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SIPA-19-0017.1

Internet in a Box
Bridging Offline Internet to the Peruvian Ministry of Education

Executive Summary

Education is a key equalizer in ensuring growth potential for developing countries. In the 21st century, however, digital technology increasingly became a necessity for effective education. In the mid-2000s, a partnership of nonprofits, tech companies, and international organizations formed One Laptop per Child to remedy the issue by widely distributing cheap laptops. But a key element was still missing: internet access. For many schools located in poor, rural areas, internet was prohibitively expensive.

In 2018, a team of Columbia School of International (SIPA) students, funded by the Wikimedia Foundation, conducted field research in primary and secondary schools across rural Peru lacking internet access. The team, led by Professor Anne Nelson, focused on two offline internet devices as possible solutions: Internet in a Box and RachelPLUS. The following written case study tracks the story of their research and is based off the report the team produced for the Peruvian Ministry of Education.

The case includes the following elements:

a) Video Intro and Discussions – Available Online

b) Written Case Study (This Document)

c) Annex A – Original Documents

d) Annex B – Selected Interviewee Bios and Interview Transcripts (not needed for core case, presented for research purposes)

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The Digital Divide

Since the widespread popularization of the World Wide Web in the mid-1990s, the internet became ever more important. In 2016, the digital economy was worth $11.5 trillion – a staggering 15.5% of global GDP.[1] By January 2020, 3.8 billion people, a full 49% of the world's population, were connected via social media.[2] With internet increasingly becoming a necessity in more areas of life, from work to education, the question of who was being left behind became all the more pressing.

In 2020, 58.7% of the global population, or 4.6 billion people, were connected to the internet. While access had expanded rapidly, nearly twelve-fold since 2000, certain areas had persistent difficulties in gaining access. Lack of access for the world's remaining 3.2 billion inhabitants was often a serious disadvantage in a digitizing world. Like traditional infrastructure, major inequalities existed between developed and developing regions. In 2020, North America had a 95% internet penetrance rate, in contrast to 39% for Africa.[3]

The unprecedented wealth of cheap, easily accessible information offered by the internet was revolutionary for many industries, yet it also presented a promising opportunity to improve the quality of education across the globe. But first, internet access would have to be expanded to the remote areas that most needed educational improvement. Among the 65% of people ages 16-18 enrolled in school globally, internet access in schools ranged from 4% to 100%, falling along familiar lines of economic development.[4] In 2014, about 30% of Peru's schools were online, placing it below average for Latin America and the Caribbean, but still above countries like Nicaragua and Venezuela.[5, 6]

In the case of Peru, internet expansion was rapid, with the household penetration rate increasing from 21% to 53% between 2006 and 2018.[7] Nonetheless, broadband internet access was two thirds below the average for Latin America and the Caribbean.[8] Within Peru, inequalities in internet access not only fell along rural/urban divides; in addition, poor Peruvians and indigenous or African-descended communities were much less connected to the internet. According to the World Bank, less than 25% of Peru's population is

[1] Huawei and Oxford Economics, "Digital Spillover: Measuring the True Impact of the Digital Economy," p. 2. 2017.
[2] Kepios. "Social Media Users by Platform." DataReportal, 2020.
[3] Internet World Stats. "World Internet Users and 2020 Population Stats." Miniwatts Marketing Group, 2020.
[4] UNICEF, "Secondary education." UNICEF Data, 2019.
[5] Kevin Kho, Leah K. Lakdawala, and Eduardo Nakasone. "Impact of Internet Access on Student Learning in Peruvian Schools," p. 7. Agricultural and Applied Economics Association Annual Meeting, 2019.
[6] Michael Trucano, "How many schools are connected to the Internet?" World Bank Blogs, 2014.
[7] "Percentage of population using the internet in Peru from 2000 to 2018." Statista, 2019.
[8] "Internet Via Satellite Peru." Vizocom, 2011.

rural, but 82% of the country's extremely poor live in the countryside.[9] Even as the economy has steadily developed, with poverty rates dropping and GDP growing at an average 5.9% annually from 2005 to 2015, remote areas have seen few of the gains, including in digital access.[10]

