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Use of ICT tools in secondary school students: a systematic review

Uso de herramientas TICs en los estudiantes de secundaria: una revisión sistemática

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Abstract

This article presents a systematic review of the use of information technologies among secondary school students. The main objective was to analyze research published between 2022 and 2025 in the SciELO database, focusing on the application of digital tools in learning processes. The methodology used was based on the PRISMA protocol, conducting an exhaustive search of the aforementioned database. Four studies were included, selected according to specific criteria: educational level corresponding to high school, technology-based pedagogical approach, publication period within the last five years, and empirical relevance. The results revealed benefits associated with the use of digital technologies in the classroom, such as increased student motivation, the development of cognitive skills, and improvements in participation and autonomy in learning. However, limitations were also identified, especially related to connectivity issues. The empirical evidence reviewed shows significant progress in the integration of ICT, while highlighting the need to strengthen sustainable educational policies that promote equitable implementation. It also underscores the urgency of research that focuses on the real contexts of secondary school students.

Keywords: learning, information technology, digital technology.

Resumen

El presente artículo expone una revisión sistemática sobre el uso de tecnologías de la información en estudiantes de educación secundaria. El objetivo principal consistió en analizar investigaciones publicadas entre los años 2022 y 2025 en la base de datos SciELO, centradas en la aplicación de herramientas digitales en los procesos de aprendizaje. La metodología empleada se fundamentó en el protocolo PRISMA, realizando una búsqueda exhaustiva en la mencionada base de datos. Se incluyeron cuatro estudios seleccionados bajo criterios específicos: nivel educativo correspondiente a bachillerato, enfoque pedagógico basado en tecnología, periodo de publicación en los últimos cinco años y relevancia empírica. Los resultados revelaron beneficios asociados al uso de tecnologías digitales en el aula, tales como el incremento de la motivación estudiantil, el desarrollo de competencias cognitivas, y mejoras en la participación y la autonomía en el aprendizaje. No obstante, también se identificaron limitaciones, especialmente vinculadas con problemas de conectividad. La evidencia empírica revisada muestra avances significativos en la integración de las TIC, a la vez que resalta la necesidad de fortalecer políticas educativas sostenibles que promuevan una implementación equitativa. Asimismo, se subraya la urgencia de investigaciones que se centren en los contextos reales de los estudiantes de secundaria.

Palabras clave: aprendizaje, tecnologías de la información, tecnología digital.

Introduction

This article addresses the use of Information and Communication Technologies (ICT) among secondary school students, emphasizing their impact on teaching and learning processes. At this educational level, such tools enable the diversification of teaching strategies, strengthen digital skills, and facilitate access to interactive content. This transformation responds to both technological advancements and the demands of an increasingly digitalized school environment.

In particular, ICT tools are associated with improvements in academic performance, increased motivation, and the development of critical thinking skills among adolescents (Ñañez Javier et al., 2025). Their integration into the educational environment has altered not only the way teachers deliver content but also how students access knowledge. Their presence has generated new dynamics in the classroom, methodological transformations, and multiple challenges for those implementing them. However, the pedagogical use of these tools still faces various

barriers, especially in school contexts with limited access, low teacher training, or insufficient technological infrastructure. UNESCO (2023) warns that 90% of teachers do not possess the digital competencies necessary to integrate ICT into the curriculum, which compromises their pedagogical utilization and deepens inequalities in access to quality digital education.

This inquiry is justified on a social level, as it addresses structural inequalities, particularly in sectors where access to connectivity, devices, and digital training remains restricted. Secondary education constitutes a crucial stage for the development of academic, personal, and technological competencies. Neglecting this stage could widen educational gaps and limit future opportunities for students. Additionally, the review is justified from a practical standpoint, providing teachers, institutions, and educational policymakers with systematic information to guide the design of sustainable pedagogical strategies (Salcedo Aparicio et al., 2025).

The theoretical foundation is based on Piaget's constructivist approach to learning, which views the student as an active protagonist in the construction of knowledge. Within this framework, ICT do not merely serve as auxiliary tools but act as mediators in the educational process. The axes guiding this analysis include digital competence, technological literacy, the pedagogical integration of ICT, and self-assessment as a formative practice (Calderón et al., 2024).

