Research Article

Institutional Barriers to Development Innovation: Assessing the Implementation of XO-1 Computers in Two Peri-Urban Schools in Peru

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Abstract

We analyze the implementation of One Laptop per Child's (OLPC's) XO-1 computer at two primary schools on the outskirts of Lima, Peru. Using a socio-technological approach, we identify the institutional and human barriers to the success of this initiative in these two case studies. As a device incorporated into a sociotechnological system, the XO-1 computer was in direct conflict with the schools' institutional arrangements and, more generally, Peru's educational system. The role of specific agents, particularly principals and teachers, conflicted with the interest, or lack thereof, that students showed for the computer. Meanwhile, the device did not conform to expectations based on previous experience with computers at commercial public access centers. We consider the hands-off approach advocated by the promoters of OLPC deployment and recommend revisions.

As one of the biggest possible investments a nation may incur, education has received significant attention from technologists who feel compelled by concurrent perceptions of a need to update antiquated systems to meet the needs of a new economy, and of computers as technologies of freedom, to paraphrase Ithiel de Sola Pool. In recent years, the One Laptop per Child (OLPC) initiative has made front-page news with its combination of free software, child-oriented design, and the tinge of technological sophistication lent by the initiative's association with MIT, as well as the variety of expectations about the demands computers place on people and the achievements they help realize.

Few countries have adopted the XO-1 computers the OLPC Foundation designed and marketed as a wholesale solution to education's woes (OLPC, 2009). According to the foundation's website, some 1,841,573 laptops have been distributed in 42 countries, with Cameroon receiving only 100, and Peru having the most, some 900,000 units. While Peru may be the largest buyer, Uruguay is the only country achieving one-to-one distribution—that is, one laptop for each schoolchild (Warschauer & Ames, 2010, p. 36). These two middle-income countries with small rural populations are not the kind of country OLPC originally envisaged as the ideal place to transform education with computers. Notably, Peru and Uruguay differ considerably in income levels, as well as in educational achievement: Uruguay has an adult literacy rate of 97.9%, while Peru's is 88% (UNESCO, 2012).

The XO-1 computers—rugged plastic machines with free and open software designed or adapted for learning activities—are, in effect, a complete technological system, tools intended to be not only used by children, but also tinkered with, modified, and even repaired if needed. The apparent ethos promotes a hacker-style approach to using them (Villanueva, 2011), which means that the children are expected to use them both in a school/learning context and beyond the classroom, in their homes and elsewhere, and to appropriate the computers to change their learning style, as well as content, software, and hardware, creating their own learning processes and innovating beyond the classroom.

OLPC's educational approach is based on this small computer explicitly designed for the goals of the initiative. As its website states, "By giving children their very own connected XO laptop, we are giving them a window to the outside world, access to vast amounts of information, a way to connect with each other, and a springboard into their future" (OLPC, 2009). Thus, OLPC tries to achieve learning by allowing schoolchildren to access information through a device that will help them to develop themselves, on their own terms.

Aside from the grandiosity of such a statement, the logistics and investment associated with the XO-1 are large enough to give one pause. Beyond the pilot phase, a commitment to using these machines places significant demands on a country's bureaucracy. Meanwhile, the computers themselves have not had a "production-level" quality of build, nor has the software worked as promised from the start (Derndorfer, 2010). Roughly speaking, the OLPC initiative has not succeeded in achieving a fully working computer or convincing many governments, donor agencies, or even philanthropists to invest in buying and distributing it.

The Peruvian experience, however, offers a number of lessons for discussion. This article does not focus on the actual workings of the computer, but rather, on the implementation of the XO-1 system, taking two primary schools on the periphery of Lima, (Peru's capital city) as examples of the initiative's developmental shortcomings, and as a demonstration of the difference between an individual process, such as learning, and a societal institution, such as an educational system. This article does not attempt to establish the success or failure of OLPC's Peruvian deployment. Its aim is, instead, to explore how a specific set of students and teachers perceived the capabilities and functions of these computers, and how the daily use of the OLPC computers changed, or did not change, their understandings of the role of computers in education and daily life.

