CAN ONE LAPTOP PER CHILD SAVE THE WORLD'S POOR?

Mark Warschauer and Morgan Ames

The One Laptop per Child (OLPC) program is one of the most ambitious educational reform initiatives the world has ever seen. The program has developed a radically new low-cost laptop computer and aggressively promoted its plans to put the computer in the hands of hundreds of millions of children around the world, including in the most impoverished nations. Though fewer than 2 million of OLPC's XO computers have been distributed as of this writing, the initiative has caught the attention of world leaders, influenced developments in the global computer industry and sparked controversy and debate about the best way to improve the lot of the world's poor. With six years having passed since Nicholas Negroponte first unveiled the idea, this paper appraises the program's progress and impact and, in so doing, takes a fresh look at OLPC's assumptions. The paper reviews the theoretical underpinnings of OLPC, analyzes the program's development and summarizes the current state of OLPC deployments around the world. The analysis reveals that provision of individual laptops is a utopian vision for the children in the poorest countries, whose educational and social futures could be more effectively improved if the same investments were instead made on more sustainable and proven interventions. Middle- and high-income countries may have a stronger rationale for providing individual laptops to children, but will still want to eschew OLPC's technocentric vision. In summary, OLPC represents the latest in a long line of technologically utopian development schemes that have unsuccessfully attempted to solve complex social problems with overly simplistic solutions.

The One Laptop per Child (OLPC) program is one of the most ambitious educational reform initiatives to date. The program has developed a radically new low-cost laptop computer and aggressively promoted its plans to put laptops in the hands of millions of children around the world, including those in the most impoverished nations. The program's founder and chairman, Nicholas Negroponte,

Mark Warschauer is a professor in the Department of Education and the Department of Informatics at the University of California, Irvine; director of UCI's PhD in education program; and founding director of UCI's Digital Learning Lab. Morgan Ames is a PhD candidate in the Department of Communications at Stanford University.

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has argued that children can use this new computer to not only teach themselves, but also their family members.[1]

This paper argues that the premises and approach of OLPC articulated by Negroponte are fundamentally flawed. The poorest countries targeted by OLPC cannot afford laptop computers for all their children and would be better off building schools, training teachers, developing curricula, providing books and subsidizing attendance. Middle- and high-income countries may benefit from educational use of laptops. However, this can only happen if they devote substantial effort and funding to the kinds of infrastructure development, teacher training, curriculum development, assessment reform and formative evaluation necessary for school laptop programs to work. Unlike Negroponte's approach of simply handing computers to children and walking away, there needs to be large-scale integrated education improvement efforts.[2]

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OLPC's Vision

OLPC's vision is strongly shaped by Negroponte's background and views. Having been the founder of the Massachusetts Institute of Technology's (MIT) Media Lab and an initial investor in *Wired* magazine, he is not bashful about asserting his idealistic views on the transformative power of new technologies. As he wrote in an influential 1995 book, "like a force of nature, the digital age cannot be denied or stopped."[3]

The OLPC program represents a marriage of Negroponte's digital utopianism and the constructionist learning theory of Seymour Papert, Negroponte's long-time colleague at MIT. Papert views learning as highly dependent on students constructing ideas and individual laptop computers as essential for carrying out such construction in today's world. He argues that having several students share a computer is as inadvisable as having multiple students share a single pencil.[4] In the OLPC program, Negroponte, Papert and others sought to develop and distribute a low-cost "children's machine" that would empower youth to learn without, or in spite of, their schools and teachers.

