Brian Moss
May 11, 2017

The Technology Trap: Lessons from the One Laptop Per Child Program

Just as the industrial revolution reshaped society in much of the world during the 19th century, the rapid spread of computer technology has dramatically changed the world in the late 20th and early 21st centuries. However, just as the industrial revolution was slow to reach many parts of the world, the spread of computer technology around the globe has been anything but even. Developed countries are advancing at a faster pace than most less-developed countries, despite having started with a relative advantage, and the gap between the "global north" and the "global south" continues to grow. As a result, many efforts have been made to narrow the gap – in terms of education, health care, living standards, and more – with mixed results. In many cases, the assistance comes in the form of "boomerang aid," which helps the donor country more than the recipient. Other cases are more benign, such as the One Laptop Per Child program explored in this paper, where well-meaning efforts fail to properly anticipate real-world challenges, leading to limited successes at best.

The One Laptop Per Child (OLPC) program began as a philanthropic endeavor to introduce technology to children throughout the developing world. The program's aim was to reduce the gap between rich and poor countries by providing laptop computers to children, inspiring children to learn and thereby leading to long-term development. Nicholas Negroponte announced the creation of the OLPC program in January 2005 during the World Economic Forum in Davos, Switzerland (Kraemer, Dedrick, & Sharma, 2009). Speaking as then-director of the MIT Media Lab – a technological think tank closely affiliated with the Massachusetts Institute of Technology – Negroponte stated the program's goal would be to design a revolutionary new laptop, and Negroponte predicted OLPC would soon be able to deliver up to

150 million laptops per year at a target price of only $100 each (Hamm, Smith, & Lakshman, 2008; Luyt, 2008). Due to the program's positive and hopeful message, along with Negroponte's natural skill as a promoter, the OLPC program quickly garnered a great deal of media attention. Negroponte set about trying to sell the program to world leaders, while observers eagerly awaited the results of the program's efforts.

In conjunction with the MIT Media Lab, OLPC began to design a working prototype of what eventually became the "XO" laptop. The sturdy XO could withstand the rigors of use by children (having been drop-tested at 15 feet) while also resisting environmental hazards such as sand and water (Kraemer et al., 2009). Released in late 2007, the first XO laptops ran on a pared-down version of the Linux operating system, with a specially-developed user interface called Sugar, in keeping with the program's philosophy of using only open-source software (Tabb, 2008). Taiwan-based Quanta Computers signed on to manufacture the XO at a facility in Songjiang, China, providing OLPC with a supplier presumably capable of meeting the low price target as well as the extremely high production demands (Kraemer et al., 2009). While the XO laptop won awards for energy efficiency and design, mismanagement and lack of foresight prevented the OLPC program from realizing the goal of deploying laptops worldwide. The program continued to focus on developing new laptops – first the upgraded XO 1.5, followed soon by the XO 1.75 – before scrapping plans for both the XO 2.0 and the XO 3.0. The last iteration of the XO was a simply a standard Android tablet with XO branding and a handful of built-in educational programs. By then, the program had clearly strayed far from the original mission.

Although the OLPC program launched pilot programs in nearly forty countries, Uruguay remains the only major country to have distributed one laptop to every child nationwide. (The

tiny island nation of Niue distributed one laptop to each of the island's 500 children, but the program soon lost funding and discontinued operations.) Uruguay proved to be a good fit for the OLPC program, largely due to the newly-elected government's active support for inclusion and equal opportunities in education. Also, Uruguay's education system was already using a constructivist learning model, closely related to the constructionist model upon which Negroponte based the XO laptop's educational programs (Bender, Kane, Cornish, & Donahue, 2012). Furthermore, Uruguay is small enough to have required only 450,000 laptops for nationwide deployment (Plan Ceibal, 2017). By way of comparison, Peru distributed approximately one million XO laptops, yet never came close to the goal of providing one laptop to every child. The OLPC program also enjoyed some success in Rwanda, though Rwanda's program eventually morphed into a more cost-efficient model of providing two computer labs per school. Elsewhere, the OLPC program never managed to progress beyond pilot projects.

Ultimately, the OLPC program fell victim to a number of challenges both within the program's control and beyond the program's control. For example, despite being commonly referred to as the "$100 laptop," the actual cost of the XO laptop remained constant at nearly $200, in part because a lack of orders prevented the program from realizing an economy of scale in laptop production. At the same time, countries were wary of investing in an unproven program, especially at such an elevated cost, causing a vicious cycle whereby the program could not sell laptops because the program had not previously sold enough laptops. Meanwhile, for-profit corporations – most notably Intel and Microsoft – began to view the OLPC program as a competitor in the developing world's sizable markets. Nicholas Negroponte did little to help the OLPC program succeed against for-profit competitors, alternately befriending and alienating companies in a series of failed collaboration efforts. Negroponte eventually stepped away from

day-to-day management of the organization, remaining focused on technological development instead, but by then the program's best window of opportunity had passed.

