solid foundation that ensures its diffusion (Alviar et al., 2025; Córdova, 2025).

Tabla 1
Apropiación de la tecnología.

RESPONSE	ALWAYS		ALMOST ALWAYS		SOMETIMES		RARELY		NEVER		MEAN
Indicator	FA	%	FA	%	FA	%	FA	%	FA	%	
Network Access	40	50,0	13	16,7	0	0,0	27	33,3	0	0,0	3,83
Technology Infrastructure	27	33,3	0	0,0	7	8,3	46	58,3	0	0,0	3,08

Note: Absolute frequencies (AF) and percentages correspond to the responses provided by the 80 participating teachers for each indicator. The overall arithmetic mean for the dimension was 3.46, a value that falls within the High Presence (HP) category, thereby demonstrating a favorable perception of technological appropriation among the participating teaching staff.

Conclusions

- The study reveals that connectivity constitutes the most strengthened aspect of teachers’ technological appropriation. The majority of the teaching staff has continuous or near-continuous network access, a factor that positions this indicator within the high presence level and establishes an environment conducive to the utilization of digital resources. Conversely, the availability of hardware, software, and technical maintenance exhibits an intermediate level, denoting deficiencies in the physical and logical infrastructure required to sustain technology-based practices. Despite the disparity between these two indicators, the overall average classifies technological appropriation within the high presence range, indicating a favorable institutional perception toward ICT integration. However, the predominance of network access over infrastructure points out that the process relies more heavily on connectivity than on material availability. This situation generates a heterogeneous adoption within institutions and suggests that the consolidation of technology in the classroom will depend on effectively and sustainably balancing access with resource allocation, thereby guaranteeing the continuity and quality of pedagogical experiences mediated by digital resources.
- These findings allow us to assert that teacher technological appropriation within the studied context is in an advancing phase but is not yet fully consolidated. While the high availability of network access represents a favorable condition for developing ICT-mediated pedagogical practices, the limited sufficiency of technological infrastructure restricts the possibility of sustaining broader educational innovation processes. Consequently, educational institutions must orient their efforts toward comprehensive technology management that combines stable connectivity, hardware renewal, software availability, technical maintenance, and continuous teacher training. Only through this articulation will it be possible to transform technological access into effective pedagogical appropriation, ultimately leading to enhanced learning opportunities for students.

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