Prior to the emergence of OLPC, a number of one-to-one (one computer per student) laptop programs were launched in the United States and other countries, including a well-regarded program in the state of Maine. In most of these programs, laptops are owned and maintained by schools and deployed to students

for individual use and at home, starting at upper elementary grades or higher. Laptops are viewed as one component of an overall educational reform based on broader technological infrastructure, provision of technical support, professional development, curriculum development, assessment reform and a carefully planned implementation process that involves staged distribution and ongoing evaluation. Research suggests that such programs result in improved student writing, increased student engagement, improved information literacy and, in many cases, higher student test scores.[5]

Unlike these programs, which typically use computers available to the general public, OLPC developed its own laptop called the XO and its own software interface and package called Sugar. OLPC also chose a different implementation model than that used in previous one-to-one programs. OLPC stipulates that laptops be owned by children over the age of six rather than by schools. Efforts to reform curricula and assessment are viewed as too slow or expensive and teacher training as of limited value due to teacher absenteeism and incompetence, so laptop implementation must proceed without them. As Negroponte explained, "[W]hen you go to these rural schools, the teacher can be very well meaning, but the teacher might only have a sixth grade education. In some countries, which I'll leave unnamed, as many as one-third of the teachers never show up at school."[6]

Papert went further, explaining that children will teach themselves. "In the end, [students] will teach themselves [how to use the laptop]. They'll teach one another. There are many millions, tens of millions of people in the world who bought computers and learned how to use them without anybody teaching them. I have confidence in kids' ability to learn."[7]

Based on the urgency of getting laptops in the hands of children, Negroponte has suggested that pilot programs, staged implementation, monitoring and formal evaluation should be shunned as well, since they can only slow down this vitally needed reform. As he explains,

> I'd like you to imagine that I told you "I have a technology that is going to change the quality of life." And then I tell you, "Really the right thing to do is to set up a pilot project to test my technology. And then the second thing to do is, once the pilot has been running for some period of time, is to go and measure very carefully the benefits of that technology." And then I am to tell you what we are going to do is very scientifically evaluate this technology, with control groups - giving it to some, giving it to others. This all is very reasonable until I tell you the technology is electricity, and you say "Wait, you don't have to do that." But you don't have to do that with laptops and learning either. The fact that somebody in the room would say the impact is unclear is to me

amazing—unbelievably amazing.[8]

Results of OLPC's Implementation

To achieve a rapid saturation without pilot programs or evaluation, OLPC initially set a policy of only taking orders in lots of 1 million. With no takers, they then lowered the amount to 250,000.[9] Finding few buyers at this level, they eventually allowed some smaller programs, but still forbade general sales to either the public or individual schools.

When Negroponte launched the program in 2005, he predicted the initial distribution of 100 to 150 million laptops by 2008 to targeted developing countries.[10] As of August 2010, about 1.5 million XO laptops had actually been delivered or ordered. More than 80 percent of these have gone to countries categorized by the World Bank as high or upper-middle income. Only two countries have implemented nationwide use of XOs in primary schools: Uruguay and the small Pacific Island nation of Nieu (with a total school-age population of 500). In Peru, after a first phase in which some 290,000 children in rural schools were given laptops, the program will reportedly be extended to the rest of the country on a per-school rather than per-child basis. In Rwanda, where only 7 percent of homes have electricity, the government has joined the OLPC program as a way to spur development, but has only purchased or had donated enough computers for fewer than 5 percent of primary school children in the country, and only a fraction of those have been distributed.[11] The U.S. government bought 8,080 XOs for donation to Iraq, but they never reached children's hands; half were auctioned off to a businessman in Basra for $10.88 each and half are unaccounted for.[12] In most other countries, there are either small pilot programs implemented by NGOs or OLPC programs in local areas or regions that have not yet spread elsewhere.

Each OLPC program around the world is implemented with a large degree of autonomy, so results vary. Nevertheless, from evaluation studies published by OLPC programs or outside agencies, investigations by journalists and our own case study research on OLPC programs in Uruguay, Paraguay, Mexico and the United States, a number of common trends have emerged. Below we will discuss four salient trends regarding OLPC to date: the affordability of a laptop program for the countries targeted, flawed expectations about the effects of implementation, problems with the design of the XO and the realities of student use.

