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Accessible digital resources in Scratch to support inclusive learning

Recursos digitales accesibles en Scratch como apoyo al aprendizaje inclusivo

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Abstract

The main purpose of this study was to systematize an innovative practice focused on the implementation of Scratch programming to create accessible digital resources geared toward inclusive learning. The experience was developed within the framework of the project "Little Programmers with Scratch in Virtual Classrooms: Resource Creators," carried out with seventh-year students of Basic General Education between 2020 and 2022. The research adopted a qualitative approach, employing focus groups and individual interviews with semi-structured questionnaires. Eighteen students participated, organized into two groups of nine, along with 15 teachers and two administrators. The results revealed that the project allowed for the adaptation of content and methodologies from an inclusive perspective, promoting student participation, autonomy, creativity, and logical thinking. Furthermore, the experience demonstrated that Scratch, as an accessible digital resource, contributes significantly to educational inclusion by fostering active, creative, and contextualized learning, especially in contexts of diversity and vulnerability.

Keywords: active learning, digital divide, teaching competence, educational technology.

Resumen

La principal finalidad de este estudio fue sistematizar una práctica innovadora centrada en la implementación de la programación con Scratch para la creación de recursos digitales accesibles, orientados al aprendizaje inclusivo. La experiencia se desarrolló en el marco del proyecto “Pequeños Programadores con Scratch en las Aulas Virtuales: Creadores de Recursos”, llevado a cabo con estudiantes de séptimo año de Educación General Básica entre 2020 y 2022. La investigación adoptó un enfoque cualitativo, empleando grupos focales y entrevistas individuales con cuestionarios semiestructurados. Participaron 18 estudiantes, organizados en dos grupos de nueve, junto con 15 docentes y dos directivos. Los resultados revelaron que el proyecto permitió adaptar contenidos y metodologías desde una perspectiva inclusiva, promoviendo la participación estudiantil, la autonomía, la creatividad y el pensamiento lógico. Asimismo, la experiencia evidenció que Scratch, como recurso digital accesible, contribuye significativamente a la inclusión educativa al favorecer aprendizajes activos, creativos y contextualizados, especialmente en contextos de diversidad y vulnerabilidad.

Palabras clave: aprendizaje activo, brecha digital, competencia docente, tecnología educativa.

Introduction

Technological advancement has driven significant innovations, establishing digital tools as fundamental engines in pedagogical transformation (Parentela, 2021; Pincay-Chiquito & Cuero-Delgado, 2024). This development has piqued the interest of educational institutions, which promote the integration of artificial intelligence, online learning, and augmented reality environments as means to enhance the teaching-learning process (Mancilla-Vela et al., 2020; Mena-Guacas et al., 2024; Cabero-Almenara et al., 2018; Sousa et al., 2021;

Lancheros-Bohorquez & Vesga-Bravo, 2024). In this context, these tools encourage the development of inclusive, adaptive, and accessible methodologies (Castro et al., 2019; Sandoval-Poveda & Tabash-Pérez, 2021).

The COVID-19 pandemic accelerated digital transformation in education. A study on the digital divide in the European Union (Gomes & Dias, 2024) revealed that Romania has an internet access rate of 74.8%, lower than Denmark's 97.8%. In Africa, the Ibrahim Foundation report (2021) indicates that 89% of students lack access to computers at home, and 82% have no internet connectivity; furthermore, it is estimated that at least 20 million children live in areas without mobile network coverage. In East Asia and the Pacific, about 80 million children were unable to continue remote learning in 2020 due to lack of connectivity (Dao et al., 2022). In Latin America and the Caribbean, the pandemic exacerbated inequalities, as millions could not study or work from home due to lack of internet access, particularly in rural areas (García Zaballos et al., 2023).

Ecuador was no exception, as many students lacked computers and internet, accessing classes via mobile phones and applications like WhatsApp (Galabay-Cajas & Álvarez-Lozano, 2021). Only 16.1% of rural households had internet access, compared to 37.2% nationwide (INEC, 2020; Vivanco-Saraguro, 2020). In Manabí, school absenteeism reached 16%, and 58% of schools reported technological difficulties (Cedeño & Roca, 2022). Additionally, less than 10% of students with specific educational needs have access to adapted technologies, and only 40% are integrated into the formal education system (Ministerio de Educación del Ecuador, 2022). Indigenous students face high dropout rates due to discrimination and lack of relevant curriculum (Fernández Ramírez & Zhang, 2024), while others experience school exclusion due to their sexual orientation. Furthermore, only 28% of teachers have received training in inclusion, highlighting the urgent need to equip educators for equitable education (Tárraga-Mínguez et al., 2020).