One Laptop per Child

Unfortunately, the tendency for digital access to compound existing inequalities was not unique to Peru. Within countries, from the least to the most economically advanced, scholars had identified this trend to varying degrees.[11] Since the 1980s, Nicholas Negroponte and Seymour Papert, two professors at the Massachusetts Institute of Technology Media Laboratory had been concerned about digital inequality in education. Though they had run smaller pilots introducing free technology for children in areas in need, such as Senegal, the first major program to result from their work was the Maine Learning Technology Initiative.[12]

In 2002, Maine began providing all seventh through eighth grade students in its public schools free laptops, with other students receiving partial coverage. The Maine Learning Technology Initiative was spearheaded by then-governor Angus King, after Papert convinced him that digital technology could revolutionize technology only if each student and teacher had her own device.[13] Eventually, other states, including Hawaii and Vermont, joined a similar, multi-state-initiative.[14]

But outside of the United States, internet access for young students remained in even more dire need of improvement. Recognizing this problem, Negroponte developed the idea of an $100 laptop that could be produced and distributed to underserved students en masse. In 2005, at the World Economic Forum in Davos, he successfully pitched the idea to executives of several corporations, gaining the support of companies ranging from Advanced Micro Devices (AMD) to News Corporation.[15]

In 2006, the $100 laptop initiative was launched as a nonprofit, One Laptop per Child, with the mission "to provide a means for learning, self-expression, and exploration to the nearly two billion children of the developing world with little or no access to education."[16] The same year, the United Nations Development Fund committed to "working together with local and international partners to deliver the new technology

[9] Bolivia, Chile, Ecuador, and Perú Country Management Unit, "Perú: Systematic Country Diagnostic," pp. 31-32. World Bank Group, 2017.
[10] "GDP growth (annual %) - Peru." The World Bank Group, 2019.
[11] Massimo R Agnedda and Glenn W. Muschert, *The Digital Divide: The Internet and Social Inequality in International Perspective*, pp. 25-26. Routledge, 2013.
[12] Brittney Fraser, Isabelle Kim, Marcia Lee, Ed Luong, "History of the OLPC." Stanford Computer Graphics Laboratory, 2008.
[13] Deborah Lajoie, "MLTI History." Maine Department of Education, 2006.
[14] Sean Cavanagh, "Maine Leading Initiative for Multistate Tech Buys." *Education Week*, 2013.
[15] John Markoff, "Taking the Pulse of Technology at Davos." *The New York Times*, 2005.
[16] "Mission." *One Laptop per Child*, 2007.

to targeted schools in the least developed countries," through arranging large purchases by national governments.[17]

As of 2015, Peru's government was one of the largest buyers of devices from One Laptop per Child. Even though laptops had been distributed in over fifty countries, one third of them, or 860,000 laptops, went to Peru.[18] But in order for these devices, or other computers used in education, to be useful, Peruvian schools needed internet connectivity. In particular, creative solutions would be needed for rural areas, to which extending reliable internet infrastructure was implausible. One possible part of the solution was especially promising: offline internet. In devices such as Internet in a Box (IIAB) and RachelPLUS, portions of the internet essential for learning – such as Wikipedia – were saved to a small hard drive. Laptops or tablets could then be connected to the device wirelessly or via cable, allowing a classroom to simultaneously a sizeable, if limited, web of their own. But were IIAB and RachelPlus plausible means of narrowing the digital divide in education? And if so, what was the best strategy to implement it?

SIPA Capstone: Background

In 2018, a group of students from Columbia University School of International and Public Affairs (SIPA) took on this research question through the SIPA capstone program, in which students spend a semester conducting desk research, carrying out fieldwork for a week, and then consulting with clients, in this case the Peruvian Ministry of Education (MINEDU).