Local Context: OLPC in Peru

Peru's General Education Act of 2003, Ley N° 28044 (CNE, 2010), organizes the pre-university educational system in three stages: initial (preschool), primary, and secondary (middle and high schools combined). There are also modalities, including regular basic education (in schools), special education programs, and distance education. Peru's public expenditure on education has grown significantly in the last decade. Official Peruvian sources report a jump of S/.9 billion (approximately US$3.5 billion) between 2007 and 2009, even though enrollment has diminished. However, school desertion rates have also declined, dropping from 22% to 15% between 2005 and 2010 (MINEDU–Perú, 2011).

Attesting to the deficits in Peru's educational system are the Programme for International Student Assessment (PISA) 2001 exam results: Peru's scores were among the lowest worldwide, and second to last in the Americas (Trahtemberg, 2010). PISA results for 2009, the only year that Peru has participated since 2001, were still comparatively poor (ibid.); Peru remains one of the lowest-scoring countries in the region.

Peru's government expressed its interest in using OLPC's XO-1 computers in May 2007, committing the country to acquiring the machines without a public procurement process or any support outside the Ministry of Education, except for a number of computing businesspeople connected professionally with Universidad San Martín de Porres, the private tertiary education institution where the minister of education and most of the politicians in that sector studied.

A number of previous initiatives created content that could, in some cases, be used for XO-1 school deployments. These included the creation of the National Institute for Teleducation in the 1970s; the establishment of a computer-oriented distance-learning office specifically tasked with increasing

access to quality education; and the launching of Plan Huascarán, a more conventional initiative undertaken during Alejandro Toledo's presidency. Plan Huascarán used computer labs in high schools as a way to generate "democratic, knowledge societies" and bridge the digital divide among Peruvians and between Peru and the developed world (Trinidad, 2005, pp. 29–30). However, the decision not to bring Internet connectivity to the schools that would be getting the computers meant that content had to be distributed offline, which posed logistical challenges. The Ministry of Education drafted a set of XO-1 manuals for inclusion in every delivery and also made them available on its website. These manuals were to be the basis for training (Derndorfer, 2010).

In Peru, the Ministry of Education oversees the use of XO-1 computers through the Dirección General de Tecnologías Educativas (DIGETE) and defines the project as the Programa Una Laptop por Niño (POLPC). The stated goals of the program in Peru are:

- Main goal: improve the quality of public primary education, especially for remote students in extreme poverty, with priority on multigrade, one-teacher schools.
- Specific goals:
  - To generate educational management capabilities in the teaching institutions for access to ICT;
  - To develop students' capacities, capabilities, and skills, as established in the curricula for primary education, by using the portable computers as an instructional appliance; and
  - To train schoolteachers in the instructional use (appropriation, curriculum integration, methodological strategies, and production of teaching materials) of the portable computers to improve the quality of teaching and learning. (POLPC, 2010; translated by the authors)

Public pronouncements from the higher echelon of government about POLPC have been limited and generally lack specifics. It is arguable that the benefits of using computers were accepted prima facie, without much discussion of the program's actual goals and expectations in relation to education. Seen as beacons of modernity, computers in the classroom were presented as a win-win proposition, and criticisms dismissed as mere misunderstanding of this particular machine's potential to change education.

The marvel of this machine, designed as a tool for learning, is that you may support higher-quality education from the same platform without pressure: There are no plans to demand a specific number of teaching hours, as it is based on free usage, stimulating creativity (Becerra, 2010).

This line of thought connects to an approach, pervasive in Peru in recent years, that posits personal achievement as the solution to a number of societal ills, including poor education: "Oftentimes, it's seen from a very optimistic perspective, since technology is understood by itself as a solution for the chronic ills of Peru's education" (Trinidad, 2005, p. 22). The actual effects of introducing computers into classrooms have been little discussed. Officials who regarded training as a function of the computers demanded that teachers learn how to use them, rather than focusing on how to deal with the new approaches to learning and dissemination of information that were supposed to become the norm once the XO-1 was generalized as a teaching tool.

After a pilot project began in 2007 in Arahuay—a settlement in the Andes about 126 km from Lima and about 2,300 meters (approximately 7,500 feet) above sea level—laptops were delivered to children in rural schools as of 2008. Starting in July 2010, the strategy shifted from a one-to-one distribution model to a lab-based approach, with computers sent to Technological Resources Centers (TRCs) at selected schools. The number of schoolchildren participating in the program and the number of delivered computers thus increased at different rates. In many cases, actual decisions on use are left to the teachers, who have to incorporate the laptops into their curricular activities.