In light of the OLPC program's history, this paper will attempt to determine what factors contributed to the OLPC program's relative success in Uruguay and Rwanda, and what factors may have worked against OLPC elsewhere. Given the program's implementation of a "one size fits all" solution in developing countries around the world, the results arguably should have been relatively consistent in every country. However, the program was truly successful only in Uruguay, with moderate success in Rwanda. OLPC ultimately failed in all other countries, usually without progressing beyond the pilot phase. Therefore, certain conditions must have existed in Uruguay and Rwanda to help the program succeed in those two countries but not elsewhere.

In answering the above question, I explore how the geography, history, and economies of Uruguay and Rwanda contributed to the OLPC program's success in those two countries. I begin with an examination of the global digital divide, along with an overview of technological interventions that have previously attempted to reduce the divide. I also look at the role of international aid in education, both in terms of size and effectiveness. Next, I discuss the theory of technological determinism, particularly the utopian notion that technology alone (such as the XO laptop) can greatly improve education, thus helping a country "leapfrog" to a developed state. In the methodology section I explain how this paper is the culmination of ten years of study, including academic sources, media reports, non-governmental organization reports, and first-hand information from the OLPC program. I then compare data on selected countries, such as education spending per pupil, along with an analysis of various OLPC evaluation reports. I subsequently compare and contrast the conditions contributing to the program's relative success

in Uruguay and Rwanda. Finally, I discuss how OLPC's top-down, one-size-fits-all solution contributed to the program's downfall, particularly given the program's failure to give students, teachers, and parents adequate consideration. If anything, the program's success in Uruguay and Rwanda appears to have been due to special conditions within the countries themselves, not a result of the program's own efforts.

LITERATURE REVIEW

Bridging the digital divide

As personal computers become nearly ubiquitous in the developed world, concern has grown among educators and policymakers about the increasing "digital divide" between developed countries and developing countries. Not only is the digital divide already large, but the divide widens as the developed world continues to advance more quickly than the developing world. The growing divide appears in increasing inequity, which technology worsens rather than lessens (Dutta, Geiger, & Lanvin, 2015; Van Deursen & Van Dijk, 2014; Wessels, 2013). Furthermore, the digital divide exists within countries as well as between countries, and the divide between digital "haves" and "have nots" is widest within developing countries (Norris, 2001; Tiene, 2004; Chen & Wellman, 2005). To decrease the digital divide, officials and philanthropists need to focus on countries with the least access to computers. And within those countries, focus must be on the communities with the lowest level of access to technology.

If the most obvious indicator of a digital divide is access to computers, then the most obvious solution would be for governments and philanthropists to provide computers to people with the least access. However, while the mere presence of computers is helpful, the computers are much less effective when not appropriately geared toward local conditions, especially in educational settings. For example, students in developing countries who simply have access to

computers do not outperform students without computers (World Bank, 2011; Barrera-Osorio & Linden, 2009), while "students who use computers very frequently at school do a lot worse in most learning outcomes, even after accounting for social background and student demographics" (OECD, 2015, p. 3.) One reason for the ineffectiveness of computers in the classroom is teachers not knowing how best to integrate technology into the curriculum, then underutilizing the computers as a result (Ganimian & Murnane, 2016). Technology alone generally fails to achieve desired outcomes due to additional factors, such as the appropriateness of the devices chosen, the level of appropriate teacher training, and the amount of technological infrastructure (Warschauer et al., 2014). Therefore, computers alone may not be an adequate solution to solving the digital divide. Rather than merely introducing computers, educators must find a way to leverage the computers effectively.

For educators seeking to maximize the effectiveness of computer learning, a common approach is the "one-to-one" or "1:1" model providing one computer to every child in a given class or school. One-to-one models are attractive due to the inherent equality in such programs, and one-to-one models provide much better access for students than traditional computer labs. One-to-one programs can have a variety of intended outcomes, including: 1) improving academic achievement, 2) increasing equity and reducing the digital divide, 3) increasing economic competitiveness, and 4) transforming the quality of instruction (Penuel, 2006). However, a comparison of three 1:1 laptop programs in the US found mixed results, noting the computers alone do not affect learning; any positive effects stemmed from how students and teachers actually used the technology (Warschauer, Zheng, Niiya, Cotten, & Farkas, 2014). Furthermore, 2:1 programs – with two students sharing each computer – have frequently proven to be more effective than 1:1 programs, while also greatly reducing the cost (Owston &

Wideman, 2001). Ultimately, computers alone may not serve as a panacea for bridging the digital divide. Moreover, the introduction of technology often comes at the cost of more urgent needs, especially given the limited amount of money available for education in the developing world.