But the story of the project began before 2018, with the work of Columbia SIPA professor and capstone team advisor Anne Nelson. In the 1980s, Nelson had reported on the civil wars in El Salvador and Guatemala, and she was interested to observe that poor civilians were remarkably isolated from information. In the mid-1990s, she began teaching human rights reporting at Columbia Journalism School, before moving to Columbia SIPA in the early 2000s. There, she felt that "just teaching writing courses wasn't addressing these monumental seismic shifts we were seeing in information and technology. So, [she] started the first course at SIPA on digital technology and information systems."[19]

In 2016, Nelson led a research project that brought together these two topics: information scarcity in the developing world and information technology. She led a team to Cuba, where government policy prevented most civilians from freely accessing the internet. Cuban doctors, however, had devised a simple yet clever system to share important medical information. Through "El Paquete" (the Packet), they would circulate flash drives with digital medical resources. Though this digital information environment was in many ways uniquely Cuban, the question arose: Could something like El Paquete be adopted in other contexts to help bridge the digital divide? Seeing that Cubans had adopted digital technology to

[17] "United Nations Agency to Back One Laptop per Child (OLPC) Project to Distribute $100 Laptops." *United Nations News Centre*, 2006.
[18] Beuermann et al., "One Laptop per Child at Home: Short-Term Impacts from a Randomized Experiment in Peru," p. 53. *American Economic Journal: Applied Economics*, Vol. 7, No. 2, 2015.
[19] Kyle Neary's interview with Anne Nelson on April 21, 2020, in New York City.

their needs in ways Silicon Valley had not anticipated, Nelson's team got the "idea is to look at user behavior before you bring the technology into the picture. It sounds obvious, but it has been surprisingly innovative."[20]

In 2017, Nelson led a team to conduct trials in Dominican Republic in which the team distributed Internet-in-a-Box devices with medical Wikipedia loaded on them. Initially, results were promising, with doctors, administrators, and government officials expressing excitement about the potential for the device to facilitate diagnosis with more up-to-date medical information.[21] But after the devices had been distributed to rural clinics, their doctors generally did not learn how to use them, instead preferring familiar resources such as textbooks. Additionally, the Spanish-language default for the devices proved a limitation in areas near the Haitian border, where many patients' first language was Haitian Creole.[22]

Though Nelson had hoped to return to Cuba and pilot medical IIAB, by 2018 it was too difficult for American researchers to work in the country. Fortunately, however, Peru's Ministry of Education had become interested in the potential of IIAB devices not for physicians, but for young students. In 2012, the Ministry had created the Office of Educational Services in Rural Areas with the goal of improving the quality of education in rural areas and closing the gap with urban schools.[23] The Wikimedia Foundation, with whom Nelson had worked since the early 2010s, also supported the project; the content of the IIAB devices, including the foundation's online encyclopedia, Wikipedia, is all open-source. A number of schools in other countries, including Haiti, Ghana, and Rwanda, had successfully integrated IIAB into their classrooms, but whether IIAB could be of help for a whole school system remained to be answered.[24]

Fieldwork in Peru

In order to understand how IIAB might be used in remote schools, the capstone team had to consider the unique structure of Peru's rural education system, in which most schools are one of three types. *Residencias*, yearlong boarding schools, were most common in the rainforest because of the distance from students' homes: In the case of some schools the team visited, it would "take up to five days to actually get to the school walking," recalls Kathryn Uhl, a student on the team.[25] In *Centros Rurales de Formación en Alternancia* (CRFAs), secondary students would alternate between fifteen-day periods spent in school and at home. In *multigrados*, about 92% of rural primary schools, classes comprise students from various grades.

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[20] Adam Stepan's interview with Anne Nelson on February 28, 2018, at Columbia University SIPA, New York City.

[21] "Wikipedia Project For Offline Education in Medicine." Columbia University School of International and Public Affairs, 2017.

[22] Kyle Neary's interview with Anne Nelson on April 21, 2020, in New York City.

[23] Jorge Galvan, Megan Germain, Sriranjini Kozhissery, Justine Lavoye, and Kathryn Uhl. "Closing the Gap with Educational Resources," p. 5. Peruvian Ministry of Education, 2018.

[24] "Internet-in-a-box." *Engineering for Change Solutions Library*, 2019.

[25] Adam Stepan's interview with Kathryn Uhl on April 25, 2018, at Columbia University SIPA, New York City. All further quotes from Uhl, unless otherwise attributed, are from this interview.