Affordability

There are many possible explanations for OLPC's failure to meet its distribution goals, but one likely factor is affordability. Though Negroponte's initial goal

was to sell the XO laptop for $100 or less, the sales price per laptop in a bulk order is about $188. The cost of implementing an XO program, including the purchase of laptops and other infrastructure, as well as development expenses, has been estimated at about $75 per student per year.[13] Even a less expensive national program would be difficult to afford in a country such as Rwanda, which currently spends a total of about $109 per pupil per year on primary education.[14]

If donors are expected to foot the bill, they need to consider how the costs and benefits of laptop computers compare to the proven cost-benefit ratios of other aid programs for improving social or educational conditions; in short, opportuniy costs. For example, apportioning a total of $8 per person per year over the next five years to basic health expenses could save 11 million lives in Africa, according to projections of a prominent coalition.[15] A total expenditure of $0.50 per pupil per year in Kenya on deworming was found to increase school participation by 14 percent.[16] The building of schools, the hiring of additional teachers or tutors and provision of subsidies to mitigate costs of school attendance and expenditures on textbooks have all been found to improve educational outcomes in impoverished countries.[17] Low-cost initiatives to increase girls' access to education have substantial long-term effects on literacy, wage equity, economic growth, productivity, public health and the development of democratic institutions.[18] Given the demonstrated social and educational benefits of other low-cost programs versus the uncertain benefits of OLPC, it is neither realistic nor desirable that governments or donors would make the kinds of investment necessary for distribution of laptops to all children in low-income countries without evaluating the benefits of OLPC.

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Implementation

Negroponte's belief that great benefits will be achieved by simply giving children laptops and getting out of their way reflects naïve and technologically determinist views: Information and communication technology (ICT) is a tool to be passed out, implementations are one-shot, technological effects are direct and immediate, politics are irrelevant, social effects are benign, contexts are simple, knowledge and expertise are easily made explicit and ICT infrastructures are fully supportive. However, as demonstrated by Kling, ICT is more of a sociotechnical network than a tool. Implementations are ongoing, effects are often indirect and involve multiple timescales, politics are central and even enabling, social repercus-

sions are unpredictable, contexts are highly complex, knowledge and expertise are inherently tacit or implicit and much additional skill and work is needed to make infrastructures function appropriately.[19] To understand this point further, it is helpful to briefly consider a few examples of OLPC programs, including the two largest to date and two smaller ones that represent diverse approaches to implementation.

In 2007, the Government of Peru ordered 290,000 OLPC laptops to be used individually by children in rural one-room schools, and Lima has reportedly ordered another 230,000 to 260,000 for future distribution. A preliminary evaluation carried out by the Inter-American Development Bank (IDB) and an independent investigation both suggest that the program, though viewed positively by teachers and parents, is mired in infrastructure difficulties.[20] A number of the country's rural schools still lack electricity access and those that do have electricity access sometimes have only one outlet in the principal's office, making charging—and subsequently using—the laptops nearly impossible. Most schools lack Internet access, further limiting how the laptops can be used. According to the IDB evaluation, only 10.5 percent of teachers receive technical support and 7 percent receive pedagogical support for use of the laptops. Even when training was offered, teachers in one-room schools were often unable to leave their school to attend the training and were unwilling to travel to receive unpaid training during their vacation time. Some 43 percent of students do not bring their laptops home, mostly because teachers or parents forbid it out of fear they will be held responsible if anything happens. Facing these problems, Peru appears to be moving away from the laptop per child model. Upcoming deployment will be to schools rather than to individual children, where newly established Technology Resource Centers will house twenty Internet-connected XO laptops, a multimedia projector and a screen.[21] This appears similar to a model used in some Mexican schools, where XO computers are accessed by classes on a rotating basis and essentially function as low-cost computer laboratories.

