

**DIGITAL
INNOVATIONS**

LAC Series:

Brief N°. 2

CEIBAL

Transforming
Education in
Uruguay through
Technology



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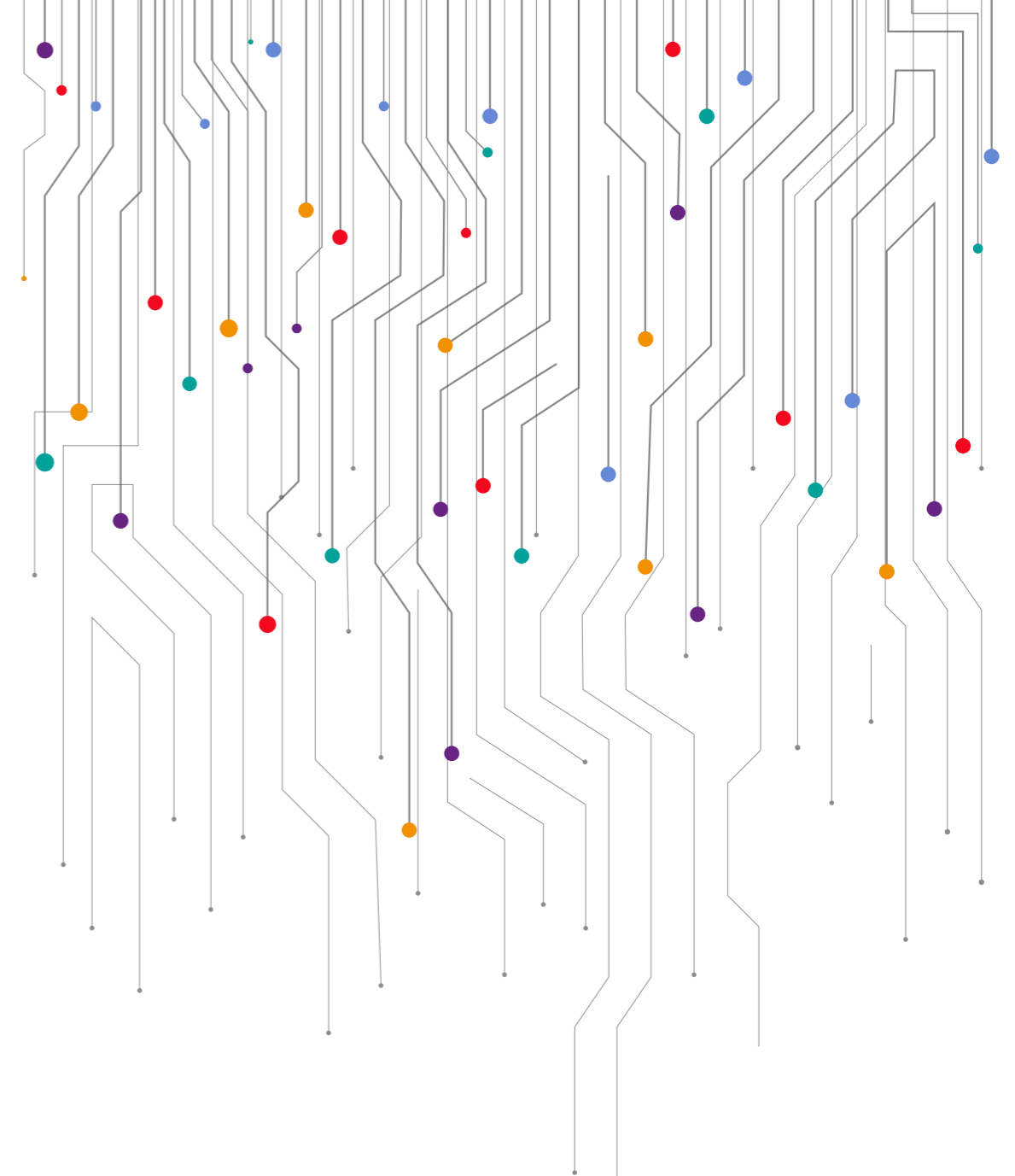
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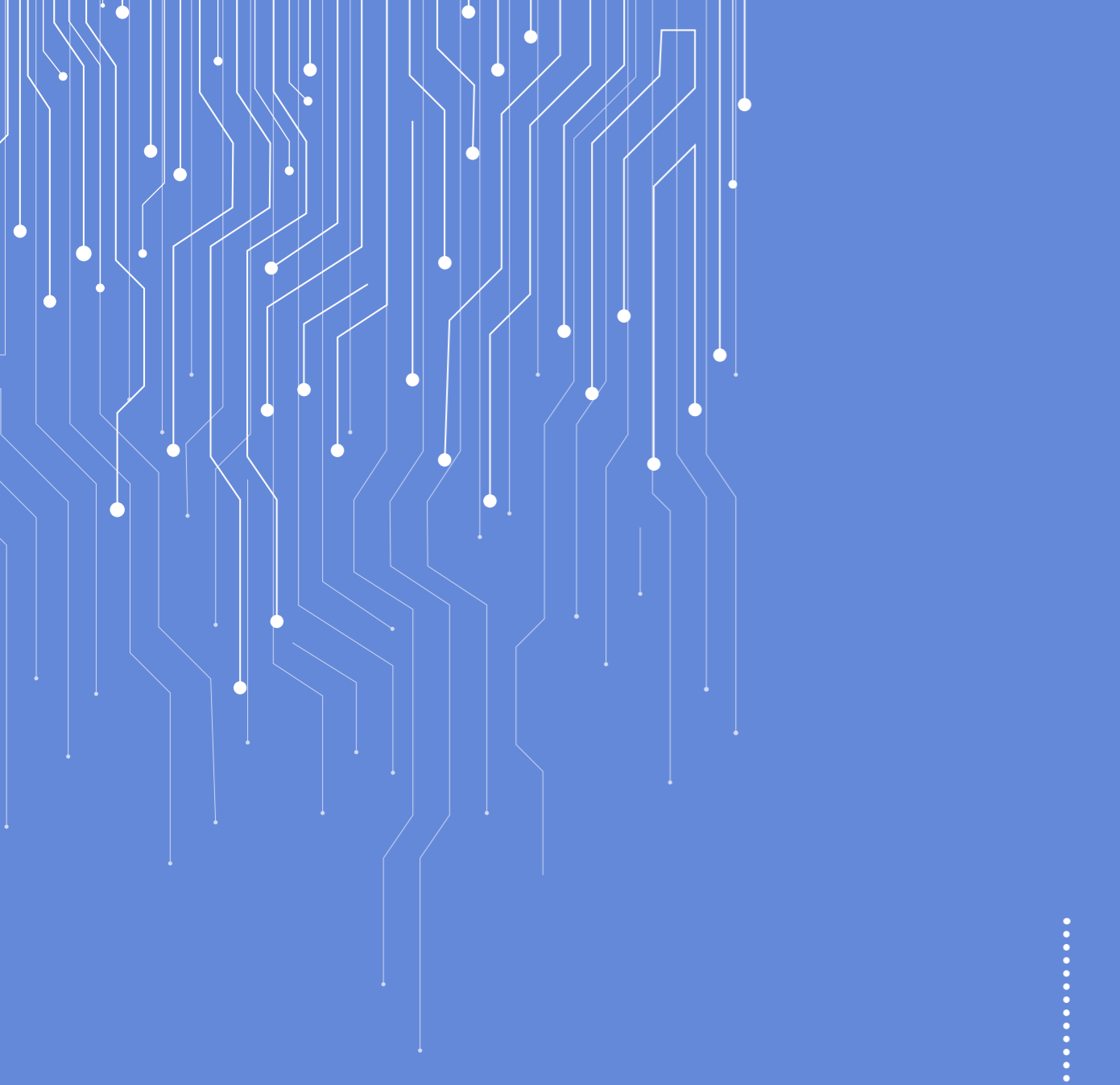