So far, published information on the number of deployed computers is confusing. Estimates by the World Bank and the Inter-American Development Bank differ from those published on the Ministry of Education website. The deployment procedure was established as a basic set of guidelines focusing mostly on technical aspects, since:

> The program delivers a portable computer to each student and each teacher . . . to be used inside

> and outside school, following their own interests and possibilities. Teachers will be trained at an entry level and will get a user's manual. The computers include educational software and a set of digital books, and they have the capability to connect to the Internet wherever a wireless setup is available and to set up a mesh network among similar computers. (Santiago et al., 2010, p. 2; translation by the authors)

In the absence of specific numbers, follow-up on deliveries, or detailed assessment of the procedures adopted at each site, broad conclusions on the managerial side of the program are necessarily imprecise. Evaluation of educational impacts is also sketchy, as no baseline was established prior to the deployment. Thus, any attempt at analysis is limited in scope. On numerous occasions, commentators and consultants in the Peruvian press have expressed harsh criticism regarding the ministry's lack of clarity. By April 2012, a more precise inventory had been conducted (relevant figures are available at http://www.perueduca.edu.pe/olpc/OLPC_Dist.html).

OLPC as a Sociotechnical System and the Peruvian Educational System

A computer like the XO-1 does not appear out of the blue, but rather, it is born out of a set of expectations of its impact and commercial viability. Management practices are incorporated into the design of the XO-1. Since its first public appearance, the grandeur of the intent behind OLPC has been evident: Its promoter, Nicholas Negroponte, chose the World Economic Forum in Davos, Switzerland, to introduce the project to world leaders, a nontechnical, non-education-related audience that accorded it immediate acceptance and approval. But the OLPC prototype, though attention-grabbing at one of the world's largest meetings of elite decision makers, was not offered to educators, or even to computer hackers. It was instead presented as a fait accompli—not in technical terms, but as an inevitable end result, as "the computer that will change education forever"—notwithstanding educators' opinions on how to use computers in the classroom, or development experts' recommendations on using resources to enhance the quality of life in the target countries.

The OLPC computer was designed around a number of premises: It would be durable, very sturdy, energy-efficient, and sized for children, and it would use open, free software to allow the lowest possible cost and engage the open software community. OLPC also expected governments to buy at least a million laptops each, achieving saturation and forcing the use of the computer across countries. The combination of ruggedness, simplicity, free software, and large-scale orders would allow makers to offer it at a low price, originally pegged as US$100—although, even in bulk, the XO-1 costs Peru around US$180 apiece at current estimates. In 2008, Peru bought a first batch of 40,000 XO-1 computers, which were deployed to 500 schools. Multigrade schools (comprising about 73% of Peru's educational facilities) received most of them, although official data are unavailable, owing to less-than-precise accounting by ministry officials. By the end of 2009, around 200,000 more XO-1 units had been delivered all around the country.

Although technical performance expectations were not met, the action of delivering the computers configured the XO-1 as what Bijker and Pinch (1987) call a sociotechnical system, where the devices are a physical manifestation of, first, associated processes that allow individuals to manipulate data, and second, large systems arranged around the techniques and skills, as well as the goals and outcomes expected from the use of such devices. Following the basic model of a sociotechnical system, these devices are only the first layer of a set of social and technical products that not only cultivate the specific practices involved in use and management of the devices, but also set societal expectations, goals, and procedures for the future—and doing so while taking account of those that are already in place, some of which have to be changed, or at least challenged, for the new device to be successful. Success is defined in terms of the sociotechnical system itself, but also in terms of the system's ability to displace current practices and redefine goals unrelated to the new device.

As a sociotechnical system, OLPC designed itself as a top-down solution with grassroots support, which sounds contradictory until it is noted that the grassroots involvement was limited to specific, computer-related roles and negated the participation of schoolteachers and of the educational system in general. Riding on a vague expectation of computers' suitability as a solution in almost any circumstance, OLPC created a discourse of empowerment

that, while accepted by some decision makers and the general public, was received warily by many in the education trenches. This pattern fits McKenzie's (1990) certainty trough, in which those in charge of the projects have much higher expectations than the people actually working with the technology, while decision makers usually adopt the project leaders' point of view, ignoring caveats being offered up from the trenches.

Exemplifying this trough, the expectations of the XO-1's hardware performance were based on the best possible results of projected innovations: Software was to be the result of collective action by developers, students, and perhaps teachers and school staff; once deployed, the devices would not present significant issues with performance or maintenance; and students would appropriate the computers, breaking dependence on teachers and allowing learning to be self-configured.