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Uruguay has the first ubiquitous national deployment to date, with nearly 400,000 in use by primary school students and teachers across the country. With a per capita gross national income of $12,600, an adult literacy rate of 97.9 percent, and a well-organized Ministry of Education and Culture, Uruguay is well situated to organize a laptop program. Uruguay has put substantial effort into technical infrastructure and support and at least some effort into social support. Wireless connectivity has been extended throughout the country and 98 percent of children with XOs can now access the Internet at school.[22] Relay points are being set up to

extend this access beyond the school, with the goal of bringing a wireless hotspot within 300 meters of children's homes.[23] The government offers free repairs for any laptop that malfunctions following proper use, and subsidizes the repair of laptops that break due to user error. Students or parents can drop their laptop off at a post office for free shipping, use one of the forty local repair centers or wait for a mobile repair team to visit their school.[24] Schools are provided with a few extra laptops—equal to 3 percent of the student population—to be used as a backup when children's laptops are out of commission.[25] Initial teacher training was reportedly light, but is supplemented by the development of training materials for online or televised delivery.[26] The Uruguay program still has much work to do: hardware and software problems remain a serious concern, and the computers are still used relatively sparsely in schools.[27] However, the expansion of Internet access may in and of itself bring benefits and the program is now being extended to secondary education.[28]

The much smaller OLPC program in Paraguay, run by the NGO Paraguay Educa, has had to deal with a different set of constraints.[29] With a smaller deployment of 4,000 laptops in ten schools and a talented development team including several international visitors, Paraguay Educa was able to improve and test the Sugar software, incorporating user feedback into the development process.[30] In December 2009, Paraguay Educa also redesigned their teacher training program and hired a local team of teacher trainers that began working day to day in the schools.[31] These fifteen full-time trainers provide ongoing pedagogical support and training to teachers and also offer direct instruction to students in advanced areas, including basic computer programming. A separate technical support team visits each school once a week to address technical issues with the XOs.[32] While laptop use in the classroom has increased significantly following this expansion of pedagogical and technical assistance, there are still challenges ahead. For example, Internet access has been provided via a donation from Personal Telcom to participating schools for a period of two years, but it is uncertain what will happen after that time.[33] Paraguay Educa's implementation cannot scale without the help of an entity larger than a small NGO. Nevertheless, this is indicative of what might be required for a robust program.

Though OLPC was originally targeted at developing countries, Negroponte later supported OLPC programs in the United States, especially in impoverished communities. The largest U.S. implementation has taken place in Birmingham, Alabama, a city with a high degree of poverty. Initiated by Birmingham mayor Larry Langford, the Alabama program took an opposite approach to that discussed above in Paraguay, with almost no resources devoted to adapt to local needs or address local problems. It thus provides an excellent example of an initiative that

adhered closely to Negroponte's one-shot implementation approach. Echoing Negroponte's vision, Langford announced on the city website, "If we give them these XOs and get out of their way, they'll be teaching us about the world."[34] Despite little school district buy-in, the mayor and city council pressured the Birmingham school district to give out XOs to all first- through fifth-grade children in the city, following a less than six-week pilot program in a single school.[35] No funds to provide Internet access to elementary school classrooms were made available. Most of the classrooms lacked Internet access and none were provided with support for laptop repairs. Only two hours of paid training were available to teachers, who showed little inclination to show up voluntarily for unpaid training on their own time. Studies found that within the first twenty months of implementation, large numbers of laptops were broken or otherwise unusable, the computers were little used in school and home use brought little benefit.[36] Schools and teachers never embraced the program and the city council eliminated funding for the program from this year's budget.

These examples illustrate the importance of adapting laptop deployment to local practices and constraints. The OLPC deployments that simply tried to hand out laptops, such as Birmingham, have failed because they ignored local contexts and discounted the importance of curriculum and ongoing social, as well as technical, support and training. Peru also experienced difficulties in implementation and is apparently moving away from a one laptop per child policy. Paraguay Educa has been able to adapt its small program to respond to the local context and provide a well-rounded educational intervention, though at a cost that may not be feasible for large-scale implementation. The long-term impact of Uruguay's national program, which provided extensive Internet access and support for teacher training and laptop repair, though perhaps insufficient, deserves close attention.

Design Flaws in the XO

While OLPC's program implementation approach has been broadly criticized, its XO laptop has generally been praised. Upon closer reflection, though, the XO hardware and software design has suffered from the same kind of utopianism as the program implementation approach and, as a result, the laptop has performed poorly in the field.