CEIBAL



Transforming Education in Uruguay through Technology

Ezequiel Molina, Cristobal Cobo, Helena Rovner, Antonella Novali, and Jasmine Pineda



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I. EXECUTIVE SUMMARY

Ceibal, an initiative in digital education transformation in Uruguay, offers valuable insights and lessons for countries aiming to leverage technology to improve learning outcomes and foster educational equity. This brief provides an analysis of Ceibal's journey since its launch in 2007, examining its key features, achievements, and challenges faced along the way. By exploring Ceibal's experience, policymakers, educators, and other stakeholders can gain a deeper understanding of the complexities and possibilities of implementing a comprehensive, nationwide program for digital education transformation. The lessons learned from Ceibal's successes and obstacles can inform the design and implementation of similar initiatives in other contexts, making this brief a valuable resource for anyone interested in harnessing the power of technology to enhance education.

Over the past 17 years, Ceibal has evolved from its initial goal of providing a laptop to every student and teacher in Uruguay's public schools to become a comprehensive platform for educational innovation. This brief explores Ceibal's significant strides in expanding access to technology, developing high-quality digital content and platforms, and investing in teacher professional development. It also examines the program's agility and adaptability in the face of rapid technological change, its emphasis on monitoring and evaluation for continuous improvement, and its targeted strategies to address digital divides and support disadvantaged populations. Furthermore, the

brief highlights Ceibal's efforts to prepare students for the future by focusing on computational thinking, programming, and artificial intelligence. By presenting these key aspects of Ceibal's journey, this brief offers a nuanced understanding of the challenges and opportunities inherent in large-scale digital education transformation.

Expanding Access to Technology and Connectivity. Ceibal has made significant strides in expanding access to technology, with almost 3 million laptops and tablets delivered to date, ensuring that every child and educator in the public school system has access to a personal computing device. The program has also invested heavily in infrastructure, achieving 100% wifi coverage across 2,993 educational institutions and providing high-speed internet access to over 778,000 users.

High-Quality Digital Content and Learning Platforms. While universal access to the devices and connectivity is a critical foundation, it must be accompanied by the development of high-quality digital content, the integration of technology into pedagogical practices, and continuous teacher training and support. In addition to hardware and connectivity, Ceibal has developed a suite of educational platforms and content, including the CREA learning management system, adaptive learning platforms like Matific, and the Biblioteca País digital library. These resources have seen high levels of usage and satisfaction among students and teachers.

Teacher Professional Development of Digital Skills.

Recognizing the importance of teacher readiness, Ceibal has placed a strong emphasis on teacher professional development, offering a comprehensive range of training opportunities and support. In 2023 alone, 6,675 teachers and student teachers participated in training initiatives offered by Ceibal's Training Department. Ongoing support, peer learning communities, and the alignment of technology with curricular goals are important strategies to ensure teachers have the skills, confidence, and motivation to effectively integrate digital tools into their practice.

Enabling Agility and Adaptability through Institutional Design.

Agility and adaptability are key in a rapidly evolving technological landscape. Rather than being embedded within the National Administration of Public Education (Uruguay's equivalent of a Ministry of Education, the national autonomous institution that is

responsible for designing and implementing public education policy), Ceibal was established as an independent agency with its own governance structure and budget. This institutional design as an autonomous agency has allowed Ceibal to be more responsive to changing needs and opportunities in digital education. However, this agility must be balanced with strategic planning, stakeholder coordination, and sustainable funding models.

Evidence-Based Decision-Making.

Monitoring and evaluation are essential for continuous improvement and evidence-based decision-making. Ceibal conducts regular surveys of the educational community, participates in international assessments and studies, and has increased its use of experimental methods to foster innovation and inform decision-making. Strengthening the capacity for data analysis, dissemination, and the use of data at all levels of the education system is an ongoing priority.

Equitable Access to Technology and Learning Opportunities.

Addressing digital divides requires targeted strategies for disadvantaged populations. Ceibal has demonstrated the importance and feasibility of such an approach, with targeted initiatives playing a critical role in ensuring equitable access to technology and learning opportunities. When the COVID-19 pandemic threatened to exacerbate existing equity gaps in access, Ceibal worked with telecommunications companies to ensure internet access for all students, including in remote and rural areas. Furthermore, they provided additional training and support to teachers, scaled up its

By exploring Ceibal's experience, policymakers, educators, and other stakeholders can gain a deeper understanding of the complexities and possibilities of implementing a comprehensive, nationwide program for digital education transformation



digital platforms and resources, and created new content specifically designed for remote learning.

Developing Computational Thinking Among Students.

Preparing students for the future requires a focus on computational thinking, programming, and AI. Ceibal has developed several initiatives to support learners in developing these skills such as their "Pensamiento Computacional" (Computational Thinking) program which has reached more than 70,000 students and 3,000 teachers in about 900 schools. Integrating these competencies into the curriculum and ensuring students have access to high-quality learning opportunities in these domains remains a challenge.

The Ceibal experience offers a rich case study of the complexities and

possibilities of digital education transformation at a national scale. While the program has achieved impressive results in many areas, it also faces ongoing challenges in ensuring equitable access, effective technology integration, and continuous improvement. As Ceibal looks to the future, it will be important to build on its strengths, learn from its challenges, and continue to innovate and adapt to the changing landscape of education and technology.

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II. INTRODUCTION

In the early 2000s, Uruguay faced a significant digital divide that threatened to widen the gap in educational opportunities and outcomes. Access to computers and the internet was limited, particularly among lower-income households, and the education system struggled to keep pace with the rapid advances in technology. Recognizing the urgent need to address these challenges, the Uruguayan government embarked on an ambitious initiative to transform education through technology. Thus, Ceibal was born (Zucchetti et al., 2020).

Launched in 2007, Ceibal set out to provide a laptop to every student and teacher in Uruguay's public schools, along with high-speed internet access in all educational institutions. The program's name, which stands for "Conectividad Educativa de Informática Básica para el Aprendizaje en Línea" (Basic Educational Connectivity for Online Learning), reflects its initial core mission: to promote digital inclusion and enhance the quality of education through technology (Ceibal, 2017). By December 2023, Ceibal had delivered nearly 3 million laptops and tablets, reaching all students and teachers in primary and lower secondary education. The program

also achieved 100% Wi-Fi coverage across 2,993 educational institutions, providing high-speed internet access to over 778,000 users (Ceibal, 2024).