In light of this scenario, the strengthening and use of technological tools in education have been consolidated through their progressive integration into curricula (García-Pinilla et al., 2023; González-Díaz et al., 2020; Aguilar & Zambrano, 2022). Various studies support the positive impact of these technologies on improving teaching-learning processes and developing digital competencies that transform pedagogical practices (Prystiananta et al., 2025; Oumelaid et al., 2025).

The programming language Scratch has emerged as an essential tool within digital resources for promoting inclusive learning, allowing students with diverse abilities and educational needs to access programming in a visual, intuitive, and meaningful way (Monge & Sáenz, 2025; Vasconcelos et al., 2023). Scratch serves as a pedagogical strategy focused on equity, effectively integrating practical learning, creativity, and interdisciplinarity (Fagerlund et al., 2022).

This research systematizes an innovative experience centered on the use of digital resources developed with Scratch as a strategy to promote inclusive learning. The study originates from the project “Little Programmers with Scratch in Virtual Classrooms: Resource Creators,” implemented with seventh-grade students during the periods from 2020 to 2022. It highlights the lessons learned from this practice, emphasizing its impact on improving teaching-learning processes and its viability as a replicable model in similar school contexts.

Furthermore, the study aimed to address two fundamental questions: (1) How was the educational practice developed in the project “Little Programmers with Scratch in Virtual Classrooms: Resource Creators” from an inclusive perspective with seventh-grade General Basic Education students? and (2) What learnings and best practices can be identified from the implementation of accessible digital resources with Scratch to support inclusive learning?

Methodology

This innovative pedagogical experience focuses on the use of digital resources developed with Scratch as a strategy to promote inclusive learning. The study arises from the project “Little Programmers with Scratch in Virtual Classrooms: Resource Creators,” implemented with seventh-grade General Basic Education students during the periods from 2020 to 2022. The research is oriented to answer two fundamental questions: How was the educational practice developed in the project from an inclusive perspective? and what learnings and best practices can be identified from the use of accessible digital resources with Scratch to support inclusive learning?

The study is framed within a qualitative approach, centered on understanding the deep meaning of the project from the perspective of its protagonists. The methodology employed is the systematization of experiences, understood as a participatory, critical, and reflective process that seeks to reconstruct, analyze, and re-signify relevant pedagogical experiences (Jara, 2018). Eighteen students participated, organized into two groups of nine, along with 15 teachers and two administrators. The project was executed during the pandemic at the Unidad Educativa del Milenio “Jatun Kuraka,” located in the Otavalo canton, province of Imbabura, Ecuador.

The reconstruction of the experience was structured in four phases: (1) identification of the problem and delimitation of the object of systematization; (2) recovery of the lived process through primary and secondary sources; (3) organization and critical interpretation of the information; and (4) identification of learnings.

The analysis was conducted using qualitative matrices (Sacoto Loor et al., 2018), which allowed for coding, classifying, and establishing semantic relationships among testimonies and reviewed products. The main analytical axes revolved around three emerging nodes: educational inclusion, virtual education, and pedagogical use of Scratch. Based on these, conceptual maps, inductive categorizations, and data triangulation were generated to ensure interpretative validity. The coding of participants included the interviewee number, role (student, teacher, or authority), and initials of their first and last names.

The following table presents the operationalization of variables that guided the interpretation of the findings:

Table 1
Operationalization of variables

Specific Objectives	Analyzed Categories	Contents	Qualitative Indicators
SO 1. Analyze the educational practice implemented in the project "Little Programmers with Scratch in Virtual Classrooms: Resource Creators" from an inclusive perspective for seventh-grade GBE students.	Development of inclusive educational practice with Scratch.	Teacher and student experience. Challenges faced. Use of Scratch in the teaching-learning process. Application of digital resources.	• Perceptions of the assumed role. • Narration of difficulties encountered. • Description of strategies adopted to overcome challenges. • Testimonials on how Scratch was used to teach content. • Opinions on changes generated in teaching practice.
SO 2. Identify the lessons learned from the application of digital resources in Scratch as support for inclusive learning.	Learnings and best practices in the use of accessible digital resources.	Inclusion and digital divide. Lessons learned.	• Perceptions of Scratch. • Accounts of student participation with SEN. • Narratives about lessons learned. • Narratives reflecting positive impact on learning.