Apart from the disproportionate expectations, the main conflict between OLPC and educational systems is derived from the assumption that the program will have a disruptive effect in terms of the role of teachers, and that this disruption will be positive (Leaning, 2010). Of course, any innovation has the potential for disruption, but the introduction of a sociotechnical system into an institutional arrangement as wide, old, and entrenched as a national educational system entails a number of possible outcomes, including the possibility of failure. As Cutts (1991) stated, any failure in an innovation process costs money, time, and resources, but a failure that is identified in the planning stages is less expensive to deal with. Since there was no planning for Peru's OLPC program, the hurdles arising from the clash of two very different systems had to be cleared once the computers were in place, and the cost of fixing the problems was significant.

Quoting Toyama (2011):

> Computers are no exception, and rigorous studies show that it is incredibly difficult to have positive educational impact with computers. Technology at best only amplifies the pedagogical capacity of educational systems; it can make good schools better, but it makes bad schools worse. (2011, para. 3)

That is, any computer only amplifies the intent and capabilities already in place, and its potential for achieving results depends on timely attention to both intent and capabilities. To bring together intent and capabilities in the specific case of Peru's educational system, the introduction of a full computer system into the main classroom required adapting not just content, but also practices and the roles of specific agents. Meanwhile, at all levels of the educational system, concerns arose about dedicating resources to this program at a time of low achievement in an educational system already suffering from insufficient investment (e.g., Ames, 2004; Trahtemberg, 2012; Trinidad, 2005).

OLPC's conflict with both intent and capabilities is clear: The intent of the educational system is to guarantee baseline educational capabilities for all who attend school, and to integrate children into society as citizens. Education is something more complex than learning, and educational achievement, as expressed in multiple tests applied worldwide, is a method of defining collective achievement. The educational system requires that the capabilities should work toward the collective goal—that is, the capabilities developed are those that can be aggregated and measured as collective results.

On the other hand, OLPC can be seen as an empowerment tool by which individual children redefine their learning processes. In this view, the intent is individual, and the achievement is one of learning only, without consideration of the societal benefits of either integration of citizens or baseline-defined achievement. Those with capabilities, latent or already developed, that align with either self-conducted learning or the general "hacker attitude" of tinkering and exploring the workings of a digital system are rewarded by design; those who do not have this set of capabilities are left to adapt.

However, realizing even the alleged individual-centered intent of the XO-1 computers requires consideration of the reality of using them in the classroom—a classroom managed by teachers and administrators working in and for an educational system. Educational systems are old and large, with well-defined missions, though they may lack the tools or people needed to reach the goals. Specifically, an educational system has to perform according to its own rules and established measures of performance, in its own country as well as internationally, and it has to produce a certain end result: citizens who are ready for further education or the job market. The test-drafting process does not nec-

essarily take individual learning styles or goals into account, but rather, it adheres to the guidelines of the national curricula and national goals, as defined by faraway experts. Furthermore, not even OLPC has come up with a strategy that actually changes instruction beyond the classroom practices—it has only changed the style and amount of potentially useful information available (Weston & Bain, 2010).

Thus, OLPC tries to infiltrate systems that are not designed for the kind of almost unmeasurable achievement the program aims to provide, setting up a conflict not only of intent or capabilities, but of purpose—as explicitly proposed by Nicholas Negroponte, who said that OLPC was trying to end education as we know it. Nonetheless, the facts remain that educational systems are the place where OLPC computers are implanted, and that families, communities, and governments aim for more than individual learning when they invest in education.

To attain harmony, a strategy of alignment must be in place to enable each of the two systems to achieve its own goals without blocking the other. The OLPC system should design strategies to satisfy the goals and needs of the educational system, while teachers should leave time for exploration and self-learning. An alternate strategy is to change the educational system wholesale through a political decision, removing the system-imposed demands that cannot or will not be satisfied by the XO-1 computers.

Case Studies: Peri-Urban Schools and the XO-1

Cieneguilla, a district on the outskirts of Lima, was the main focus of fieldwork for this study. Two primary schools that received XO-1 were analyzed: School 0101 (the school names included here are pseudonyms) has received enough computers for all its students since 2009; School 0102 got enough laptops to set up a TRC by mid-2010.