Over the years, Ceibal has evolved its mission, moving from a focus on bridging the digital divide to a broader emphasis on learning and educational quality (Ceibal, 2021). To this end, it has developed into a comprehensive platform for educational innovation, offering a wide range of digital tools, content, and services to support teaching and learning. These include videoconferencing capabilities reaching over 1,500 schools, training over 6,600 teachers in 2023 alone, and providing a suite of adaptive learning platforms with hundreds of thousands of active users (Ceibal, 2024). Notably, Ceibal's efforts have had a substantial impact on digital equity - as of 2022, 66% of public school students from the lowest-income households only have computer access through Ceibal (Ceibal, 2024). Figure 1 below illustrates the evolution of Ceibal's mission and the institutional design that has underpinned their strategy and enabled agility, adaptation, and resilience—all of which will be explored further in this brief.

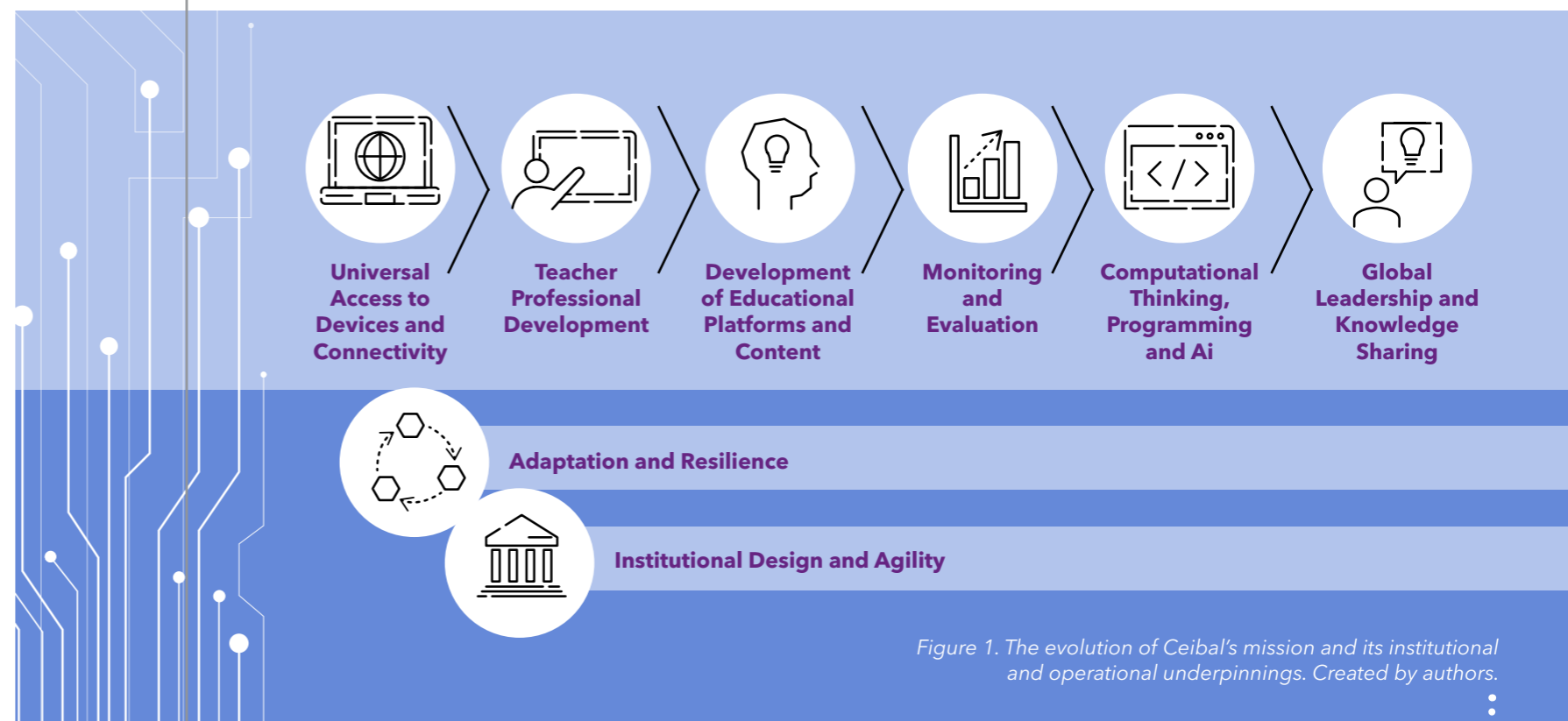


Figure 1. The evolution of Ceibal's mission and its institutional and operational underpinnings. Created by authors.

This brief is part of the *Digital Innovations in LAC* series, which aims to provide insights into ways to improve the digitalization of education in the Latin America and Caribbean (LAC) region, with a focus on innovations that enhance learning outcomes. By showcasing actual cases from LAC countries and highlighting successful implementations and best practices, this series supports the World Bank's and Inter-American Development Bank's [strategic partnership](#) to accelerate the digital transformation of education systems in the region. You can find more about the series, as well as previous briefs, [here](#).

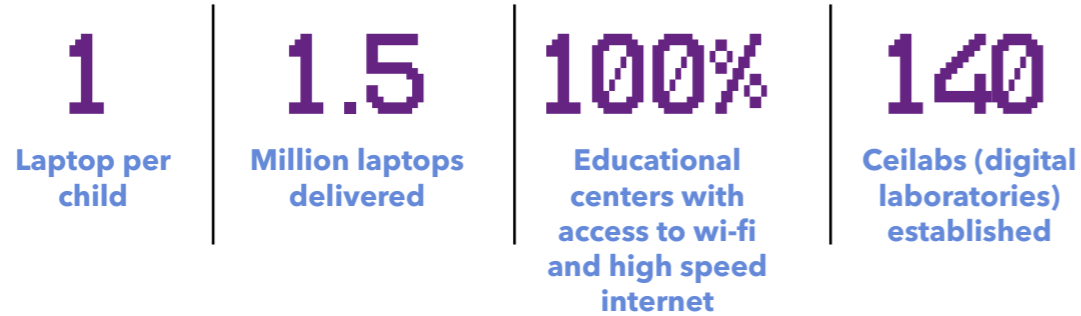
Over the years, Ceibal has evolved its mission, moving from a focus on bridging the digital divide to a broader emphasis on learning and educational quality.



III. UNIVERSAL ACCESS TO DEVICES AND CONNECTIVITY

Digital Devices for Teaching and Learning. One of the cornerstones of Ceibal is its commitment to providing universal access to digital devices and connectivity. The program began, based on the One Laptop Per Child (OLPC) model (Rodriguez-Segura 2022), by distributing laptops to all students and teachers in public primary schools, gradually expanding to cover secondary schools as well. To date, over 1.5 million laptops have been delivered, ensuring that

every child and educator in the public school system has access to a personal computing device (Ceibal, 2021). As of December 2023, Ceibal had delivered a total of 2,922,443 laptops and tablets, with 635,375 of these devices being updated to reach all primary and lower secondary students and teachers. An additional 34,288 devices were provided in a library format to support teachers and students (Ceibal, 2024).



Infrastructure for Connectivity in Education. In addition to the devices themselves, Ceibal has invested heavily in infrastructure to ensure that schools have reliable, high-speed internet access. By December 2023, 100% of the 2,993 educational centers had Wi-Fi networks, providing high-speed internet access to over 778,300 users (Ceibal, 2024). This has involved installing fiber-optic networks, setting up wireless access points, and providing technical support to ensure that the connectivity is stable and sufficient to support digital learning activities. Uruguay's national connectivity infrastructure prioritizes schools, enabling Ceibal's success in this area (Zucchetti et al., 2020).