The XO was custom designed by OLPC, which has proven problematic for maintenance. In particular, its screen was the first of its kind, but it is also expensive—$65 in Paraguay or $85 on Amazon.com—, difficult to replace and proprietary; one cannot use a generic screen or one from another laptop model.[37] A report published in August 2010 stated that 25 percent of technical problems in Uruguay involved installing a new screen.[38] In Paraguay, where repairs have generally been

unsubsidized, replacement screens are too expensive for many parents to afford.

The first XO model (XO-1) has a number of other unintentional design flaws that would have been caught had there been more pilot programs or testing. The keyboard membrane, meant to be spill-resistant, is so thin that normal usage results in the membrane around keys breaking and keys falling off. Because of this, in Uruguay, 33 percent of reported technical problems involved installing a new keyboard.[39] The touchpad mouse similarly degrades with time: it loses sensitivity and becomes more prone to erroneously detecting signals, resulting in a mouse that is very difficult to control and that often drifts away from the target.[40] While the keyboard and touchpad are fixed for the new XO-1.5 model, the 1.5 million laptops that are currently in use are almost all XO-1 laptops, and while the keyboard could in theory be replaced with the improved version, the touchpad, a different size, cannot.[41] Other problems include an easily breakable charger cable due to shoddy manufacturing, the placement of the cable on the side of the transformer rather than the back, and the lack of a standardized cable between the transformer and the power outlet.

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As a result of all of these problems, large numbers of XO laptops are rendered unusable within the first one or two years. In Uruguay, even with its extensive support network in which repairs are free or partly subsidized, 27.4 percent of machines were out of commission in a recent poll, or more than 100,000 out of the 400,000 in the country. In schools in the lowest socioeconomic tier, the percent out of commission was 33.7. In the Alabama deployment, 16 percent of children surveyed within six months of receiving their XOs reported that they had problems with their laptops that were not fixed. A visit to an Alabama school nineteen months after deployment found that only 40.3 percent of the students had functioning XOs with them, with almost all of the rest reporting that they were broken or not working.[42]

Though hardware and software problems are natural occurrences in all school laptop programs, most of these programs budget for computer maintenance. In the kind of deployment OLPC advocates, children own the laptops and thus are either fully or partly responsible for maintaining them. Earlier, Papert claimed that "an eight-year-old is capable of doing 90% of tech support and a 12-year-old 100%."[43] This may well be true in theory, but in practice large numbers of XOs go unrepaired, as seen in Uruguay, where more than half of those out of commission were determined to be unusable due to breakage. Thus, in many OLPC programs,

the principle of child ownership has come into contradiction with the principle of ubiquity, as the large number of broken or unusable laptops negates the possibility of one laptop per child classroom activity.

The XO also has a number of performance problems that make it more difficult to use than a regular laptop, even when nothing is broken. On the hardware side, its battery, originally advertised to last all day, actually lasts just a couple of hours and its capacity degrades over time like any other lithium-ion battery.[44] Its slow CPU and small memory, both claimed as tradeoffs for making the laptop robust and low-power, make it difficult to run more than one program at once or open multiple web pages. Students are forced to delete content or reformat their small, one-gigabyte hard drives when they fill up, losing prior work.[45] Also, the lack of an external display output means that there is no easy way to use a projector in front of the classroom, thus limiting the ability of students to share work with others.[46]

The OLPC deployments that simply tried to hand out laptops have failed because they ignored local contexts.