International aid for education

One of the biggest challenges to bridging the digital divide is the question of how developing countries can afford to invest in new technologies with so many other competing pressures on already strained budgets. International aid – in the form of grants, loans, and in-kind donations – can be a way to afford technology that otherwise might not be within reach, including computers for education. Unfortunately, international aid can be variable and unpredictable from year to year, leading to difficulties in long-term planning (Benavot, 2010; Ganimian & Murnane, 2016). Donors also inadvertently create inequities through distribution methods, "such as donors providing aid directly to villages through community-driven development programs rather than to central governments" (Radelet & Levine, 2008, p. 431). When donors fail to properly target aid, aid does little to reduce global digital inequality. In fact, a reliance on aid can even lead to increased digital inequality within target countries.

Overall, little aid goes to education in developing countries. With multiple demands on donors – including emergency relief, food aid, health care, and infrastructure support – long-term investments such as education and the environment struggle to compete for available funds. On average, donor countries contribute less than $0.75 per child per year for education in developing countries (d'Aiglepierre & Wagner, 2013). Moreover, all types of aid are subject to aid fragmentation and "aid orphans" – meaning certain countries receive a disproportionately low amount of aid relative to local needs because donors favor other countries instead (OECD, 2016).

At the same time, donors often focus attention on short-term achievements, such as disaster relief, rather than focusing on long-term goals, such as education (Riddell & Niño-Zarazúa, 2016). By improperly targeting aid, donor countries risk undermining the effectiveness of aid dollars. Donors may further undermine the effectiveness of aid by focusing on short-term goals rather than long-term development, including education.

As with all types of aid, evidence of effectiveness is an important factor in convincing donors to initiate and continue aid for education. However, while aid has shown promise for improving access to education, the effectiveness of that education remains questionable. For example, aid for the educational sector has helped developing countries achieve nearly universal enrollment in primary education, in keeping with the United Nation's Millennium Development Goals (Dreher, Nunnenkamp, & Thiele, 2008; UN, 2015a). However, "with respect to enhancing primary education outcomes, aid has been more relevant for improved enrollment (education quantity) than for increased achievement (education quality)" (Birchler & Michaelowa, 2016, p. 48). Ultimately, donor motivation largely determines the size and targeting of aid. However, the philosophy underlying donor motivations may ultimately undermine the effectiveness of the aid.

Technological determinism

The theory of technological determinism explains the logic behind the OLPC program and similar technologically-oriented philanthropic endeavors. In fact, with a stated goal of transforming the world through the dissemination of technology, the OLPC program is a textbook example of technological determinism. Technological determinists view technology, including educational technology, as central to societal progress (Smith, 1999; Jones, 2001; Servaes, 2015). Technological determinists generally split into "hard" and "soft" camps, with hard determinists arguing technology alone drives social change; soft determinists also view

technology as determining change within society, albeit with more room for people to exercise agency over society's ultimate destiny (Heilbroner, 1967; Friesen, 2008; Oliver, 2011). Hard determinists would expect the mere existence of educational technology in a developing country to lead to improved education and, eventually, to result in economic development. However, determinist thinking fails to consider the way technology is introduced, as well as local factors that may contribute to (or work against) successful implementation of technology.

A fundamental weakness of technological determinism is the theory's inherent optimism – often referred to, in the most extreme form, as technological utopianism. Hard determinists cite the positive effects of new technologies, while ignoring the possible downsides. At best, soft determinists may view technology as inherently neutral (Winner, 1980). In popular culture, for example, the debate over technological neutrality has most famously played out over the gun lobby's claim "guns don't kill people, people do" (Grint & Woolgar, 2013; Toyama, 2011). From a technological determinism standpoint, the gun is indeed innocent. Nevertheless, technologies do not exist in a vacuum, and social and economic surroundings will invariably affect the nature and severity of technology's impact – including for computers in education.

Technological determinists see considerable opportunity in the field of education. If educators make use of computers, the internet, and other technological advances, then student learning should invariably improve, and society will benefit as a result. In practice, however, educators have found "the focus on the tech has at times become the problem rather than the enabler" (Nalder, 2012). By centering a project's focus on the technology, rather than on student learning, well-meaning educational technology endeavors often suffer from teacher resistance, disinterested students, poor management, and cost overruns (Tiene, 2004; Windschitl & Sahl, 2002). At the same time, "technological opportunism" leads ambitious educators to reverse

engineer educational theories and practices to justify utilizing new technologies (Salomon & Perkins, 1996; Mende, 1974). Technological determinism causes educators to increasingly focus attention on educational technologies – on the assumption students will benefit from the technology – rather than focusing on the students. At the same time, the difficulty of configuring educational technologies to match local conditions can lead to "one size fits all" solutions such as the OLPC program.