However, providing devices and connectivity is just the foundation. Ensuring effective use and integration of technology in teaching and learning practices remains an ongoing challenge.

Establishing Systems to Minimize Technological Disruptions. Ceibal has also established a robust system for maintaining and repairing devices, with a network of technical support centers throughout the country. This ensures that students and teachers can continue to benefit from the technology even if their devices experience issues, minimizing disruptions to learning (Severin, 2016). While these achievements are remarkable, Ceibal has also faced challenges in ensuring equitable access, effective technology integration, and continuous improvement throughout its journey.

Digital Laboratories for the Development of Computational Thinking Skills. As part of its efforts to enhance the educational experience, Ceibal has implemented 140 digital laboratories known as Ceilabs across the country by December 2023. These maker spaces provide students and teachers with access to various technologies, knowledge, and resources for project development. Ceilabs promote hands-on, collaborative learning and the development of computational thinking skills (Ceibal, 2024). In 2023 alone, 6,131 teachers and students participated in the Robotics, Programming, and Video Games Olympics organized through the Ceilab initiative.

Furthermore, Ceibal is providing tactile large screens for schools, expanding accessibility and opening up new possibilities for interactive learning experiences in the classroom.

Ceibal has invested heavily in infrastructure to ensure that schools have reliable, high-speed internet access... However, providing devices and connectivity is just the foundation."



IV. DEVELOPMENT OF EDUCATIONAL PLATFORMS AND CONTENT

To maximize the impact of technology on learning outcomes, Ceibal has developed a comprehensive suite of educational platforms and content. At the heart of this ecosystem is CREA, a learning management system (LMS) that facilitates communication, collaboration, and resource sharing between students and teachers. CREA was developed by a third-party provider (Power-school) but has been customized and integrated into Ceibal's offerings. It includes features such as virtual classrooms, discussion forums, and the ability to assign and grade assignments. CREA also incorporates elements of artificial intelligence to personalize the learning experience and provide targeted support to students (Ceibal, 2021). As of December 2022, CREA had 671,535 total users, with 454,208 active users. Over 9 million comments and 8 million assignment submissions were made by students and teachers through the platform (Ceibal, 2024).

In addition to CREA, Ceibal offers a wide range of digital educational resources, including interactive textbooks, multimedia content, and educational software. Some notable examples include:



Figure 2. Screen capture of Matific

Matific: A gamified platform for learning mathematics that adapts to each student's individual needs and progress (Ceibal, 2023a). In 2022, Matific had 187,378 student users across primary education, with 82,472 active users completing over 4.4 million learning episodes (Ceibal, 2024). Teachers have praised Matific for its ability to motivate students through game-based learning and personalize content to each child's level (Nómade Consultora, 2022).

Biblioteca País: A digital library offering free access to ten thousand books, textbooks, and other educational materials (Ceibal, 2023a). In 2022, Biblioteca País had 144,541 users, with over 467,000 loans, downloads, and visualizations made through the platform (Ceibal, 2024). Teachers have noted the usefulness of the library for developing literacy skills and incorporating texts into classroom activities (Nómade Consultora, 2022).

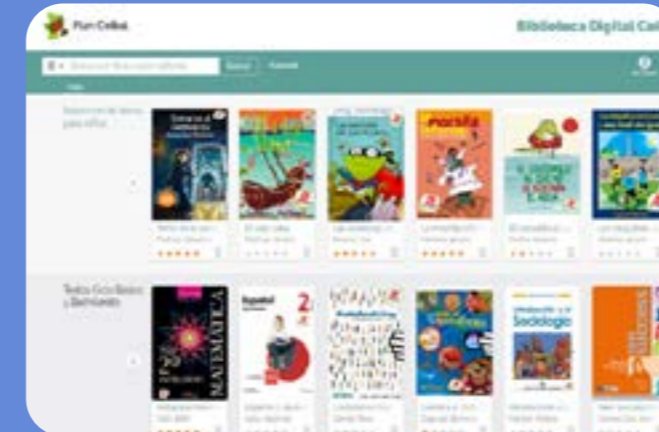


Figure 3. Screen capture of Biblioteca País

Ceibal en Inglés: An English language learning program that combines videoconferencing with native speakers and digital activities on CREA (Ceibal, 2023a). The Language Platform, a component of Ceibal en Inglés for 4th-6th grade, had 34,670 unique student users in 2022, with over 30,000 lessons started (Ceibal, 2024). Teachers have found the platform well-organized, engaging for students, and aligned with curricular requirements (Nómade Consultora, 2022).

Production and Partnerships to Expand Offerings of Educational Content. Ceibal has also invested in the creation of original transmedia content, such as educational video games and interactive simulations, to engage students and promote active learning. For example, the Little Bridge platform, aimed at 4th-6th grade English learners, had nearly 61,000 unique student users in 2022 who completed over 3.5 million learning activities (Ceibal, 2024). Through partnerships with



Figure 4. Promotional communication of Shakespeare Festival 2019-2022, programming of Ceibal en Inglés

organizations like the British Council and Fundación Ceibal, the program has been able to expand its offerings and ensure high-quality, relevant content for Uruguayan learners (Ceibal, 2021).

While these platforms have seen high levels of usage and satisfaction, ensuring their alignment with curricular goals and effective integration into pedagogical practices is an ongoing process that requires continuous teacher training and support.



V. TEACHER PROFESSIONAL DEVELOPMENT



Figure 5. Teacher professional development (Ceibal, 2022)

Recognizing that technology alone cannot transform education, Ceibal has placed a strong emphasis on teacher professional development. The program offers a comprehensive range of training opportunities, both in-person and online, to help teachers integrate technology effectively into their teaching practices and adopt innovative pedagogical approaches (Ceibal, 2023a).

Flexible and Personalized Teacher Professional Development. For in-service teachers, Ceibal provides a flexible and personalized approach to professional development. Teachers can choose from a variety of formats, including online courses,

workshops, and learning communities, tailored to their specific needs and interests. Training programs cover a wide range of topics, from basic digital literacy to advanced subjects like data analytics and adaptive learning (Ceibal, 2021). In 2023 alone, 6,675 teachers and student teachers participated in training initiatives offered by Ceibal's Training Department (Ceibal, 2024). These figures underscore the ongoing efforts to build teacher capacity and integrate technology meaningfully into instruction. Despite these efforts, ensuring that all teachers have the skills, confidence, and motivation to effectively leverage technology in their teaching remains a persistent challenge.



VI. INSTITUTIONAL DESIGN AND AGILITY

One of the key factors behind Ceibal's success has been its institutional design, which has allowed it to operate with a high degree of autonomy and agility. Rather than being embedded within the National Administration of Public Education (ANEP, the national autonomous institution that is responsible for designing and implementing public education policy), Ceibal was established as an independent agency with its own governance structure and budget (Zucchetti et al., 2020).

Autonomy, Agility, and Adaptability. This autonomy has enabled Ceibal to make decisions quickly and respond to emerging needs and opportunities by minimizing delays due to complex bureaucratic processes not suited to a technological environment. It has also allowed the program to forge strategic partnerships with private sector companies and international organizations, leveraging their expertise and resources to drive innovation (Severin, 2016).

Ceibal's legal status as a parastatal organization, governed by Law No. 18.640 and amendments in Law No. 18.719, with its operation regulated by Decree 56.010, has been crucial in maintaining its independence and flexibility (Ceibal Policy Committee, 2011). The Center is directed by a board that includes representatives from the Executive Power and is financed by public funding, enabling it to pursue public goals while operating with a degree of autonomy.