On the software side, the Sugar interface is radically different than that used in Windows, Macintosh or other Linux environments and thus takes a greater investment of time and effort by teachers to learn.[47] The challenge of teachers learning the new interface is magnified by the small size of the XO's keyboard, designed for young children rather than adults, and the limited time devoted to professional development in many OLPC implementations. There is also no special teacher interface or software for tracking attendance or easily distributing, collecting or grading work on the laptop. This fact, plus the difficulty in connecting the XO to printers or external monitors, means that many teachers are unable to access student work on the XOs without walking around a class and looking at each student's small screen, one at a time.[48]

There are also numerous problems with the software that began as features. Many early news reports lauded OLPC's innovative mesh networking, which, in theory, would allow students to connect and collaborate with one another even without Internet access. However, this functionality was buggy, poorly tested and used so rarely in the field that it was recently dropped from the new Sugar release. Due to software problems, OLPC's security model, called BitFrost, mistakenly deactivates and locks up large numbers of laptops, and the only solution is to reboot and re-initialize each machine individually from an external drive, a labor- and time-intensive process. In Uruguay, for example, 50,000 XOs suddenly deactivated and had to be individually unlocked by technical support staff since

teachers and students were not provided the codes to do so.[49]

Of the many problems with the XO laptop, some are mistakes that were a result of inadequate testing and rushing a product to market, some were the result of incognizance about laptop use in a classroom or home compared to use in a laboratory, and some are intentional design decisions. Yet all of these problems stem from utopianism about how a laptop hastily designed in the lab will perform in the real world and about how children can learn from a machine that, through its design, makes teacher-student interaction difficult.

The XO hardware and software design has suffered from the same kind of utopianism as the program implementation approach.

Student Use

Studies to date indicate that XO computers are, for the most part, little used in schools, an unsurprising finding given all of the implementation and technical problems previously discussed. In Uruguay, for example, only 21.5 percent of teachers report using XOs in class on a daily or near daily basis for individual student work and 25 percent report using them less than once a week.[50] In Birmingham, Alabama, 80.3 percent of students report that they either never use the XOs in schools or seldom use them.[51] In Peru, usage appears to diminish substantially within the first few months: 68.9 percent of teachers in Peru who have had the XOs for less than two months reported using them three or more times a week, but only 40 percent of teachers who had the XOs for more than two months reported that level of use.[52]

This low and falling level of laptop usage stands in contrast to computer use in more traditional one-to-one laptop programs, where recent research indicates that students typically use laptops every day in schools for about two hours per day.[53] The lower level of school laptop use in OLPC programs is likely due to a number of reasons, including the technical problems with XO laptops and the particularities of the XO interface previously discussed; the lack of Internet access and peripheral media or, in some cases, electricity to support laptop use; a mismatch between the XO and extant forms of school curriculum, pedagogy and assessment; and lack of teacher training.

Furthermore, studies in Haiti, Uruguay, the United States and Paraguay suggest that many children, especially the most marginalized students targeted by OLPC, are not able to exploit the potential of the XO on their own, whether using it at school or at home. An IDB study of a pilot project in Haiti noted that a large number of participating students reported experiencing a ceiling effect on learning

with XOs, as students avoided aspects of the XO that were confusing or problematic to them and thus engaged only in simple activities with which they were most comfortable.[54] A national evaluation study in Uruguay pointed out the challenge of reaching the portion of children who excessively or exclusively use the XO as an entertainment device.[55] In Birmingham, students actually reported spending *less* time using computers to do research, homework or to share creations online than they spent prior to getting XOs. However, after getting the XOs, they spent substantially more time in online chat rooms.[56] Our interviews and observations in Paraguay suggest that XO use there is stratified, with a minority of youth making use of the XOs in creative and cognitively challenging ways, and a majority using them only for simpler forms of games and entertainment. We also found that the children who are already most privileged socially and economically tend to make use of the XOs most creatively. Thus, independent XO use by children might exacerbate divides rather than overcome them.