After several weeks of desk research, the capstone team flew into Lima, Peru's capital. On their first day in the country, they discussed strategy and research priorities with members of the Ministry of Education, including technology and rural education specialists. The devices were a particularly timely opportunity as the Ministry was in the midst of implementing a national curriculum.[26] The Ministry explained how impracticable implementing this policy would be traditionally; delivering textbooks could be prohibitively expensive due to both the need to replace degraded or antiquated textbooks and remote schools' inaccessibility. In fact, when travelling to the most remote sites, Megan Germain, one of the capstone members, recalls, the "schools were located in really rural areas that you couldn't get to by road, so we had to hop in … canoes with essentially a weed whacker on the back."[27] In addition to the potential cost cuts from delivering fewer physical materials, IIAB and RachelPlus had the advantage of being wireless. Not only could computers connect without wires, but the device itself could run off battery. This was important for areas poorly integrated into the electrical grid, whose classrooms were not connected.

On day two, three capstone team members travelled to Cusco, the historical seat of the Inca empire nested in the central highlands around the Andes mountains. One of Peru's largest cities outside the coastal western region, it is an indigenous cultural hub, half of whose residents' primary language is the native Quechua.[28] Interviewing instructors and administrators at a Quechua-language school near Cusco, the team learned that educators were excited by the prospect of Spanish and Quechua Wikipedia in the classroom. But Jorge Galvan, a capstone member with experience in Mexico's Secretariat of Public Education, recalls, "We knew that technology by itself wasn't supposed to solve all the problems of the Peruvian education system. People were familiar with technologies, but they didn't know how to use them and they didn't know how to apply them to education."[29]

Meanwhile, the other two team members travelled to the Peruvian Amazon to visit some of the most remote schools. Visiting schools in the Cajamarca and Amazonas, two of Peru's northernmost regions, they found some of the most striking examples of poorly implemented attempts at improving educational access via technology. As Kathryn Uhl recalls, "[T]here would be a lab with 20 or 30 computers, but some of them wouldn't turn on, or they were older. And we had some challenges with connecting to the [IIAB or RachelPlus] device, just because potentially they don't have the capability to connect to wireless devices." In the last schools, they found "boxes and boxes" of unused XO laptops, provided by the government through One Laptop per Child. While some of these devices were still functional and could even be used with offline internet libraries, no one had ensured instructors were shown the technicalities

[26] Adam Stepan's interview with Justine Lavoye on February 28, 2018, at Columbia University SIPA, New York City. All further quotes from Lavoye, unless otherwise attributed, are from this interview.
[27] Adam Stepan's interview with Megan Germaine on April 25, 2018, at Columbia University SIPA, New York City. All further quotes from Germaine, unless otherwise attributed, are from this interview.
[28] Mark Schneider. "Quechua Language Use And Attitudes In Cusco, Peru," p. 1. Cornell University Library eCommons, 2019.
[29] Adam Stepan's interview with Jorge Galvan on April 23, 2018, at Columbia University SIPA, New York City. All further quotes from Galvan, unless otherwise attributed, are from this interview.

of using them and the best practices for integrating them into the classroom. As a result, though some schools with XO's improved students' logical reasoning and cognitive abilities, the government's rollout of the laptops in rural Peru did not cause long-term gains in math scores, language scores, or school enrollment.[30]

Initial Findings and Recommendations

In the shadow of a mostly unsuccessful effort such as One Laptop per Child in Peru, many educational professionals had reasonable doubts about the efficacy of a large-scale IIAB rollout. One technical specialist for the Ministry of Education's regional offices in Cusco noted, "The project sounds great but I am nervous it will be just another technology project that is implemented by the Ministry and left unused."[31] Finding out how to avoid the pitfalls of similar previous initiatives was thus a priority for the capstone team.

The research team discussed how to introduce IIAB in Peru with 43 Ministry of Education specialists, 85 teachers, and 42 students across seven schools. Interviewees noted the need for content that could be integrated with mixed national and local curriculum; for example, material for a standard Ministry of Education curriculum might be supplemented with guides for Andean agricultural stapes, such as *cuy* (guinea pigs). In addition to the favorability of preloading devices with content in indigenous languages, such as Quechua and Aymara, where applicable, training teachers to add customized material would incentivize them to take fuller advantage of IIAB or RachelPlus.