Figure 6. How Ceibal relates to other entities (Ceibal, 2022)

Streamlining Procurement. Another key aspect of Ceibal's institutional design is its specialized procurement process. Recognizing that the technology landscape is constantly evolving, Ceibal has established a streamlined system for acquiring and deploying new devices, software, and services. This includes rigorous testing of devices, often pushing them to the point of failure, to ensure their durability and suitability for classroom use. Ceibal also works with multiple vendors to mitigate supply chain risks and promote competition (Ceibal, 2021).

A Culture of Collaboration and Innovation. Within the organization, Ceibal fosters a culture of innovation, which encourages staff to propose and develop new ideas for improving the program's offerings. Cross-functional collaboration is also actively promoted, with teams from different areas regularly coming together to share knowledge and solve problems. However, this agility must be balanced with the need for strategic planning, coordination with other educational stakeholders, and sustainable funding models to ensure long-term success.



VII. MONITORING AND EVALUATION

To ensure that Ceibal is achieving its goals and to inform continuous improvement, the program has established a robust monitoring and evaluation system. This system collects data on a wide range of indicators, from student achievement and engagement to teacher practices and technology usage (Ceibal, 2021).

Institutionalizing Behavioral Science. As Ceibal has developed a more comprehensive approach to educational innovation, its research agenda has expanded to include the promotion of behavioral changes and attitudes towards education. In 2022, Ceibal launched the first Behavioral Science & Technology Lab in South America. The lab leverages Ceibal's national digital infrastructure and vast amount of data to design interventions that target key educational challenges and promote evidence-based policymaking.

Reducing Student Absenteeism through Behavioral Insights. One notable example is Ceibal's collaboration with the Behavioral Insights Team (BIT) in 2023 to reduce student absenteeism in primary school. The intervention used a multi-component approach to raise awareness about the issue among families and teachers. This included personalized text messages to teachers with information about their students' attendance rates and the risks of chronic absenteeism.

The messages aimed to correct misbeliefs about student attendance and encourage teachers to take action. The intervention was evaluated through a cluster randomized trial with approximately 30,000 students. The results showed a 6.8% reduction in absences for at-risk

students from low sociocultural contexts, translating to over 16,920 additional school days at a cost of just \$2.50 per day. Chronic absenteeism was reduced by 6 percentage points, from 65% to 59% (BIT & Ceibal, 2024).

Building on the success of this intervention, Ceibal plans to scale it up nationwide in 2024 as a public policy. The program will target 50,000 students in the grades and contexts where the intervention had the greatest impact. It is expected to generate over 110,000 additional school days and reduce chronic absenteeism from 82% to 77%. Ceibal will work to transfer capacities to ANEP and support implementation throughout the year.

In addition to the absenteeism project, Ceibal's Behavioral Science & Technology Lab has conducted several other successful interventions. For example, in 2022, the lab used text-based reminders to increase teacher attendance in virtual training sessions from 50% to 61%. The reminders leveraged behavioral insights such as simplification, ownership, and reciprocity to encourage participation.

Closing the Gender Gap in STEM with Behavioral Science. Another example of Ceibal's behavioral science initiatives is an intervention aimed at reducing the gender gap in STEM through in-exam stress management (Gomez-Ruiz & Franco, 2023). This intervention assigned Coding Program applicants to stress management exercises involving positive stress interpretation and meditation. The results showed that treated women omitted fewer exam questions, resulting in a 0.13 standard deviation boost in overall per-

formance compared to control women. Consequently, the admissions gender gap was virtually closed, and 10% more women were admitted to the Coding Program as a result of the intervention.

International Assessments and Studies for Benchmarking Progress. Ceibal has also participated in international assessments and studies, such as the Programme for International Student Assessment (PISA), the International Computer and Information Literacy Study (ICILS), and Global Kids Online. The latter, carried out in partnership with UNICEF and UNESCO, focuses on children's safe and responsible use of digital technologies (Ceibal, 2021; AGESIC et al., 2022). These studies have provided valuable benchmarking data and insights into the program's impact and areas for improvement.

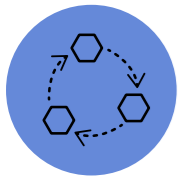
Gathering Feedback from Key Stakeholders. In addition to these studies, Ceibal conducts regular surveys of the educational community to gather perceptions and feedback on the program. In 2023, surveys were administered to school leadership teams, teachers, students, and the general public. The results show high levels of awareness and perceived relevance of Ceibal's role in Uruguayan education, with 88% of the public and over 90% of teachers and principals considering it relevant or very relevant. Satisfaction with Ceibal is also high across all stakeholder groups, ranging from 74% among private primary school principals to 94% among public primary school principals (DIEM, 2024).

The surveys also provide insights into the use of and satisfaction with specific Ceibal resources and platforms. For example, usage of the CREA learning management system is high among both teachers (97%

in primary and 90% in secondary) and students (47% in primary and 46% in secondary). Satisfaction with CREA is also high, with 96-97% of principals reporting being satisfied or very satisfied. Key reasons cited for satisfaction include the ability to share resources, communicate with the educational community, and access training (DIEM, 2024).

Towards a Culture of Rigorous Evaluation for Evidence-Based Decision-Making. Moving forward, one of the pillars of Ceibal's monitoring and evaluation strategy is the increased use of experimental methods, such as randomized controlled trials (RCTs), to generate knowledge and inform decision-making in the education system. Beyond serving as a tool to evaluate behavioral science projects, Ceibal seeks to promote the use of RCTs for decision-making across all areas of the organization and with its ANEP counterparts. This is not intended to be the only evaluation tool, but rather to address the current underutilization of this valuable methodology.

By integrating behavioral sciences into its monitoring and evaluation framework and leveraging a broad set of approaches - from large-scale assessments and surveys to in-depth qualitative studies and rigorous impact evaluations - Ceibal aims to continuously learn, improve, and ensure its programs are effectively supporting educational innovation and positive outcomes for Uruguayan students. This evidence-based approach positions Ceibal as a global leader in using technology and research to drive systemic change in education. Nonetheless, translating data into actionable insights and using evidence to inform policy and practice at all levels of the education system remains an ongoing challenge in Uruguay.



VIII. ADAPTATION AND RESILIENCE: RESPONDING TO THE COVID-19 PANDEMIC

The COVID-19 pandemic posed an unprecedented challenge to education systems worldwide, forcing schools to close their doors and shift to remote learning. Thanks to its strong foundation in digital education, Ceibal was able to respond quickly and effectively to this crisis (Ripani, 2020; Carbajal et al., 2022).

Ensuring Continuity of Learning in Times of Crisis. Within days of the school closures, Ceibal scaled up its digital platforms and resources to support remote learning for all students through its “Ceibal en Casa” (Ceibal at Home) initiative. The program provided additional training and support to teachers, created new content specifically designed for remote learning, and worked with telecommunications companies to ensure internet access for all students, even in remote and rural areas (Ripani, 2020). Usage of Ceibal’s platforms grew exponentially, from 15,000 users before the pandemic to 700,000 users in 2020 (Carbajal et al., 2022).