Situated on Lima's periphery, these schools are not so far from the capital as to match the level of autonomy, in terms of curricula and schedules, exercised by some more remote schools. However, they are far enough from areas of high population density to share characteristics with rural schools. While their respective principals make day-to-day decisions, management of the system—including decisions over how to allocate financial, material, and human resources—is the responsibility of Unidades de Gestión Educativa Rural (UGEL, a community educational management office) 06. This UGEL has a large, poor to middle-income urban population spread across six districts ranging in size from more than 1 million inhabitants in San Juan de Lurigancho to fewer than 39,000 in Cieneguilla (INEI, 2012).

These two schools were selected because they were not the specific kind of schools that the program was originally meant for, as they are peri-urban instead of rural, thus implying a different set of students compared to those normally found in rural schools in the Andean region. The main difference between the students is the availability of connectivity in the form of Internet commercial public access centers (CPACs) which brings awareness of the potential of computers and the Internet for individual usage. This previous experience brings the opportunity of assessing the potential for education and other uses of the XO-1 laptops for a group of children with an already-established understanding of how computers work and what they are for. In Cieneguilla, as it is a part of Lima, access is easier, while the rural nature of this suburb did make it different enough from the capital city as to provide a very specific setting—to the point that the schools were included in the OLPC plan, as they have conditions comparable to those in actual rural settings. As they were the two schools with XO-1 computers in the district, it was considered relevant to observe them both.

In November and early December 2010, all grades at both schools were observed, and afterward a set of students was interviewed, all with the authorization of the principals and teachers involved. Loose, semi-structured interviews were used, conducted after actual observation of usage in classrooms and during recess. Eight observations in different grades were conducted at School 0101, followed by five collective interviews with students, two with the teacher in charge of computing classes, and one with the principal. At School 0102, six observations were carried out in different grades, followed by eight collective interviews with students, two with the sixth-grade teachers, and one with the principal. In all cases, but especially with the students, the preferred approach was to let the conversation flow instead of sticking to detailed questioning. Only with the teachers in charge, a follow-up interview was conducted, with the express

intention to clarify their perception of the role they were asked to play, as well as to ask what they thought about both the role and their individual performance.

School 0101

One-to-one computing was possible at School 0101, since the 63 laptops that arrived in July 2009 were enough for the entire student body, comprising 58 students. The extra laptops remained at school for safekeeping. Although, in principle, each student had access to a laptop, in actuality, the principal asked all students to return the devices for safekeeping at the end of school day and kept the computers locked in a secure room when they were not being used for specific activities during classes.

Work with the laptop was limited to computing sessions, continuing a course that, before the arrival of the XO-1 units, had consisted of the teacher using the computer while the students took notes on the projected images and the teacher's explanations. When the laptops arrived, the teacher in charge attended some training sessions with an officer from the ministry and applied what he had learned to his class. The principal and a sixth-grade teacher were trained as well, although the principal had no direct contact with students during classes, and the other trained teacher left the school shortly thereafter. No further training or in-house training took place, nor did the ministry require it.

Though the computing course was part of the official curriculum, the principal had no information about its content. All groups used the laptops only during that course, though some were permitted to take the computer home as a reward for achievement or good behavior. As there was no Internet connection, the school planned to request connectivity and incorporate its use in all classes: "We don't have Internet here in our institution; I'm about to request it, anyway," 0101's principal said. Nonetheless, the final decision on providing Internet connectivity rests with the ministry.

The teacher in charge attached great importance to using computers, although he believed that the XO-1 was suited only to the earlier grades, and that older students (11- to 12-year-olds) should use the same Windows-based equipment they would encounter and use later on. This teacher evidently thought that, while learning to use the computers was a goal in itself, using them in the regular, non-computing-oriented classes was a hindrance, since it would require instructors to teach computer use and the course material simultaneously. As he stated:

> The best thing about this school is that I'm the one in charge of computing, while other schools don't have such a person. In other schools, the same teachers are in charge of regular classes and also have to teach computing. They cannot cope with all the demand, and classes become quite unruly. They cannot deal with this. Perhaps that's why they don't care much about it. They don't pay much attention. If there is a teacher dedicated exclusively to computing, well, the kids will be more interested, because the teacher is dedicated to this and will show them new stuff, stuff they wouldn't believe, virtual games. They are going to be more interested. (0101 teacher in charge of XO-1 use; translation by the authors)

Even with a computer for each student to use, neither the principal nor the rest of the teaching staff tried to use the laptops for any activity besides the computing course. They explained this lack of initiative as a cautious approach in view of the potential for damage, classroom disorder, or students' lack of attention.