Such an outcome would be consistent with what has been found in a substantive body of prior research on children's use of technology. Simply put, when children are just handed computers without any accompanying technical or social support, usage tends to be stratified.[57] Youth in low-income families and marginalized communities, who ostensibly have fewer family members or friends that are sophisticated users of new technologies and have less supervision as their parents work long hours, tend toward more basic uses of computers: chatting with friends, playing simple games and downloading media.[58] Research suggests that reading and math test scores of low-income youth tend to decline after receiving access to computers, whether in school or at home.[59] In contrast, youth in high-income families and privileged communities are more likely to use computers for sophisticated media creation, programming and participation in complex multiplayer games.[60]

This amplification of pre-existing differences through computer access stem from two main factors. First, students from high socioeconomic status backgrounds are more likely to have family members and peers who can support and guide them in learning more sophisticated new technology. This kind of support is referred to as the social envelope of educational computing. In other words, it is not the computer itself that brings benefit, but rather the social and technical support that surrounds the computer that makes the difference.[61] Second, students who already have strong language and literacy skills, as well as background knowledge on topics at hand, benefit most from unstructured learning environments. In contrast, students with weak language or literacy skills or insufficient background knowledge often find the cognitive load of these environments overwhelming and thus learn less from them.[62] These two unacknowledged factors represent a flaw in the one-sided belief in self-directed constructionism. Children who are most

marginalized generally need more guidance, mentoring, modeling and appropriate types of direct instruction in order to succeed, while those who are already privileged usually benefit the most from pure constructionism. Thus, while constructionism is an important concept to consider in education, it has to be deployed with sufficient scaffolding for learners, especially those who have limited literacy or education.

Finally, no studies have reported any measurable increase in student performance outcomes in reading, writing, language, science or math through participation in an OLPC program. Most recently, for example, the IDB's study of Peru found no differences in test scores between children who received an XO and a comparative group who did not.[63] This occurrence in Peru was not surprising as the program was in its first year of implementation and, therefore, was in and of itself no great cause for concern. However, such findings stand in contrast to the exaggerated claims of OLPC organizers of program impact on student learning.

The Future of OLPC

In 2010, OLPC divided into two separate organizations: the OLPC Foundation, based in Boston and led by Negroponte, and the OLPC Association, based in Miami with a separate leadership structure. The Foundation assumed responsibility for future hardware developments and deployments based on donations (intended for places such as Iraq, Afghanistan and Gaza), and the Association assumed responsibility for manufacturing, sales, supply chain and working with paying customers, such as those in Uruguay and Peru.

In October 2010, two important developments were announced that bode well for each side of the operation. First, it was announced that the Foundation received a $5.6 million grant from Marvell, a California-based semiconductor maker, to fund development of a next-generation tablet computer.[64] According to a report on the announcement, the technology developed by OLPC would first be deployed by Marvell in its own tablet for use in developed countries. A follow-up version, based more completely on OLPC's design and targeted for developing countries, would be released later. If this plan comes to fruition, the close partnership between OLPC and an existing firm may help OLPC avoid some of the design problems with its original XO, as the first iterations of the new tablet would be tested for use by an established company in a mature market.

The following day, it was reported that Walter Bender, former president of software and content for OLPC (who had left the organization in 2008 due to disagreements with Negroponte), was once again working closely with the project, this time via the OLPC Association. Most notably, speaking less than two months after Negroponte repeated his view that "you can give a kid a laptop that's con-

nected and walk away," Bender put forth a very opposite perspective:

> Building a learning environment is hard work….[T]o take root, it's got to be a prolonged community effort. If you simply present it as, "We're going to give computers to kids," the story is not adequate. The key to success is to really take a holistic approach to the servers, the infrastructure, the logistics, the software, the preparation and training, the pedagogy, and the community that is using all this stuff."[65]

According to the report, Bender agreed to work with the OLPC Association after receiving assurance that there was a commitment to this "social side and support in the field." If that proves true, it might mean that we will see a more holistic approach in OLPC implementations in the future. Small pilot efforts in Nicaragua, Afghanistan and Nepal have already been working to deploy XOs as part of broad educational reform efforts that focus on curriculum, pedagogy and professional development, and these projects and others could benefit from international project leadership that takes a similar approach.[66]

Many children, especially the most marginalized students targeted by OLPC, are not able to exploit the potential of the XO on their own, whether using it at school or at home.

Conclusion

OLPC is widely credited with creating international market pressure for the development of low-cost laptop computers for both the education sector and the general public. The program has sparked the involvement of talented staff and volunteers in many countries who are passionate about improving education using digital media. As a research and development project, OLPC has also spurred some important technical breakthroughs in screen technology, low-power computing and collaborative software. For all these contributions, OLPC deserves praise.