More generally, training teachers how to use these devices in the classroom was essential. In previous initiatives such as OLPC, not only had teachers often never been shown how to integrate the technology in the first place, but the program failed to provide sustained technical and pedagogical support in later stages. Schools had the various degrees of internet connectivity in Peru; for example, some teachers would go to local internet cafes if in need of online materials, while others lacked even that resource. Therefore, the Ministry of Education would need to formulate various ways to provide updated content for the IIAB devices.

When considering the contextual needs of different schools, the capstone team found not only that IIAB content would need flexibility, but that in some cases IIAB or RachelPlus would not be the right technology solution at all. For example, in Cusco, SIPA students found that one school with XO devices also had a functional internet connection, but instructors did not know how to start the router and connect to it. Evidently, fixing some connectivity shortcomings could be achieved without new hardware.

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[30] Julian Cristia, Pablo Ibarrarán, Santiago Cueto, Ana Santiago and Eugenio Severín. "Technology and Child Development: Evidence from the One Laptop per Child Program," pp. 295-297. *American Economic Journal: Applied Economics*, Vol. 9, No. 3, 2017.

[31] "Closing the Gap with Educational Resources," p. 14.

But for schools that would benefit from offline internet devices, the capstone team found from its desk and field research that IIAB would be a feasible tool for widespread integration. At $100-$150 per device, each of which can serve up to 20-30 students, it is highly affordable to government.[32] RachelPlus, though more expensive at $400, can connect to 50 devices at a time; it also holds 500 GB of data, whereas IIAB holds 128 GB, as of 2018.[33]

Additionally, the compatibility of OLPC devices and some desktops in computer labs with IIAB meant that many schools would not need additional computers to make use of IIAB. Similarly, schools unable to acquire desktops or laptops could consider using IIAB with mobile devices like smartphones, though such devices are by no means ubiquitous either.

In addition to technical issues, IIAB or RachelPlus integration would require systematic training of teachers. Instructors would have to learn how to use, fix, update, and teach with these offline digital libraries – a feat that necessitating guidance from educational authorities. Ensuring instructors remain engaged with technology had proven difficult with projects like OLPC, but the capstone team noted the impact of what Nelson terms "evangelists": early adopters and promoters of technology. As few as one teacher per school with technological expertise and curiosity could not only support the use of IIAB or RachelPlus among instructors, but also liaise with the Ministry of Education.

Piloting IIAB in Peru

Since the capstone team members were limited to a week in the field, they acknowledged they could not fully address the many factors in a successful potential IIAB rollout in Peru. The capstone team stressed the need for further research to survey need, determine best practices, and assess feasibility in more types of schools. The research team suggested that data from trials of the devices be collected to measure effects on learning indicators like test scores and graduation rates. Fortunately, one SIPA student was able to do a feasibility study by visiting previously unselected schools to demo five IIAB devices.

In summer 2018, the Peruvian Ministry of Education invited back SIPA to further study the practicability of implementing IIAB in rural Peru. This time, with continued support from the Wikimedia Foundation, Harold Cárdenas Lema travelled to schools to demo IIAB devices loaded with Spanish and Quechua content from Wikipedia, Khan Academy, and more. Nelson, the capstone team's faculty leader, had met Cárdenas in 2016 while conducting research in Cuba, where he worked as a blogger and former philosophy professor. By 2018, Cárdenas was a student at Columbia SIPA and remained interested in IIAB.

He recalled his experience showing students to use laptops with IIAB: "It was impressive to see these students. They're teenagers and they were looking at Wikipedia for the first time in their lives. And it's

[32] *Ibid*., p. 6.
[33] *Ibid*., p. 7.

impressive to see the eyes of the student that discovers something like internet, even if it's offline."[34] Cárdenas further that it was not just the IIAB devices themselves which made OLPC laptops newly relevant in the classrooms he visited. Rather, students were engaged by material both in their own languages and pertaining to their own culture, including art and war history. Students were especially responsive to video content, which was most novel to them.

Conclusion

While early findings, from both the capstone team's research and Cárdenas' follow-up fieldwork, were positive, scaling the program remained a work in progress. Due to the mixed mountainous and rainforest terrain of rural Peru, building out wired internet infrastructure was uniquely difficult. Even as mobile phones reached 69% of the rural population in 2019, the most remote areas remained inaccessible to cell signals.[35] Nor did mobile phone penetrance translate to adopting online learning in classrooms. Offline digital libraries like IIAB and RachelPlus thus held great promise as an interim solution to the digital divide in Peruvian education.