In the realm of higher education, Ñañez et al. (2025) evaluated the application of ICT in mathematics teaching and highlighted that active methodologies, such as webquests and flipped classrooms, promote deeper learning when supported by digital resources. Digital literacy represents a key dimension in the integration of educational technologies. Coitinho and González (2024), for example, noted that in Uruguay, secondary school teachers face a gap between access to digital resources and their pedagogical application, particularly in post-pandemic contexts. This evidence reinforces the need to address both technological availability and teacher professional development as structural conditions.

From the perspective of digital competencies, Chambi et al. (2025) identified significant advancements in the attitudes of students and teachers toward the use of technology, although they also found shortcomings in technical training and material conditions. Similarly, León et al. (2023) studied the equipment and use of ICT in university contexts, discovering important generational differences: while students exhibited greater familiarity with technologies, teachers faced greater challenges in their effective integration. Ventura et al. (2024) demonstrated that the pedagogical use of technological tools fosters critical thinking, creativity, and reflective capacity in university students through strategies integrated into real educational contexts.

Based on this diagnosis, the following research problem is proposed: What are the benefits, limitations, and implementation conditions of ICT tools in the learning of secondary students, according to evidence published between 2022 and 2025?

Consequently, the general objective of this research is to analyze scientific studies published between 2022 and 2025 regarding the use of ICT tools in secondary school students. The study aims to identify benefits, limitations, and pedagogical applications based on systematic evidence.

Methodology

The study was conducted using a qualitative approach, of a documentary type, with a non-experimental design and a systematic review modality. The methodological strategy was based on the PRISMA protocol, employed to identify, select, and analyze scientific articles related to the use of Information and Communication Technologies (ICT) among secondary school students.

Inclusion criteria

To ensure the relevance and quality of the selected studies, inclusion criteria were established to identify research aligned with the objectives of this study. First, only articles published between 2022 and 2025, written in Spanish, and available in full text through the SciELO database were considered. Additionally, studies addressing ICT usage in school contexts, especially those presenting findings, pedagogical proposals, or practical applications applicable to the secondary level, were included.

Although initially only five articles centered on this age group were identified, broadening the criteria allowed for a total of 13 relevant studies with scientific validity, peer review, and clear pedagogical orientation, thereby strengthening the rigor and richness of the documentary analysis.

Exclusion criteria

During the screening phase, more than 220 articles that did not meet the established parameters for this systematic review were discarded. The main reasons for exclusion included: a focus on educational levels other than secondary (such as early childhood or higher education), the absence of pedagogical guidance on ICT usage (focusing solely on technical or general aspects without educational linkage), and lack of availability of the full text. These restrictions were necessary to ensure the validity, coherence, and applicability of the obtained findings.

This procedure ensured transparency, coherence, and rigor throughout all stages of the process, distributed across four phases:

1. **Search phase**: The search was conducted in the SciELO database, with a cutoff date of May 2025. This database was chosen for its open access and availability of updated studies in the Ibero-American context. The following keywords were used: “information and communication technologies” (2192 results), “digital technology” (2410), “secondary student” (131), and “learning” (319).

By refining the terms through more specific combinations, the following were identified:

- 238 results under “Use of ICT tools”
- 95 results under “Use of ICT tools in students”
- 5 results under “Use of ICT tools in secondary students”

Subsequently, filters were applied by language (Spanish) and publication period (2022–2025), reducing the total number to 4 articles directly related to the specific focus of the study.