The law of technological amplification presents a counterbalance to the overly optimistic outlook of technological determinism. While not opposed to technology in general, the law of amplification seeks to frame technology's effects in more nuanced terms, recognizing that technology merely serves to reinforce existing social inequities. As Kentaro Toyama (2015) explained in his seminal work on amplification theory, "technology's primary effect is to *amplify* human forces" (p. 29). Therefore, the "indiscriminate dissemination of packaged interventions" – such as the one-size-fits-all OLPC program – "is a waste of resources and often counterproductive" (p. 108). As a relatively new theory, few scholars have written about Toyama's law of amplification to date, and the theory has yet to withstand much examination beyond Toyama's own writings. However, the following analysis will seek to explain how the OLPC program supports the law of amplification while simultaneously demonstrating the folly of technological determinism.

DATA AND METHODS

The OLPC program has generated considerable interest among academics in many different fields of study, particularly in education, information technology, political science, and economics. Thus, a fair amount of academic literature already exists about the OLPC program – although not as much as I had initially expected, indicating a need for further research. The peer-

reviewed literature also proved to be more reliable than many of the other sources described below. Scholarly articles provided background information on the program and key actors, data about laptop deployments, and project evaluations for studying the effectiveness of the OLPC program. At the same time, lending an interdisciplinary perspective revealed gaps in the literature, as most researchers have a narrow focus within a given discipline. Borrowing from different disciplines also enabled me to find connections scholars within individual disciplines may have missed, such as combining relevant details about geography, economics, and political science.

Similarly, newspapers and other media from around the world have produced many stories about the OLPC program since its inception in 2005. As a result, I was able to draw upon news reports from local and regional sources, particularly from Rwandan newspapers. The feel-good nature of the OLPC program lent itself well to human-interest stories, even if the stories were frequently light on substance and lacked subsequent follow-up. Nevertheless, many news articles provided information about the timing and location of OLPC deployments, along with firsthand accounts. News reports also captured the mood at the time, such as the promise of a pending deployment, or the disappointment of a failed pilot program. Therefore, media reports contributed to the overall picture of OLPC's reception locally, while providing details unavailable elsewhere.

The OLPC program also served as a source of data, particularly data that was not available through secondary sources. OLPC sources included the official website (one.laptop.org), the official wiki (wiki.laptop.org), and the official blog (blog.laptop.org). These sites provided firsthand information about the program, including background information, deployment statistics, and technical specifications about the laptops. Unfortunately, the OLPC

sites are strongly biased in favor of the program, and I was unable to independently verify much of the information. The official OLPC data is also frequently incomplete and out of date. Nevertheless, OLPC data was useful as primary information about deployments, particularly when OLPC provided data unavailable elsewhere. Therefore, when considered critically, OLPC data added to the overall analysis of the program.

Meanwhile, non-governmental organizations (NGOs) and other third-party reports provided supplemental information not available from OLPC. For example, the World Bank provides trusted and standardized data about GDP per capita and education spending per student. By gathering data from the World Bank, I could directly compare conditions across countries. Also, a report by the Inter-American Development Bank (IDB) on the effectiveness of the OLPC program in Peru was valuable, as the OLPC program did not perform effectiveness studies. In fact, the IDB report stands the only large-scale, randomized, controlled evaluation of the OLPC program. Despite Peru not being a focus of this project, the report's findings were sufficiently generalizable, especially in lieu of any other studies of comparable scope.

To collect a representative sample of scholarly articles about OLPC, I performed numerous searches in library databases and Google Scholar. Sample search terms included constructionism, technological determinism, the law of technological amplification, and combinations of OLPC and individual country names, such as OLPC and Uruguay. Additionally, I searched for names of key actors, such as Nicholas Negroponte, Walter Bender, and Miguel Brechner. Meanwhile, I have been receiving search alerts through Google Scholar and the ExLibris Primo discovery system for several years, providing me with links to scholarly articles at the time of publication. Through these techniques, I ultimately gathered more sources than I could use in a project of this scope. However, the abundance of possible sources allowed me to

broaden my understanding of the OPLC program, while selecting the articles that most directly addressed my research question.