But to avoid the mistakes of previous technological initiatives in education, the material in such digital libraries would have to be adopted to each school's local and national context. Educators also observed that more interactive content would be an important supplement to reading material and video, in order to keep students engaged. To that end, IIAB and RachelPlus had one significant advantage over the traditional use of internet in education, as Nelson observes: "It's as a closed environment. There's no surfing. There's no Facebook. It's all educational content."[36]

That said, the decisive disadvantages of IIAB or RachelPlus would have to be addressed for the devices to have their intended effect in the classroom. Would the Peruvian Ministry of Education or nonprofits be willing to provide the necessary support for updates and repairs, in addition to the initial purchases? Would training and guidance be offered, to avoid the One Laptop per Child's pitfalls? Would content be catered to students in their languages of choice? And since many OLPC devices had fallen into disrepair, could schools procure the laptops or tablets need to use with IIAB?

Clearly, implementation of Internet in a Box and RachelPlus would take a great deal of effort and resources to succeed. But the problem of educational inequality was commensurately significant. As Nelson stated, "With each child, you only have one chance at that educational moment, and you seize it

[34] Adam Stepan's interview with Harold Cárdenas Lema on October 9, 2018, at Columbia University SIPA, New York City. All further quotes from Germaine, unless otherwise attributed, are from this interview.
[35] "82% of Peruvians use internet via mobile phone." *Andina*, 2019.
[36] Kyle Neary's interview with Anne Nelson on April 21, 2020.

now. Whatever you invest in their education is going to pay off for the rest of their lives, and for their families and their communities."[37]

As of 2020, the Ministry of Education had not yet rolled out offline digital libraries in rural Peru on a large scale. But if it does so, its lessons may apply widely. In other countries, from Uruguay to Rwanda, collective hundreds of thousands of IIAB-compatible OLPC devices remained underused.[38, 39] And in developing countries in particular, the rural/urban digital divide in education is even more ubiquitous. While history has made it clear that technology cannot cure all educational ills, offline digital libraries could be an important part of closing the gap.

[37] Adam Stepan's interview with Anne Nelson on October 9, 2018, at Columbia University SIPA, New York City.
[38] Gioia de Melo, Alina Machado, Alfonso Miranda, and Magdalena Viera. "Profundizando en los efectos del Plan Ceibal," p. 19. Universidad de la Republica Uruguay, 2013.
[39] Geoffrey B. Saxe and Kenton de Kirby. "Analyzing the Evolution of a Digital Technology Intervention: One Laptop Per Child in a Remote Papua New Guinea Community," p. 397. *Anthropology & Education Quarterly*, *49*(4), 2018.

ANNEX A: Original Documents

Annex A-1: Topographical map of Peru

Annex A-2: Map of SIPA Capstone Sites

Annex A-3: Example of an IIAB device

Annex A-4: Image of a One Laptop per Child Computer

Annex A-5: World Map of XO Laptop Distribution

Annex A-1

Topographical map of Peru. As can be seen, the country roughly divides into three areas: coastal in the West, mountainous in the central regions, and rainforest in the East. The costal regions are most densely populated and enjoy better internet connectivity. Available from Mapsland here.

Annex A-2

Map of Columbia SIPA capstone team's fieldwork locations. The northern cluster is in areas of Amazonas and Cajamarca comprising mostly rainforest, and the southern cluster is in the mountainous areas of Cusco region. Available from the original case report.

Annex A-3

An example of an Internet-in-a-Box device. In this case, a medical digital library is loaded onto a Raspberry Pi – a type of cheap, single-board computer. Photo available from Internet in a box here.

Annex A-4

The XO Laptop, the most popular model produced by One Laptop per Child. The pivot and touchscreen monitor allows for it to be converted between a laptop and tablet. Image available from One Laptop per Child here.

Annex A-5

Map of the global prevalence of XO Laptops, the most common model from One Laptop per Child. As some critics have observed, the nonprofit has not reached some of the neediest populations since their respective governments are less likely to be able to invest in the devices. Available from Wikimedia Commons here.