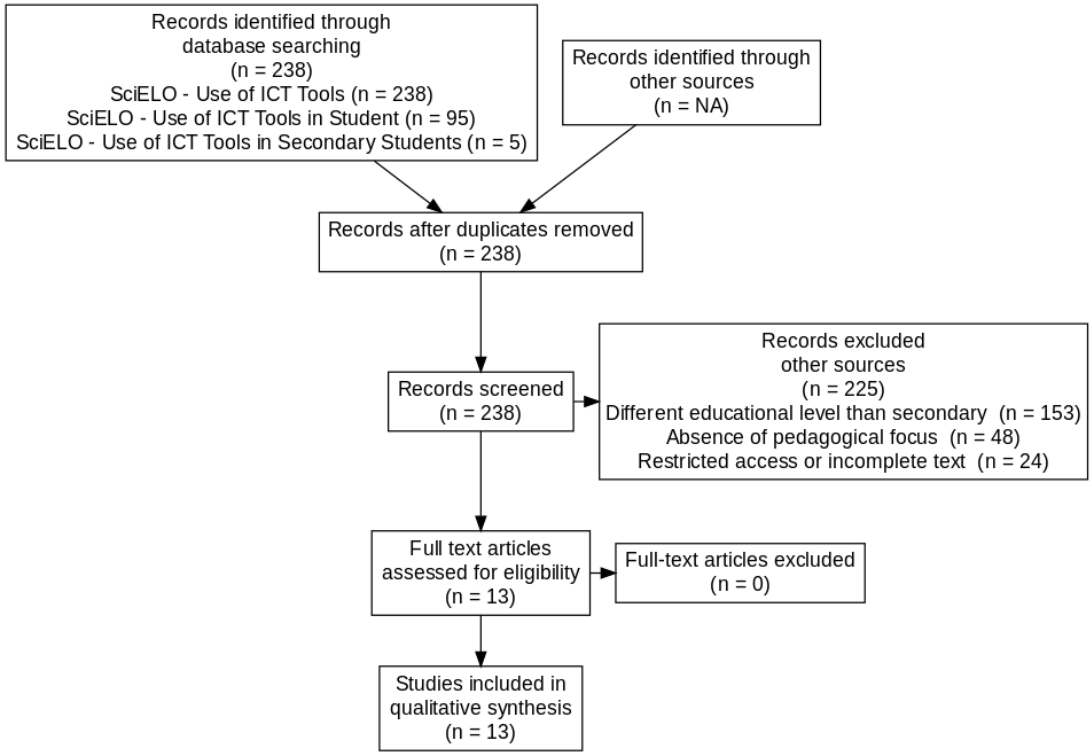
2. **Evaluation phase:** Given the limited number of publications focusing exclusively on the secondary level, the inclusion criteria were broadened to incorporate articles that, while not solely directed at this age group, presented findings or pedagogical proposals applicable to secondary students. This decision allowed for the selection of 13 relevant articles, all with full access, scientific validity, and direct linkage to the use of ICT in school contexts. More than 220 articles were excluded during the screening due to the following reasons:

- Focus on educational levels other than secondary (such as early childhood or higher education)
- Absence of pedagogical guidance
- Restricted access to the full text

3. **Analysis phase:** Data extraction was organized around variables such as: studied population, type of methodological design, technological tools used, identified benefits, reported obstacles, and proposed improvements. The unit of analysis comprised the 13 selected articles, which were considered sources of scientific information.

4. **Synthesis phase:** As this was a documentary research study, it did not involve human subjects, and ethical consent was not required. The synthesis of findings was conducted through comparative analysis, contrasting results among the articles and establishing common categories. This process enabled the integration of an overview of trends, challenges, and opportunities regarding the use of ICT in the learning of secondary students.

Figure 1
PRISMA Diagram



Results and discussion

The systematic review allowed for the analysis of the content, methodologies, and findings of thirteen selected studies, all related to the use of ICT tools in the educational process. While most of the works do not focus exclusively on secondary students, they provide valuable information that prompts reflection on the conditions, benefits, and limitations of digital technologies in the classroom.

Selected articles under inclusion and exclusion criteria

Thirteen studies were selected after applying the defined inclusion and exclusion criteria. These included empirical research or systematic reviews published between 2022 and 2025, with a pedagogical focus and full access. Below, the most representative articles are described according to their relevance to the topic.

Table: Critical study analysis about the use of ICT tools in secondary education

No.	Author and Year	Analyzed Theme	Study Contribution	Tensions, Contradictions, or Gaps
1	Ñañez et al. (2025)	Use of ICT in mathematics teaching under PRISMA and PICOC	Strengthens learning through active methodologies; university approach transferable to secondary	Focus on higher education; limited evidence for secondary
2	Cárdenas et al. (2023)	ICT and active methodologies for critical thinking and participation	ICT promotes meaningful learning and student engagement	Lack of analysis on institutional conditions hindering practical application