However, there are important differences between a research-oriented development effort and a large-scale international campaign involving the production, distribution and use of millions of educational computers. For an effort of that sort to be successful, it requires an understanding of how to organize large-scale social improvement efforts involving technology and how best to support learning in diverse contexts. Racing ahead without this understanding can waste precious resources required for development and divert attention from more promising approaches to educational and social reform. Regrettably, there is no magic laptop that can solve the educational problems of the world's poor.

The effort to improve education around the world through better use of digital media is a long term one that is still at an early stage. This effort will require the talents of a wide array of policymakers, practitioners, scholars and designers, including the kinds of technology innovators that have been drawn to OLPC. The diversity in OLPC implementations is advantageous in that less and more effective approaches can reveal themselves. If OLPC learns from what has occurred in its implementations and steps away from utopianism in the design and deployment of its children's machines, it will be better prepared to contribute to this worthwhile long-term endeavor. ♔

NOTES

[1] Nicholas Negroponte, "Lessons Learned and Future Challenges" (speech, Reinventing the Classroom: Social and Educational Impact of Information and Communication Technologies in Education Forum, Washington, DC: 15 September 2009), http://www.olpctalks.com/nicholas_negroponte/nicholas_negroponte_lessons_learned_and_future_challenges.html.

[2] Nicholas Negroponte, "What Technology Wants vs. What People Want Panel" (speech, Techonomy Conference, Lake Tahoe, CA: 6 August 2010), http://www.youtube.com/watch?v=_9JoyyTSQQ8.

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[29] One of the authors has spent three months in Paraguay investigating this program, and much of this information comes from original research and personal communications with Paraguay Educa during this time.

[30] Including OLPC programmers Daniel Drake in early 2009 (see http://wiki.laptop.org/go/OLPC_Paraguay/Daniel_Drake_report_2009) and Bernie Innocenti for seven months in 2010 (see http://codewiz.org/wiki/blog/2010/01). Bernardo Innocenti (OLPC programmer) and Raúl Gútierrez (Paraguay Educa co-founder), observations and interviews by Morgan Ames, July 2010. Also see http://wiki.sugarlabs.org/go/Dextrose/Build_System and http://wiki.paraguayeduca.org/index.php/Inventario_manual/en for details about the software innovations developed by Paraguay Educa.

[31] Sebastian Codas (founding employee of Paraguay Educa), personal communications, 30 September 2010.

[32] Sebastian Codas and other Paraguay Educa staff, interviews and observations by authors, September 2010.

[33] For information on the agreement, see http://www.abc.com.py/nota/137380-personal-seguira-dando-conectividad-a-escuelas/. Information about the two-year agreement comes from personal communication with Paraguay Educa staff.

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[38] Nogueria, 38. No comparable data are available on the rate of screen breakage of other types of laptops used in educational programs. However, replacement screens for other laptops are generally less expensive as they are available from third-party manufacturers. For example, a replacement screen for the ASUS Eee Pc 900, a low-cost netbook used in some districts in the U.S., can be purchased new on eBay for $40, which is less than half the cost in the U.S. of an XO screen, in spite of the fact that the ASUS 900 screen is 25% larger than that of the XO.

[39] Ing. Albana Nogueria, "Plan Ceibal: Red Ceibal – conectividad," (LATU, Plan Ceibal, Area Técnica), 38, http://www.eclac.org/socinfo/noticias/noticias/9/40019/SoporteCeibalSalvador.pdf.

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[41] The websites http://wiki.laptop.org/go/Touch_Pad/Tablet and http://en.wikipedia.org/wiki/OLPC_XO-1#Keyboard_and_touchpad provide brief descriptions of the old and new touchpads. A photograph of an XO-1 and an XO-1.5 side-by-side is available at http://www.olpcnews.com/laptops/xo15/olpc_in_dc_with_the_new_xo-15.html.

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