The remainder of the source types – media reports, OLPC websites, NGO data, and third-party reports – were all available online. To collect these sources, I mined the bibliographies of the abovementioned scholarly sources, followed links from other non-scholarly sources, and generally made use of online searches. Wherever possible, I also subscribed to mailing lists, such as the unofficial (and now defunct) OLPC News mailing list. As with my collection methods for scholarly literature, the push-pull mix of actively searching for information while also receiving automated updates kept me up to date on developments within the program and related to the program, such as the publication of the abovementioned IDB report. And, as with scholarly literature, the abundance of non-scholarly literature allowed for selectivity. The articles, reports, and data included here directly address aspects of the research question, including country backgrounds, education spending, and evaluations of OLPC pilot programs.

Finally, I employed a comparative analysis method for my project. This method entailed comparing and contrasting the OLPC programs in Uruguay and Rwanda, with some consideration of the OLPC program in Peru as well. (Some consideration of Peru was necessary due to the size of the OLPC program in Peru, and also to incorporate the findings of the IDB study.) Of particular interest were factors possibly contributing to the OLPC program's success, such as languages, economic conditions, and education spending. By comparing these factors between countries, I was able to draw conclusions about conditions contributing to (or hindering) OLPC's success. Uruguay and Rwanda were especially useful countries for comparison, given the sufficient similarities between the two countries – such as both countries being small, monolinguistic, and centrally administered. Other possible combinations of countries (such as

Uruguay and Peru within South America, or Rwanda and Kenya within Africa) would have been less effective because the countries differ too greatly in terms of size, linguistic conditions, and political structure. Therefore, a comparison of the OLPC programs in Uruguay and Rwanda provides an optimal framework for the following analysis.

ANALYSIS

OLPC deployments

The OLPC program distributed computers to almost 40 countries, although all but three of those deployments failed to progress past the pilot phase. According to the most recent available data, OLPC distributed approximately 2.5 million laptops from 2007 to 2013, primarily to three countries: Peru, Uruguay, and Rwanda. Peru led with 980,000 reported deployments, followed by Uruguay with 560,000 deployments, and Rwanda with 320,000 (OLPC, 2013). While impressive, the numbers fell well short of the 150 million laptops per year Nicholas Negroponte had initially predicted the program would produce (Ricciuti, 2005). Furthermore, the official counts from the OLPC program included "XOs delivered, shipped, and ordered" (OLPC, 2013). Therefore, the actual number of laptops received by children in the target countries may have been significantly lower. This lack of transparency about such basic information as the number of laptops deployed did little to instill confidence in countries considering investing in the program.

To order a significant number of laptops, a country had to be able to afford to invest in technology on a large scale, or else had to be able to find donors willing to make a large and continuing contribution. Because the actual price of the so-called "$100 laptop" consistently hovered around $200, the OLPC program represented a significant investment for any educational system, particularly in the developing world. In fact, estimates of the total cost of

each laptop – including electricity, connectivity, physical repairs, and software maintenance – ranged from $500 to $1,000 per unit (Zucker & Light, 2009). Table 1 shows the education spending of Peru, Uruguay, and Rwanda, as well as each country's per capita gross domestic product (GDP). While Rwanda leads with 5.1% of GDP spent on education, Rwanda lags far behind Uruguay and Peru with only $697 per capita GDP (World Bank, 2016). By way of contrast, Uruguay qualifies as an "upper middle income" country with $15,574 per capita GDP, making Uruguay far more able to afford an investment like the OLPC program. Meanwhile, Peru faces the double challenge of low education spending and relatively low income, along with a large population. As a result, Peru was unable to sustain the OLPC program without considerably raising overall education spending or raising considerable outside funding, neither of which the government of Peru was able to accomplish.

Table 1

Largest OLPC deployments by country, including education spending and GDP

Country	Laptops deployed	Population	Education spending (% of GDP)	Per capita GDP	World Bank designation
Peru	980,000	31,377,000	2.8%	$6,027	Middle income
Uruguay	560,000	3,432,000	4.5%	$15,574	Upper middle income
Rwanda	320,000	11,610,000	5.1%	$697	Low income

As noted in the literature review, technology in education is most effective when educators apply technology in a culturally appropriate fashion. One of the most basic indicators of cultural appropriateness centers around language, as culture is so intricately bound together with and expressed through language. Unfortunately, the OLPC program often failed to take

language into account, focusing more far more effort on technology development than on translating XO software into local languages. As a result, OLPC utilized Spanish or English in nearly all deployments (OLPC, 2013). Fortunately, the lack of language options had little or no effect in some countries – such as in Uruguay, where nearly 100% of the population speaks Spanish (CIA, 2017). However, in countries such as Peru, where only 84% of the population speaks Spanish as a primary language, minority-language speakers were at a significant disadvantage, most notably the 13% of Quechua speakers (CIA, 2017). The worst language mismatch existed in Rwanda, where OLPC initially deployed English-language laptops, though only 0.1% of the population speaks English as a first language (OLPC, 2013; CIA 2017). Fortunately, volunteers quickly set about translating OLPC software into Kinyarwanda, which is almost universally spoken in Rwanda, thereby making subsequent deployments more accessible to students. Given the complexity of adapting software language to local realities, OLPC was never able to move beyond the pilot phase in such linguistically complex countries as Nigeria or India, each with numerous official languages and hundreds of living languages in use. As a result, language presented a significant barrier to larger and more diverse countries considering adoption of the OLPC program.