3	Calderón et al. (2024)	Digital literacy and ICT proficiency in teachers	Direct relationship between teacher digital literacy and effective ICT use	Does not specify training strategies or sustainable educational policies
4	Piedra et al. (2025)	Teacher training in ICT in Costa Rica	Conceptual knowledge among teachers, but practices lack dynamism due to training deficits	Contradiction between declared knowledge and actual practices
5	Rodríguez et al. (2024)	ICT and student self-assessment	Facilitates reflection, autonomy, and learning tracking; context in medicine with implications for secondary	Results not directly applicable to secondary
6	Daher et al. (2022)	ICT, audiovisual materials, and active methodologies	Improves transversal skills and professional reflection	University context; requires adaptation for secondary
7	León et al. (2023)	Digital generational gap between teachers and students	Students dominate ICT; teachers face methodological limitations	Generational disarticulation not addressed by training policies
8	Herrera et al. (2025)	Digital competence by generations	Equality in basic skills; gaps in content creation and digital communication	Lack of evidence to address generational differences in teacher training
9	Córdova (2025)	Initial teacher training and ICT usage	Strong initial training is key for effective pedagogical use	Does not consider the impact of ongoing professional development in secondary
10	Pilay et al. (2024)	Use of ICT in higher education institutions	Weaknesses in pedagogical design and adaptation of digital content	Absence of proposals to overcome these weaknesses at lower levels
11	Maza et al. (2025)	ICT and academic performance	Positive impact depends on adequate teacher training	Lack of longitudinal studies on sustained improvements in secondary
12	Concha et al. (2023)	ICT and educational inclusion	ICT allows for addressing diversity with methodological perspective and appropriate resources	Little analysis of technological barriers in vulnerable contexts
13	Venegas et al. (2025)	Empowerment and participation technologies (EPT)	Fosters key competencies and student participation	Lack of training and resources limits their real impact

Note: Compiled by the author based on the results of the systematic review

Findings on the pedagogical impact of ICT

The systematic review included 13 studies published between 2015 and 2024, employing qualitative and bibliometric approaches. The findings highlighted that ICT has high potential to enrich the educational process at this level by promoting collaborative environments and developing competencies such as autonomy, critical thinking, and participation.

Ñañez et al. (2025) analyzed the incorporation of ICT in mathematics teaching, applying the PRISMA approach and the PICOC strategy. They identified that these tools strengthen learning through active methodologies, being more effective in higher education, although their principles are transferable to other levels. Cárdenas et al. (2023) concluded that the combination of active methodologies with ICT tools promotes critical thinking, meaningful learning, and student participation. Their research reinforces the idea that technology should

be linked to student-centered didactic proposals applicable across various educational levels.

Calderón et al. (2024) addressed the relationship between digital literacy and ICT proficiency among teachers, finding a direct connection between these variables and emphasizing that most require ongoing training for effective use of these tools. Similarly, Rodríguez et al. (2024) documented a student self-assessment experience where ICT facilitated reflection, autonomy, and learning tracking, with significant implications for the secondary context. Complementarily, Daher et al. (2022) demonstrated how the use of audiovisual materials integrated with ICT and active methodologies strengthened transversal skills and professional reflection among university students.

Obstacles to effective integration

Despite these contributions, the studies also reveal various obstacles to the effective pedagogical implementation of ICT. In a study conducted in Costa Rica, Piedra et al. (2025) concluded that although secondary teachers possess conceptual mastery, their strategies lack dynamism due to limitations in training for the use of resources such as simulators and digital platforms.

Pilay et al. (2024), when evaluating technology use in Ecuadorian higher education institutions, pointed out weaknesses in pedagogical design, lack of training, and the need to adapt digital content to the educational context—issues also relevant in secondary education. León et al. (2023) found a significant generational gap: students exhibit greater familiarity with digital tools, while teachers face methodological limitations that hinder effective technology integration. This issue was further explored by Herrera et al. (2025), who analyzed how digital competence varies between generations. Although they found no significant differences in basic skills, they identified disparities in content creation and digital communication, reinforcing the need for ongoing training in intergenerational educational environments.

Institutional conditions and teacher training

The role of teacher training and institutional conditions emerges as critical dimensions in the integration of ICT in secondary education. Córdova (2025) emphasized that the use of ICT as an educational resource at the early childhood level depends on solid initial teacher training, which also applies to the secondary level. However, data show that this initial training does not always guarantee sufficient competencies for the pedagogical use of technologies.