Responding to Evolving and Comprehensive Needs. Throughout the pandemic, Ceibal continued to innovate and adapt its offerings to meet the evolving needs of students and teachers. For example, the program developed new tools for social-emotional learning and well-being, recognizing the pandemic’s toll on mental health (Ceibal, 2021). Ceibal also collaborated with UNICEF to conduct research on chil-

dren’s online experiences during the pandemic through the Kids Online Uruguay study, which provided valuable insights into the risks and opportunities of increased internet use (AGESIC et al., 2022).

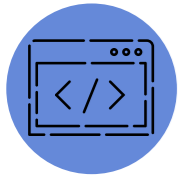
What was the impact of Ceibal’s support on learners during the COVID-19 pandemic? The success of Ceibal’s response to the pandemic is documented in a recent World Bank paper (Barron Rodriguez et al., 2021), which highlights the program’s ability to ensure educational continuity and support for learners during this challenging time. Although learning losses were inevitable, simulations suggest that the impacts in Uruguay were moderate compared to other Latin American countries, thanks in part to Ceibal’s infrastructure and agile response (Carbajal et al., 2022). However, the pandemic did exacerbate pre-existing inequalities, with students from the poorest quintile experiencing learning losses up to 30% higher than in the baseline scenario.

This experience has further demonstrated the value of Ceibal’s investments in digital infrastructure and its agile, responsive approach to educational innovation. It has also underscored the importance of addressing equity gaps and providing targeted support to vulnerable students. The pandemic has highlighted the importance of addressing digital divides and ensuring that all students have access to the devices, connectivity, and support needed to engage in remote learning.



Figure 7. Ceibal en Casa, Ceibal’s remote learning initiative

The COVID-19 pandemic posed an unprecedented challenge to education systems worldwide, forcing schools to close their doors and shift to remote learning.



IX. COMPUTATIONAL THINKING, PROGRAMMING AND AI

In recent years, Ceibal has placed a strong emphasis on developing students' skills in computational thinking, programming, and artificial intelligence (AI). These efforts are aimed at preparing learners for the rapidly evolving demands of the 21st-century workforce and society (Ceibal, 2021).

Computational Thinking as a Core Competency. A key initiative in this area is the "Pensamiento Computacional" (Computational Thinking) program, which is being integrated into the core competency in the curriculum for all students. Through a combination of online and in-person activities, students learn the fundamentals of logical reasoning, problem-solving, and creative ex-

pression using digital tools (Ceibal, 2024). The program is based on Ceibal's Computational Thinking Framework, which outlines principles, dimensions, and objectives for developing these skills across grade levels (Ceibal, 2024).

In 2023, the Computational Thinking program reached more than 3,700 groups of 4th, 5th and 6th grade students in primary education, impacting over 70,000 students, 3,061 teachers and 914 schools (80% of urban public schools). More than 926 teachers of preschool and 1st-2nd grade were also trained, reaching 702 schools and over 15,000 students. Additionally, 572 teachers received training in Computational Thinking and Artificial Intelligence courses (Ceibal, 2024).

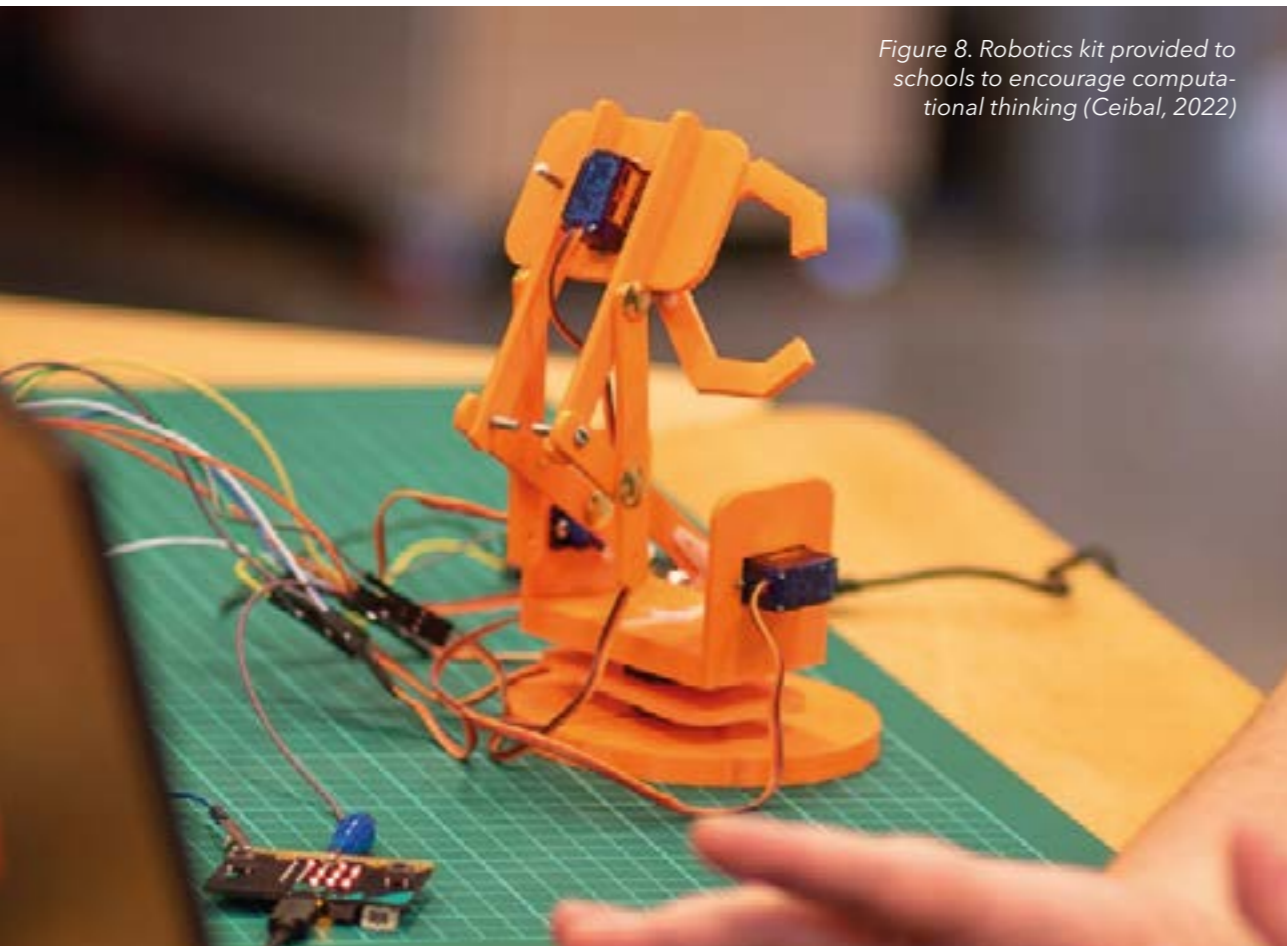


Figure 8. Robotics kit provided to schools to encourage computational thinking (Ceibal, 2022)

A Framework for Teaching and Learning Artificial Intelligence (AI) Literacy and Skills. In the area of artificial intelligence education, Ceibal has developed a Reference Framework for Teaching AI (Capdehourat et al., 2024). This framework provides a structure for curricu-



Figure 9. Reference Framework for the Teaching of AI (Ceibal, 2023c.) Recreation and English translation by authors.

ing models, which allows students to gain hands-on experience and develop a practical understanding of key technical concepts within the AI discipline.