Measuring Impact

Measuring the impact of the OLPC program posed numerous challenges, especially given the program's lack of a definition of success or failure. With no standardized evaluation system in place, countries had to devise evaluation methods from scratch. As a result, evaluations varied greatly in terms of quality and depth, making thorough comparisons between countries nearly impossible. In an analysis of 21 OLPC pilot program evaluations, Nugroho & Lonsdale (2015) noted six methodological issues: 1) little opportunity for longitudinal studies, 2) anecdotal

evidence with little formal documentation, 3) inability to generalize outcomes, 4) inability to communicate directly with local stakeholders, 5) lack of clarity regarding criteria of success, and 6) lack of baseline data (p. 6). For example, a pilot program evaluation in Afghanistan failed to include a control group, making it "impossible to separate the impact of the laptops with the effect of two months of additional learning at school" (p. 14). Meanwhile, in Mali, participants were reportedly afraid to provide negative feedback, leading to biased results (p. 13). The response bias demonstrated in the Mali study – where respondents tell researchers what they think the researchers want to hear – may have impacted many OLPC evaluation studies. Unfortunately, the unreliability of most OLPC evaluations likely prevented many countries from expanding pilot programs or from investing in the OLPC program at all.

Unfortunately, only one large-scale, randomized, controlled evaluation exists of an OLPC program that had moved beyond the pilot phase. A report commissioned by the Inter-American Development Bank (IDB) studied 319 public schools in Peru over the course of 15 months, and the results were generally unfavorable to the OPLC model. Most notably, the IDB report found "no statistically significant effects on Math and Language" (Cristia, Ibarrarán, Cueto, Santiago, & Severín, 2012, p. 16). Contrary to anecdotal claims by the OLPC program, the IDB report also found laptops did not positively affect school attendance or time students spent completing homework assignments (p. 15). In terms of the laptops' effect outside of school, the IDB report found no gains for students who took laptops home when compared with the control group (p. 19). A lack of evidence supporting home use of laptops is particularly damaging to OLPC's claims of a spillover effect, whereby parents and siblings might benefit from a student participating in the program, although the IDB report did not specifically study the impact on family members with access to laptops at home. However, the evidence XO laptops did not

affect math and language scores drew significant negative attention, further damaging the program's ability to expand.

OLPC supporters countered by arguing the IDB reports findings were mixed, with some evidence of a positive impact on students. In particular, supporters focused on findings demonstrating an increase in students' interest in learning – in keeping with the program's constructionist foundations – rather than measurements in academic subject areas such as math and languages. For example, the results of the IDB report "suggested that increased interaction with technology improved general cognitive skills" (Cristia et al., 2012, p. 17). Specifically, the report found small but significant improvements in the Raven's Progressive Matrices (RPM), a test measuring non-verbal abstract reasoning. However, "positive impacts are concentrated among schools with higher academic performance before the introduction of the program" (p. 18), indicating a widening rather than a narrowing of the digital divide within Peru. Moreover, the improvements in RPM scores were higher among boys than among girls, although the report did not investigate possible reasons for the disparity. Overall, while the findings supported earlier literature showing some benefit to increased use of technology in instruction, the costs far outweighed the benefits.

While less extensive than the IDB report, an analysis of several pilot programs in Brazil studied the effectiveness of the OLPC model as well. Conducted in 2010-2011, the study sought to measure the impact of phase three of Project UCA-Total (Brazil's implementation of the OLPC program) in five cities across the country. In a sign the OLPC program was often deaf to criticism, the report's authors learned UCA's organizers had failed to consider the findings of any evaluations conducted during phase one or phase two of UCA-Total, in part because organizers deemed the findings too negative (Lavinas & Veiga, 2013). Unlike the IDB report in

Peru, the UCA study found positive effects among students who took laptops home – although only among non-poor students, presumably because most poor students lacked internet connections at home (Lavinas & Veiga, 2013). Like the IDB report in Peru, the results in Brazil also showed "Project UCA-Total had a direct impact in terms of making better use of the technological structure already available in schools" (Lavinas & Veiga, 2013, p. 567). In other words, the UCA program amplified positive effects where technology already existed. However, by failing to address the existing disparities, the program was largely only reinforcing – and potentially expanding – the digital divide within Brazil.