Maza et al. (2025) analyzed the impact of technology on academic performance and demonstrated that digital integration requires adequate teacher training to translate into significant improvements in student outcomes. Pilay et al. (2024) noted that deficiencies in pedagogical design and the adaptation of digital content also stem from institutional weaknesses, hindering effective application of ICT. These studies agree that teacher training should be ongoing, contextualized, and accompanied by an institutional structure that promotes continuous updating.

Contextual factors and comparative experiences

Various contextual factors influence the success or failure of ICT-mediated educational strategies. Concha et al. (2023) examined the relationship between ICT and educational inclusion, concluding that digital tools allow for better addressing student diversity, provided they are used with an appropriate methodological perspective and sufficient resources. However, this optimistic view is tempered by Venegas et al. (2025), who highlighted the role of empowerment and participation technologies (EPT) in fostering key competencies but also warned about the lack of training and resources that limits their real applicability. These findings reflect that the institutional environment, public policies, connectivity, and technological infrastructure are determining variables that have yet to be structurally resolved in the educational systems of the region.

Critical discussion and analytical level

From a critical perspective, the analyzed studies reflect a strong consensus regarding the pedagogical potential of ICT, but they also reveal significant tensions between innovative discourse and educational reality. On one hand, the integration of technologies is promoted to develop 21st-century competencies; on the other, practical limitations persist, associated with a lack of teacher training, inadequate resources, generational gaps, and institutional voids.

A critical aspect is that several studies, such as those by Daher et al. (2022) and Rodríguez et al. (2024), were conducted in university contexts, limiting the direct transfer of their conclusions to the secondary level. Furthermore, while the importance of initial teacher training is recognized (Córdova, 2025), few studies delve into sustainable models of professional updating.

In terms of inclusion, the approach of Concha et al. (2023) and Venegas et al. (2025) highlights the opportunity that ICT provide to address diversity, but it also evidences the lack of a coherent public policy that guarantees access, equity, and training for all actors in the system. In summary, the 13 studies show relevant contributions but also express structural contradictions that need to be addressed more deeply from a comprehensive, critical, and contextualized perspective.

Complementary studies: teacher beliefs, school management, and complex knowledge

In addition to the central studies, complementary research was identified that offers new perspectives for understanding the use of ICT in school contexts. Arancibia et al. (2020) indicated that teachers' pedagogical beliefs directly influence technological integration. Although many teachers identify with constructivist approaches, their practices do not always reflect this orientation due to curricular barriers, institutional limitations, or lack of formative support. This tension between ideology and pedagogical practice reveals a significant gap in the alignment between innovative discourses and the real teaching conditions, especially in secondary education.

Moreover, Arce et al. (2024) documented how the establishment of a computer center, even with limited resources, produced a significant change in student motivation and promoted active interaction with technological tools. This finding underscores the role of school management and teacher commitment as key elements in generating more dynamic learning environments.

Similarly, Murrieta (2024) demonstrated that the didactic use of digital resources contributed to the development of complex knowledge among university students, such as academic writing, knowledge production, and idea structuring. Although the study focused on higher education, its implications are transferable to the secondary level, provided that the methodological approach is adapted and the processes are accompanied by metacognitive guidance. These complementary evidences reinforce the need to consider not only technical or formative conditions but also the cultural, institutional, and cognitive factors that mediate the pedagogical use of ICT.

Conclusions

The systematic review revealed that Information and Communication Technologies (ICT) enhance learning when articulated with active methodologies within a constructivist framework in which the student assumes a leading role.

The analyzed studies agree that ICT strengthen motivation, autonomy, critical thinking, and student participation. However, for their implementation to be effective, solid teacher training in digital competencies, minimum infrastructure conditions, and coherent educational policies that support their integration are required. These factors condition the real impact of technology in the classroom.

From a reflective and critical perspective, it is emphasized that digital competence must transcend the merely instrumental use of technological tools, to be understood as the capacity to strategically select, evaluate, and apply information with pedagogical meaning in digital environments. Only in this way can it be ensured that ICT contribute significantly to educational transformation and the holistic development of students.

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