The framework also addresses ethical and social aspects of AI use, encouraging informed and responsible reflection on its societal impacts. By establishing a contextualized competency framework, it serves as a guide for educators to integrate AI and computational thinking into schools, leveraging innovative teaching strategies and appropriate technological tools. The goal is to equip students with key 21st century skills and an open, adaptive mindset to face the challenges and opportunities brought by AI and digital technology.

In summary, Ceibal's initiatives in computational thinking, programming, and AI aim to provide students with the knowledge, skills, and critical perspective needed to thrive in an increasingly technology-driven world. By integrating these competencies across the curriculum and providing hands-on learning opportunities, Ceibal is working to develop a new generation of creative, collaborative, and ethically-minded digital citizens. While these initiatives are promising, ensuring that all students have access to high-quality learning opportunities in computational thinking, programming, and AI remains a challenge, particularly in disadvantaged communities

lum design and activity planning to foster a deep understanding of AI and promote competencies for analyzing, designing and solving problems using computational principles. It takes an integrated, multidisciplinary approach to developing AI literacy and enhancing skills related to critical thinking, problem solving, creativity and collaboration. Notably, Ceibal is currently implementing this framework, enabling students as young as 6th grade to engage in artificial intelligence activities. These activities include training machine learn-



X. THE FUTURE OF CEIBAL: GLOBAL LEADERSHIP AND KNOWLEDGE SHARING

Looking to the future, Ceibal is well-positioned to continue driving educational innovation in Uruguay and beyond. One of the key areas of focus for the program going forward will be leveraging the power of AI to enhance teaching and learning.

Driving Educational Innovation with AI. Ceibal has already begun experimenting with AI-powered tools such as chatbots and adaptive learning algorithms, which can provide personalized support and feedback to students. As AI technologies continue to advance, Ceibal will explore new ways to integrate these tools into its platforms and content, with the goal of creating more engaging, effective, and equitable learning experiences (Ceibal, 2021).

Beyond Uruguay: Knowledge Sharing to Support the Digital Transformation of Education Systems. Another key priority for Ceibal in the coming years will be sharing its expertise and experience with other countries looking to transform their education systems through technology. The program has already begun offering consulting services to governments and organizations around the world, providing guidance on everything from strategy and institutional setup for

digital transformation in education, to connectivity, device procurement and management, educational platforms and programs, as well as teacher training and evidence-based decision making in education (Ceibal, 2021).

As part of this internationalization effort, Ceibal is working to build a global network of educational innovators and thought leaders, fostering collaboration and knowledge-sharing across borders. The program has participated in numerous international events and partnerships, such as the Alliance for Affordable Internet (A4AI) initiative to expand connectivity in developing countries (Ceibal, 2021), and “Gateways to Public Digital Learning” (2024), an initiative by UNESCO and UNICEF. By leveraging the collective wisdom and experience of this network, Ceibal hopes to accelerate the pace of educational transformation worldwide.

As Ceibal continues to evolve and expand its impact, it will be important to learn from the challenges and successes of other education systems, and to adapt its strategies to address emerging challenges and opportunities in the rapidly changing landscape of technology and education.



XI. LESSONS LEARNED FROM THE CEIBAL EXPERIENCE

The Ceibal initiative in Uruguay offers valuable insights into the challenges and opportunities of implementing a comprehensive, nationwide program for digital education transformation. While Ceibal has made significant strides in expanding access to technology, developing digital platforms and content, and fostering a culture of innovation in education, its journey has not been without obstacles and lessons learned.

- 1. Universal access is a critical foundation, but not sufficient on its own. Ceibal’s success in providing laptops and internet connectivity to every student and teacher in Uruguay’s public schools is a remarkable achievement.** However, the experience has shown that access to devices and connectivity, while necessary, is not sufficient to transform education. Equally important are the development of high-quality digital content, the integration of technology into pedagogical practices, and the continuous training and support of teachers. Ceibal has become a hub for innovation in education, promoting disruptive approaches to pedagogy and teaching, but ensuring the adoption of best teaching and



While Ceibal has made significant strides in expanding access to technology, developing digital platforms and content, and fostering a culture of innovation in education, its journey has not been without obstacles and lessons learned.

learning practices at the country level still proves difficult in Uruguay.

2. **Agility and adaptability are key in a rapidly evolving technological landscape.** Ceibal's institutional design as an autonomous agency has allowed it to be more agile and responsive to the changing needs and opportunities in digital education. However, this agility must be balanced with the need for strategic planning, coordination with other educational stakeholders, and sustainable funding models. In the absence of solid and strong national strategies, the effectiveness of innovative programs often depends on the initiative of most innovative teachers, which could reflect inequities in the system.
3. **Teacher training and support are critical for effective technology integration.** Ceibal has invested heavily in teacher professional development, recognizing that technology alone cannot transform teaching and learning. However, the program has faced challenges in ensuring that all teachers have the skills, confidence, and motivation to effectively integrate digital tools into their practice. Ongoing support, peer learning communities, and the alignment of technology with curricular goals are important strategies to address these challenges.
4. **Monitoring and evaluation are essential for continuous improvement and evidence-based decision-making.** Ceibal has established a robust system for collecting data on various indicators of program

implementation and impact. However, translating this data into actionable insights and using it to inform policy and practice remains a challenge in Uruguay. Strengthening the capacity for data analysis, dissemination, and ensuring that the evidence produced in all education related institutions (including evaluation agencies, ANEP and higher education institutes) is used at all levels of the education system as a base for decision-making is an ongoing priority.

5. **Preparing students for the future requires a focus on computational thinking, programming, and AI.** Ceibal has recognized the importance of developing students' skills in these areas to prepare them for the demands of the 21st-century workforce and society. Even though computational thinking has been formally incorporated to the as a core competency in the new curriculum in Uruguay, ensuring that all students have access to high-quality learning opportunities in these domains remains a challenge.
6. **Global leadership and knowledge-sharing can accelerate progress and innovation.** As a pioneer in digital education transformation, Ceibal has much to share with other countries and education systems around the world. Also, the program also has much to learn from the experiences and innovations of others. Strengthening global networks and partnerships for knowledge-sharing and collaboration is an important strategy for advancing the field of digital education.

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APPENDIX 1: RESOURCES FROM CEIBAL

Computational Thinking and Artificial Intelligence

- [Website](#) with educational resources such as curricular frameworks, training, activities, and other resources for computational thinking and artificial intelligence
- [Video](#) about Ceibal's Computational Thinking and Artificial Intelligence program
- [Free book](#) *Pensamiento computacional: propuesta para el aula* (Computational thinking: a classroom proposal) which contains didactic sequences that cover computational thinking applied across various areas of knowledge such as language, math, science, and others.
- Reference Framework for the Teaching of AI ([English](#) | [Spanish](#)) which offers a general approach for teaching AI to create critical and ethical citizenship in the use and understanding of AI and its transformative potential