Nevertheless, the UCA report contained positive findings for OLPC supporters as well. For example, the report indicated a positive effect on reading. Notably, providing laptops to children at the age of 6, just as the children were learning to read, showed "a highly positive impact, increasing his or her propensity to become literate" (Lavinas & Veiga, 2013, p. 567). Not surprisingly, the introduction of laptops in the UCA program increased children's access to computers, especially among the poor, and had an impact on learning tasks such as how to search the internet (Lavinas & Veiga, 2013). Nevertheless, the positive effects of the program varied widely between cities, and varied even within individual cities, and were therefore not always generalizable. The positive outcomes were also not specific to the XO laptop, but merely a result of an increased introduction of technology into the classroom. Ultimately, in a disappointing outcome for OLPC supporters, Brazil's UCA program abandoned the XO laptop and invested in Intel Classmate PCs instead – competing laptops for the education market that were Windows-based and similarly priced to the XO.

Finally, the results of a pilot program evaluation in Haiti likewise revealed concerns for the OLPC program, including logistical problems, low battery life, and challenges with the

constructionist pedagogy. While the logistical problems were likely a result of studying an early pilot program, and battery life improved in subsequent upgrades to the XO laptop, questions about the appropriateness of constructionist pedagogy lie close to heart of the OLPC program. Despite OLPC's claims that the laptops would inspire children to learn through exploration, only 2% of students' laptop use during the evaluation period was exploratory in nature (Näslund-Hadley, Kipp, Cruz, Ibarrarán, & Steiner-Khamsi, 2009, p. 26). Students exhibited avoidance, frustration, and confusion with unfamiliar aspects of the laptops; as one child said, "The teacher doesn't explain and I don't ask" (p. 38). While the report concluded better teacher training could help alleviate the "ceiling affect" of constructionist pedagogy, the above example nevertheless demonstrates the challenge of introducing a new learning theory alongside new technology. The one-size-fits-all solution of the OLPC program – however well intended – appeared to be attempting to accomplish too much at once.

Case studies: Uruguay and Rwanda

To conclude the analysis, a comparison of Uruguay and Rwanda provides a lens for examining conditions the OLPC program faced in practice. As explained below, Uruguay and Rwanda are vastly different, though both countries also share many characteristics potentially contributing to the OLPC program's relative success. For example, Uruguay and Rwanda are both compact – measuring 176,215 and 26,338 square kilometers, respectively, or slightly smaller in size than the U.S. states of Washington and Maryland (CIA, 2017). Uruguay and Rwanda also both have relatively small populations – 3,432,000 and 11,610,000, respectively, or slightly smaller populations than Connecticut and Ohio (UN, 2015b). While Uruguay has more well-developed infrastructure than Rwanda, the manageable size of both countries makes laptop deployments much more feasible than in a country with the size and population of China, India,

or Brazil. Therefore, the manageably sized geography and demographics of Uruguay and Rwanda contributed to the OLPC program's relative level of success in those two countries.

Uruguay and Rwanda share further similarities, particularly regarding the high-level government support for the OLPC program in each country. In both cases, the OLPC program represented a major hallmark of the administration. Rwanda's President Paul Kagame announced an intention to make the OLPC program part of the Kagame administration's long-term legacy, utilizing educational technology to transform Rwanda from an agricultural society to a technology-oriented, service-based economy (Raghavan, 2014). In Uruguay, President Tabaré Vázquez announced Plan Ceibal (Uruguay's version of the OLPC program) as part of an ambitious agenda to transform education in Uruguay (Vázquez, 2009). For Uruguay's socialist government, the OLPC program served not only as a tool for technological education, but also as a means of leveling the playing field within schools by narrowing the digital divide between rich students and poor students (Bender et al., 2012). Thus, while the underlying goals of the OLPC programs in Rwanda and Uruguay differed, both programs enjoyed the dedicated support of strong, centralized government administrations in peaceful, stable countries. The top-down implementation in both countries also fit with Nicholas Negroponte's original vision for OLPC deployments, making Uruguay and Rwanda more likely to succeed with the OLPC program than countries with weak central governments or less stable conditions.

At the same time, differences between the economies of Uruguay and Rwanda make the OLPC program more likely to succeed in Uruguay than in Rwanda. As noted previously, Uruguay is considerably richer than Rwanda and could therefore better afford such a major investment in educational technology. Rwanda was able to finance the OLPC program through generous foreign aid – amounting to some 40% of the country's overall budget – meaning a

continuing OLPC program in Rwanda would have relied on a continued high level of aid, an unlikely proposition in the long term (Raghavan, 2014). Furthermore, Rwanda faced infrastructure challenges, with only 5% of schools having electricity when the program began (OLPC, 2011). From a pedagogical standpoint, many Rwandan teachers struggled to adapt to constructionism, whereas Uruguay was already utilizing constructionism prior to the introduction of the OLPC program (Tashobya, 2015; Derndorfer, 2012). While Uruguay achieved full deployment very shortly after implementation of the program, Rwanda made considerable progress with the OLPC program, yet never achieved anywhere near full deployment. Overall, a program like OLPC seems likely to truly succeed only in countries like Uruguay – hardly the world's neediest country – with the financial, technological, and pedagogical background to support such a large and complicated undertaking.