Students at School 0101 were used to playing games and loading music on the computers, and they did so freely. When allowed to take the computers home, they used the mesh network to chat while they exchanged music and games using thumb drives.

School 0102

School 0102 is larger than 0101, but as of mid-2010, only 45 laptops were available to its 215 students. Computer use went by a schedule allotting 2 hours, 45 minutes per week to each student, with every student having a set number of hours during the same set of courses. The principal believed that more flexibility could be incorporated into the schedule; however, while math and geography courses were expected to make use of the laptops, there were no plans to do specific work with the computers during other courses, as most of the time, students preferred to use them to entertain themselves, playing randomly and in groups. The following field notes provide an example of the kind of activities the students engaged in:

> 12:00. Sara plays by herself; Mario listens to music. Loyda doesn't do anything, she's bored, checks out how much battery is left. Jorge records himself making faces and singing Gorillaz's songs (he wants to see himself in the computer). Alex uses two computers on the next table. Teacher Saul edits audio tracks with Adobe Audition.

Although sixth-grade students and teachers alike commented that the computers were used for classroom work in language and math courses, we noted little actual educational use during the observation period, when they were mostly used for gaming. Battery performance was very poor, a limiting factor. Though there was no computing course, their actual use was mostly understood as an end in itself. Most of the students and all the teachers stated that they knew how to use the computers, although actual use was minimal.

Neither the teachers nor the principal had received specific information about the changes in distribution of the computers, nor had a rationale been provided for the switch from the one-to-one model to the TCR approach. The principal and the PTA had agreed to finance—through local fundraising—construction of a lab room for the computers, since the current use of the laptops was severely hindered by the lack of electrical outlets or proper workspaces.

Training was limited to one teacher and the principal. All of the teachers were invited to participate, but all but one declined because they had previous commitments that the inflexible training schedule could not accommodate. Some did commit to do in-house training conducted by the principal himself, though this was done without any specific materials for the courses.

Notably, the results in these two cases regarding students' computer use and teacher training are consistent with the findings of a previous study by the Inter-American Development Bank (Santiago et al., 2010, p. 10), in which classes were observed for qualitative evaluation. The laptops saw regular use, ranging from two or three times per week to daily, but in most cases, their use did not substantially change practices. Additionally, the aforementioned report noted a tendency among students to transcribe texts from notebooks or chalkboards to their laptops to edit them later. Another study found that "only 10.5 percent of the teachers reported having received technical support, and 7.0 percent reported having received pedagogical support for the implementation of the program at their schools" (Warschauer & Ames, 2010). As the principal at School 0102 stated, "Right now, they are doing things by themselves, because further ahead, they should take some training courses, that's a given, they've already understood that."

Expectations Regarding "Real World" Computers

The follow-up interviews indicated that most of the students considered the XO-1 computer a stopgap device to acquaint them with computers until they had the chance to learn and use a "real" computer, such as those they had seen at the CPACs in town. As one sixth-grade girl said, "In any job, at any workplace, you are going to use a computer, and you have to know and to study its use." This notwithstanding, most students considered the XO-1 an incomplete tool for certain courses, like math; in one instance, they mentioned that it provided no information on prime numbers.

The field interviews showed that principals, teachers, and students perceived the presence of the XO-1 units in the school environment as positive, though the lack of training was a significant barrier. Students thought the XO-1 should be a first step toward using traditional computers, such as those available at cybercafés/cabinas. From this angle, XO-1s are seen as incomplete, because they "lack" the applications, like chat or Internet access, that most students are familiar with from the CPAC. Various technical difficulties—a faulty touchpad, apparent slowness, washed-out colors—compound this impression, so that students perceive the XO-1 as being inferior to "real" computers.