Note. Topics addressed, central contents, indicators, and their articulation with specific objectives

Results and discussion

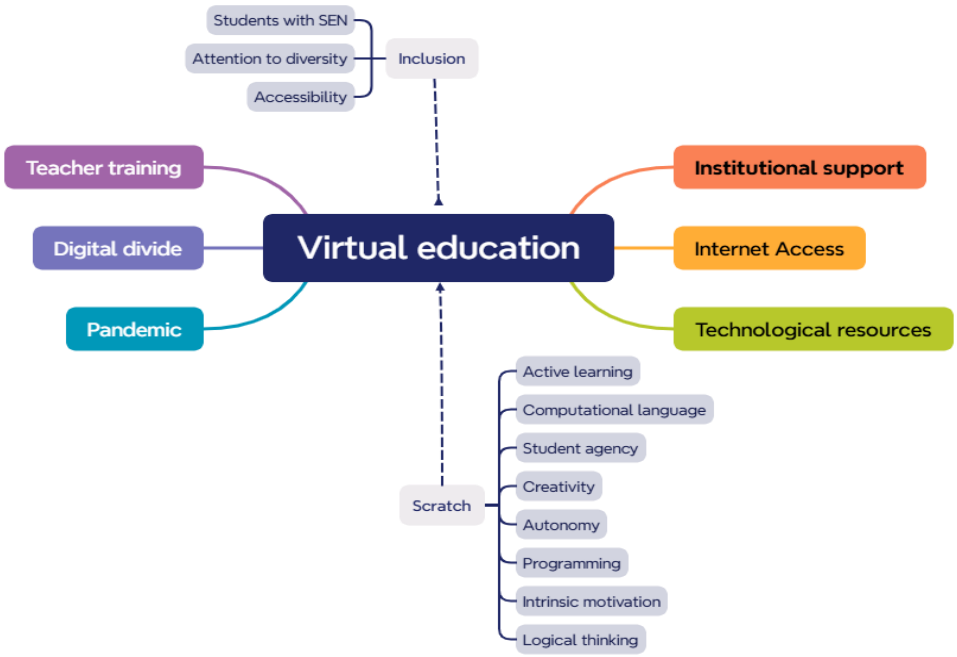
In a context marked by reliance on low-bandwidth tools, such as WhatsApp, during the COVID-19 pandemic, this educational experience emerged to promote the exploration of basic programming concepts through audiovisual and interactive resources, as well as fostering observation, research, experimentation, and problem-solving.

In the initial phase of the project, significant limitations in the use of digital resources were identified among both students and teachers. This situation prompted actions aimed at teacher training, improving technological accessibility, and raising community awareness. Virtual environments were established using specific platforms, and family co-responsibility was strengthened. From a didactic perspective, collaborative work was encouraged through groups called "Little Scratch," which were valued with a formative approach through continuous feedback.

Critical interpretation

To organize ideas in a structured manner, a semantic network was constructed to show the relationships between the concepts of inclusion, virtual education, and Scratch. These relationships were elaborated based on expressions collected from testimonies in focus groups and interviews conducted with students (S) and teachers (T).

Figure 1
Semantic network



Source. Authors' own elaboration

Node 1: Inclusion

The semantic network illustrates that the use of digital resources through Scratch significantly improved the learning of students with specific educational needs by adapting to various levels and learning styles. This allowed for the practical application of Universal Design for Learning (UDL) concepts, such as multiple representation, diverse expression, and deep engagement. As noted in code (03.D.BM): "Students with different learning styles advanced at their own pace, allowing each child with specific educational needs to progress according to their individual conditions, a great challenge overcome." Similarly, code (04.D.KS) highlights:

> To support the student with intellectual disabilities, we made second-degree adaptations in the methodological strategies. We simplified activities, provided videos, recorded classes, and accessible messages, and adjusted the evaluation. I also observed projects with simpler programming blocks. All this allowed her to learn from her cell phone, at her own pace and according to her learning style.

Teachers expressed that one of the main challenges was ensuring equitable access for all students, especially in rural areas where connectivity, technological devices, and teacher competencies were limited. This situation hindered the initial implementation of UDL, affecting the real reach of inclusion. However, it was observed that the application of adapted activities and diversification of materials favored a more personalized learning experience. Additionally, the use of Scratch as a playful, visual, and interactive tool enhanced motivation, creativity, and logical thinking, particularly in students with specific educational needs, aligning with the findings of Durango-Warnes & Ravelo-Méndez (2020) and Sánchez & Calderón (2025).