Ceilab

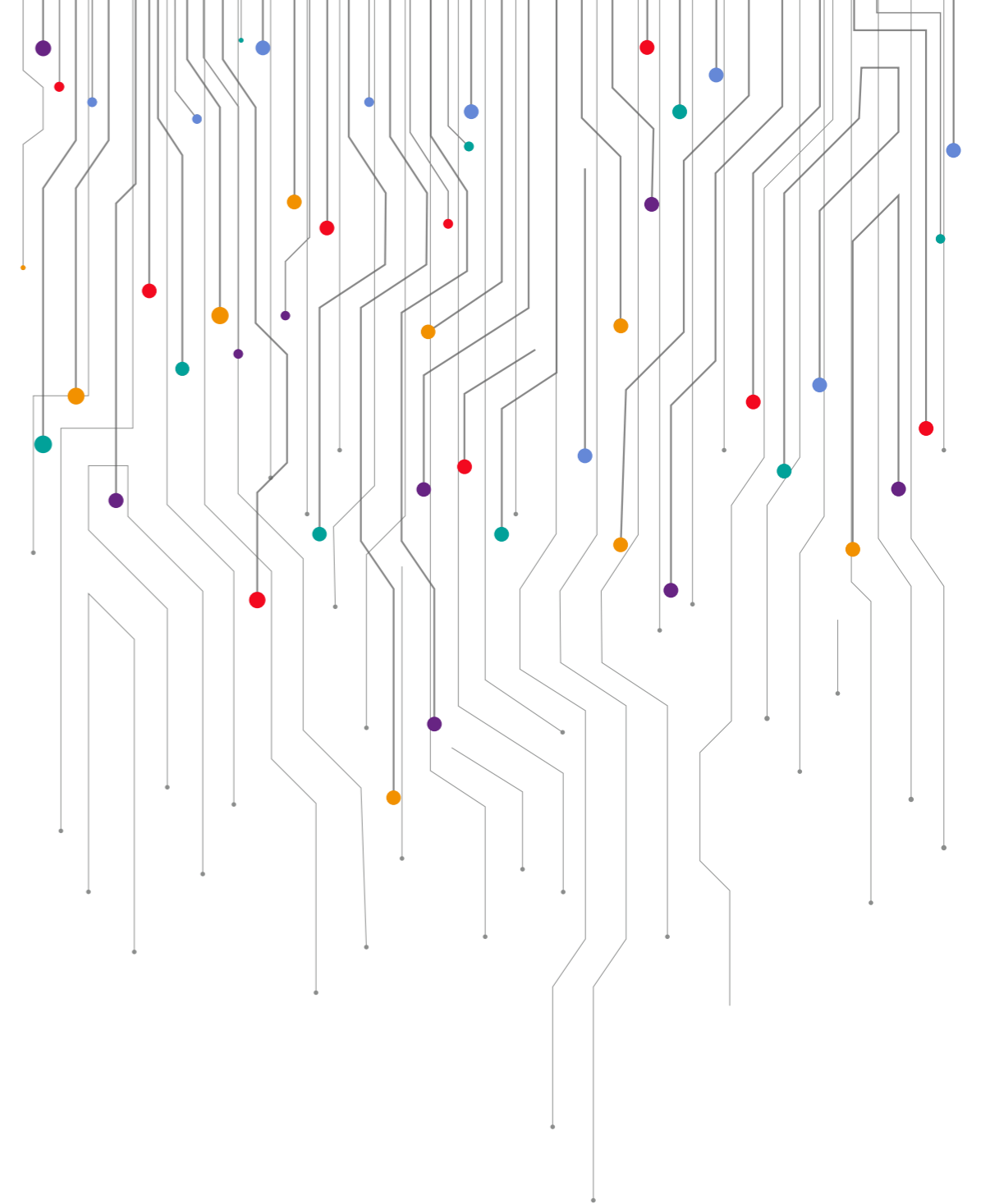
- [Website](#) describes the Ceilab program, its methodology, projects, and provides training and other resources. The Ceilab program promotes computational learning by doing anchored in the design thinking methodology.
- [Video](#) about the Ceilab program

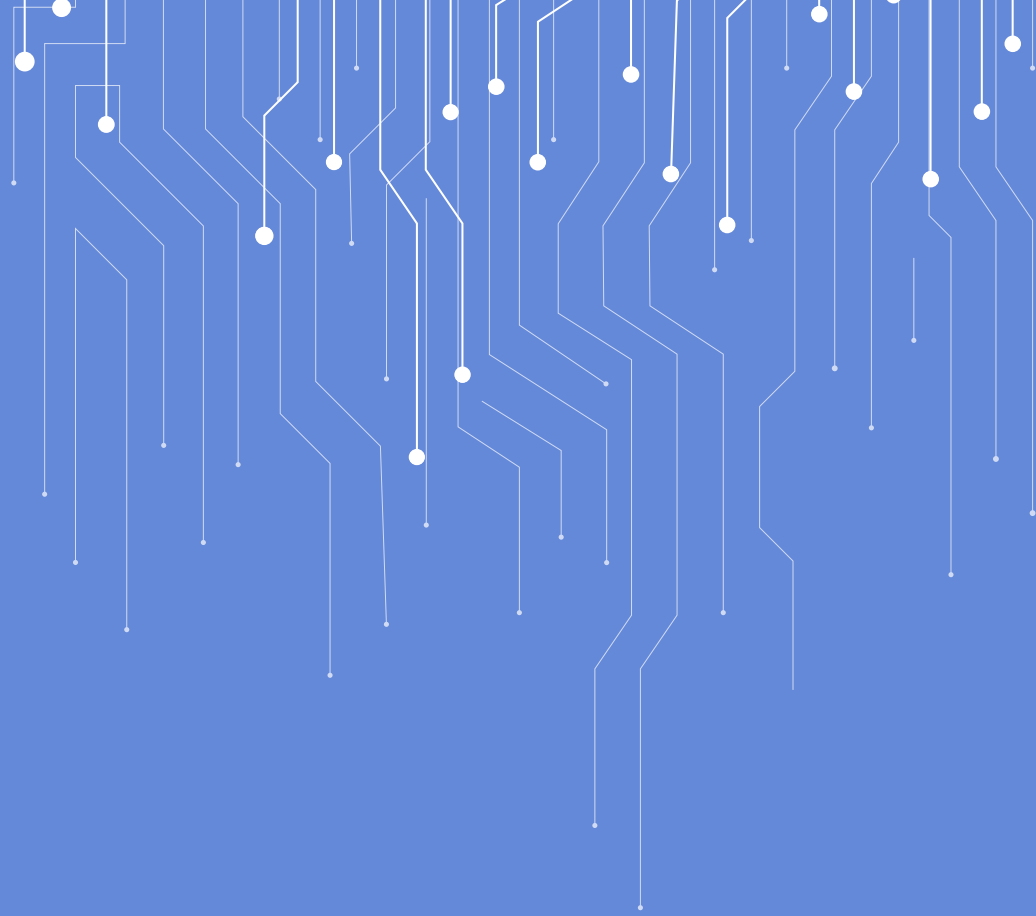
Olympiad of Robotics, Programming, and Video Games

- [Website](#) for the Olympiad of Robotics, Programming, and Video Games which is a project-based initiative promoting the use of technology and computational thinking through collaboration and friendly competition.
- [Video](#) about the 2023 Olympiad of Robotics, Programming, and Video Games

Bebras

- [Website](#) for the Bebras Challenge, an international initiative which promotes computational thinking in which Ceibal has participated since 2020. The Bebras Challenge comprises a set of short problems called Bebras tasks which are delivered online and supervised by teachers. The Challenge provides opportunities for students to engage in problem-solving, collaborative work, creativity, and critical thinking.





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