Meanwhile, the students' discussion of the computers revealed different broad narratives common to both schools. For School 0101 students, the XO-1 was a very useful tool, as it allowed for writing, as well as playing games and music, especially their own. The students themselves generated this discourse: "I like to write and play games, especially puzzles" (School 0101 student). By contrast, students from School 0102 presented more general arguments, stating that the XO-1 was great for doing research, speeding up homework, accessing new content, and perhaps enjoying themselves: "For math, we use the calculator, the map, the

world map . . . when we have free time we play, that one about weights, and sing songs we make up as we go along" (School 0102 student). Similar words were used by the School 0102 principal, who was more engaged with the process than the School 0101 principal and actively discussed the computer with the school community. Since School 0102 students learned about the XO-1 from their School 0101 counterparts, who had their devices almost a year earlier, we assume that some of the ideas expressed by School 0102 students resulted from exchanges with students from School 0101.

Discussion: Entrenched Agents Against Insufficient Innovation

It was evident from the start that, in the cases presented, there was no actual plan beyond the deployment of computers, following the reasoning expressed by both Nicholas Negroponte and Oscar Becerra, head of DIGETE at the time, who affirmed that casual use is a way to appropriation and then to learning (Negroponte, 2011, p. 6; POLPC, 2010, pp. 1–2). At the same time, however, the limited understanding of the purpose of computers in the classroom appears to have become a reason for limiting their actual use.

Since students (and to a lesser extent, teachers) were already familiar with the computers and also were users of conventional computers at CPACs, their expectations about what a computer should be used for were already established by the time the XO-1 arrived in the schools (School 0102 student: "We use the computers in cabinas all the time"). This was compounded by the students' familiarity with video games, which were available at the aforementioned CPAC and, in some cases, at home. Any computer is a source of entertainment, whether through games or media consumption, and sometimes a source of information for homework, which means copying verbatim whatever is found on the Internet or in the texts available on the XO-1. This understanding of a computer is not unique to Peruvians or children in the schools studied here. Rather, it is a trend observed by those whose interest lies not in a normative view of computing in social contexts, but in studying the actual use of computers in society (e.g., Jenkins, 2008; Montgomery, 2007).

In this case, a computer foreign to the experiences and expectations of those who would use it arrived by ministerial fiat, and it was then inserted into the educational system by external agents—that is, the decision makers at the ministry and the officials on the ground who actually brought the laptops and trained some of the teachers. After the short training was finished, no clear objectives, clear guidelines for use, or clearly defined strategies were left for the teachers' reference. Decisions about the actual handling of the computers were up to the principals, and teachers were expected to train each other.

This particular sociotechnical system evidently arrived without any strategy for embedding itself in the daily practices of a different set of agents. Significantly, the understanding of a computer that this new sociotechnical system expected the children to have was not the understanding that actually existed. Thus, two sets of conflicts were ongoing at the two schools we observed: between the educational system and the new sociotechnical system, and between the XO-1 system and the expectations and experiences of what a computer, as a sociotechnical system, should be and do.

In the first case, it is noteworthy that, while OLPC may present itself as an educational program, it in fact stresses learning, not education. Learning is an individual achievement that is reached through participation in social activities, especially for school-age children (Vosniadou, 2001). School, as the locus of this social activity, should allow for individual approaches, but it has to focus chiefly on allowing the social activity of learning to happen. Learning occurs in a variety of situations with diverse potential outcomes, not many of them actually resulting from schooling. Education, on the other hand, includes sharing and incorporating socially sanctioned attitudes and mores, as well as the systematic transmission of the official narratives that constitute a nation-state.

Teachers, as central agents of the educational system, are both information providers and social enablers of learning. Their control of the classroom, embedded in the social activity of learning at school, establishes them as leaders and "official" sources of information. The computer, in any possible form, appears alien to the old-fashioned educational process, especially when it is presented as a modernizing tool. This alien presence, combined with the usual narrative that children are more capable users of ICT devices than adults are (e.g., Negroponte,

2011), reveals an obvious gap between the authoritative role of the teacher as traditionally understood, and the role of the computer-enabled student in control of his or her learning process.

Teachers' usual reactions, upon receiving the XO-1, are to demand more training ("There hasn't been enough training," said a teacher at School 0101), which in itself is not really relevant, as it is the schoolchildren, not the teachers, who need the skills to use the computer. What should be provided is guidance on the role of these computers in the classroom and the school context, and particularly, on how to use them to achieve the school's goals. In this sense, the XO-1 demands to be understood not as a device or a skill set, but as a series of institutional arrangements providing for an understanding of its potential role as an individual tool that enables learning without disrupting the educational process, or at least not disrupting it too much.