Node 2: Virtual education

The global health emergency accelerated the virtualization of the educational system, revealing deep structural inequalities. In this scenario, teachers faced the enormous challenge of quickly learning to use digital resources to meet new demands. The effectiveness of Scratch, for example, largely depends on structural factors such as access to infrastructure, connectivity, and technical support. In countries like Ecuador, where these conditions are not always guaranteed, the implementation of emerging technologies may even exacerbate existing gaps. Therefore, the enthusiasm and commitment of teachers must be accompanied by institutional decisions that ensure sustainability, equity, and a real impact on teaching and learning processes.

In this regard, code 14.E.YM states that “a suitable socioeconomic condition is required to access these programs,” while code 02.E.GT asserts that “it would be key for everyone to benefit from the digital environment.” Code 06.E.JM expresses:

“Yes, it helped us learn and reason because it was fun; it motivated us to create, reflect, and solve problems actively, and we didn’t feel pressured.”

These expressions reveal that the use of Scratch not only facilitated cognitive learning but also generated an emotionally safe and motivating environment. It can be inferred that the playful dimension of this platform significantly contributed to intrinsic motivation, a fundamental element for self-regulated learning. According to Screpnik (2024) and García Rodríguez (2022), taking on progressive challenges and collaborating with peers fosters a learning culture based on cognitive resilience. This perspective highlights the development of metacognitive skills linked to computational thinking, as programming in Scratch requires analysis, prediction of outcomes, and reflection on the logic of operation.

Node 3: Scratch as a pedagogical tool

The interdisciplinarity promoted by the use of Scratch favored knowledge and the development of critical thinking among students, as noted by Gecu-Parmaksiz & Hughes (2023). Furthermore, it was evident that students with lower levels of technological competence could participate actively due to the accessibility and intuitive visual design of the platform.

As expressed in code 06.D.SR: “It was difficult to train teachers in a short time so they could manage the tool. The sudden transition to virtual environments required accelerated adaptation, without sufficient training resources or the time necessary for gradual appropriation”.

The implementation of the project faced a critical institutional limitation related to teacher preparation, due to the urgency of incorporating digital tools in an unplanned context during the pandemic, which highlighted the lack of prior training in technological competencies. Additionally, it is noted how initial resistance or difficulty can negatively impact the teaching-learning process when technological interventions lack solid and progressive training support. In this regard, teacher training requires institutional policies and capacity-building programs that address existing structural gaps, implying that Ecuador must ensure continuous education in the use of technological resources for teachers.

On the other hand, code 01.E.GM states: “For me, the most valuable lesson was understanding that making mistakes is part of the process; each error was an opportunity to learn, correct, and continue creating with greater confidence”. Similarly, code 14.E.YM notes: “I liked being able to teach other children who were also interested in the project; sharing what I learned made me feel useful and reinforced what I already knew”.

These testimonies demonstrate that the project generated a collaborative learning process and peer leadership, as students not only internalized the content but also developed a sense of pedagogical agency. Constant participation evidenced the appropriation of learning, fostering solidarity and sustainability of the project as an inclusive strategy. Several studies concur that such initiatives promote autonomy and intrinsic motivation (García Rodríguez, 2022; Gecu-Parmaksiz & Hughes, 2023). However, their effective integration requires more than pedagogical willingness.

An important lesson is that educational inclusion demands not only accessible tools but also a transformation in school culture, where error is a natural part of learning. This vision aligns with the principles of inclusive education and meaningful learning proposed by Parody et al. (2022) and Ardenlid et al. (2025). In this case, the use of Scratch transcended its technical functionality to become a tool with social, emotional, and cognitive impact. As affirmed by Mena-Guacas et al. (2024), Cabero-Almenara et al. (2018), and Sousa et al. (2021), the true value of educational technology lies in its ability to generate meaningful, accessible, and sustainable learning opportunities.

Conclusions

The systematization of the project “Little Programmers with Scratch in Virtual Classrooms: Resource Creators” demonstrated that the pedagogical use of accessible digital tools, such as Scratch, strengthens educational inclusion, computational thinking, and active, contextualized methodologies. This experience transformed teaching practice by facilitating adaptation to diverse learning styles and promoting student agency. Additionally, the potential of emerging technologies to reduce educational gaps is highlighted, provided that enabling conditions such as connectivity, teacher training, and inclusive policies are in place. Therefore, such initiatives require a strong institutional commitment to advance toward a more equitable, flexible, and transformative education

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