However, the actual decision of OLPC and Peru's Ministry of Education was to equip the classroom with a disruptive technology unaccompanied by specific demands for achievement or results. This approach explains why both principals and teachers use the computer in ways that do not disrupt local arrangements, allowing schools to continue to work on their own terms.

As such, this particular approach to the implementation of XO-1's presence in schools is an invitation to enact defensive measures. It does not encourage the exploitation of the computers' full potential that would, perhaps, lead to success. The XO-1's usefulness in Peru's educational system cannot be assessed, given that its manner of implementation allows such latitude in the process at the level of the individual school.

This particular stance regarding each school's level of autonomy is more an omission than an actual decision, judging from the information gleaned from qualitative studies and anecdotal commentaries. Trust in the XO-1's potential to change schoolchildren's attitudes to learning appears to have been so great that considerable effort was devoted to bringing the computers into the schools. Political pressures of the time may also have played a significant role. But the result was too much latitude for principals, latitude which, in the cases here, became a sort of passive resistance that left the computers in the hands of teachers who, though interested, lacked an actual plan for using them to change the whole educational setting.

At least in these two cases, the management of innovation failed. Disproportionate confidence in the devices' power to directly influence all involved resulted in quiet rejection by school staff and a lack of interest from students.

As mentioned earlier, the students' lack of interest in the XO-1 stems from their awareness of what a computer can do. This awareness arises from the experience of using more powerful computers as consumption and communication mechanisms, and indicates that, even in poor areas of a middle-income country like Peru, people are familiar with computers and the potential they offer for personal satisfaction and gratification. Though computers are also understood as powerful devices for self-learning and many other tasks, the schoolchildren's testimony indicates that their main reason for using a computer is gratification in the form of games and media consumption, and that they base their almost immediate assessment of the XO-1's potential on its ability to facilitate such tasks. Without proper guidance and purpose in the context of school activities, the XO-1 is only an incomplete mechanism for these non-school-oriented activities.

This circles back to Toyama's point about amplifying intent and capabilities, which the XO-1 actually did in the two schools observed: It reinforced attitudes among both school staff, regarding the need for control and the way the school should work, and schoolchildren, who appear to be dedicated to taking advantage of the potential to engage in the activities that interest them the most.

In this sense, the attempted innovation was too small. It did not try to change the receiving system or bring new capabilities; instead, it only introduced a device that was expected to be so innovative as to change everything by itself. This was an illusion rooted in the thinking of both the original promoters (the OLPC Foundation) and the officials in charge of the program in Peru. By itself, the device was only capable of stirring curiosity, and after the first impact, it was incorporated into two sets of practices already in place (Langhoff, 2010).

Final Remarks

These two small instances are an inadequate basis for assessing the Peruvian educational system's

entire experience of OLPC's XO-1 computers. However, they do support three main assertions:

1. Absent a strategy for incorporating a sociotechnical innovation into a large institutional system like Peru's educational system, the management of the XO-1 computers was left to two sets of agents with the same resources and intents they had before the implementation of this particular innovation. They did not reject it, but tried to make the devices comply with their expectations and practices, turning what was supposed to be a revolutionary device into an afterthought. Thus, we recommend that any new attempt to introduce computers should, rather than demanding compliance with the standard requirements of lesson completion, consider that many students, left to their own devices, will try to reproduce in the school computers the same habits of computer use they are accustomed to indulging with public access computer services.
2. The training was not thorough, and it appears that, even in the best conditions, it would not have been enough to promote an approach to teaching that prepared and allowed for better computer use. Training was focused too much on the computer's functionality and not enough on the actual schooling-based learning achievements sought by the educational system. Thus, we recommend that the main subject of training should not be functionality, but rather, the need for learning achievements—in other words, how to interest the students and improve standardized test results using the computer software.
3. The role of principals is critical. As these two cases show, their decisions constitute the first steps toward achieving the whole school community's commitment to using the computers. While we did not explore each principal's decisions regarding computer usage, their power must be acknowledged. Thus, we recommend that principals be incorporated as specific agents and allotted more freedom to decide whether to accept the computers as part of general school teaching, including the possibility of using them in specific courses or grades, or to assign specific teachers to tutor students in their use. Ultimately, principals would be in a position to reject the computers if, in their assessment, conditions for success were unattainable.

Further research is obviously warranted, but the results of this particular study point to the need for a different approach to OLPC implementation in Peru and probably elsewhere, since the contention that the computer is so powerful as to bring change by itself has been shown to be improbable. ■

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