DISCUSSION

One size doesn't fit all

The OLPC program's top-down, one-size-fits-all approach generally failed to take local considerations into account when planning new deployments. Negroponte sold the program to top-level government officials, who then pushed the program down to regional school administrators, who in turn pushed the program out to individual schools, and then to individual classrooms. On a macro level, the top-down deployment approach failed to account for politicians who may have exploited the "feel good" nature of the OLPC program to make campaign promises, without any sincere intention to follow through (let alone fund) the program after the election (Kraemer et al., 2009). On a micro level, OLPC's one-size-fits-all approach ignored the natural diffusion of innovation – whereby some students would adopt the technology more quickly, and others would gradually follow suit (Rogers, 1962). The top-down, one-size-

fits-all approach also failed to consider teachers and parents as crucial stakeholders, treating them instead as something of an afterthought. One nearly universal finding of pilot program evaluations was a need for more intentional and rigorous laptop training for teachers. Because the teachers and parents felt uninvolved in the decision-making process, many approached the program with suspicion and therefore did not support the program to the degree necessary to help ensure success.

Introducing a new pedagogical theory alongside a new technology only compounded the challenges to OLPC's success. In fact, OLPC's grounding in constructionism presented one of the largest hurdles to the program's success. Changing from a teacher-centered learning model to a student-centered learning model requires "considerable amounts of preparation work as well as continuous support for the local educators involved" (Nugroho & Lonsdale, 2010, p. 11). However, the program repeatedly demonstrated a focus on technology – not on teachers or students – as evidenced by OLPC's constant development of new and improved XO laptops, while devoting little attention to teacher training modules. Meanwhile, many teachers expressed concern about being replaced by computers, or at least having a diminished role due to the new technology, thereby exhibiting a clear misunderstanding of constructionism's very nature. By not foreseeing these fears, and by not addressing these fears once they arose, OLPC managed to make constructionism a barrier to adoption of the program rather than an asset.

Ultimately, the OLPC program appears to have been little more than a technology experiment, with education as a secondary goal. Despite the program's original mission of providing one laptop to every child in the developing world, focus consistently remained centered on the technology, not on logistics, training, or evaluation. OLPC founder Nicholas Negroponte attempted to shift the goalposts in this regard by claiming:

> The original mission is now ten years old and the world has changed, so the mission has changed. The world no longer asks if laptops and education are connected. The only question today is, 'How do I pay for this?' For that reason, OLPC has morphed into proof of principles. (Harris, 2014)

Negroponte's claim rang hollow, an apparent attempt to claim victory in defeat – particularly coming at a time when OLPC was closing offices rather than expanding operations. Negroponte was also refusing to acknowledge OLPC's failure to be more culturally aware in the program's efforts.

Negroponte's neocolonialist experiment

The OLPC program had strong traits of paternalism and neocolonialism, demonstrated in part by the program's top-down distribution model. As noted previously, OLPC sold laptops to top-level government officials, who then dispersed the laptops through national education ministries, thus involving large and complicated bureaucracies. While this approach ensured buy-in at the highest level, the top-down approach also ran counter to OLPC's intentional image as a grassroots organization. Somewhat tellingly, Negroponte unveiled the OPLC program at the 2005 World Economic Forum in Davos, Switzerland – an annual gathering many consider a "country club" meeting where the world's richest countries gather to discuss the fate of the world's poorest countries (Kraemer, Dedrick, & Sharma, 2009). Proponents of the OLPC program cited the influence of Paulo Freire's critical pedagogy, claiming positive change is only possible "by empowering individuals living in disadvantaged situations with the skills *they* need to change their environment" (Bender et al., 2012, p. 17). Conversely, some of the program's harsher critics argued "learning goals suggested by the OLPC smack of neo-liberal governmentality transplanted from the developed world into the developing world" (Tabb, 2008,

p. 338). In reality, the program's influence was never as strong as proponents had hoped or opponents had feared. Uruguay and Rwanda would likely have both developed their own programs, perhaps utilizing Intel Classmate PCs in place of XO laptops. In countries where OLPC pilot programs failed, those failures were rooted more in the program's cost and lack of planning than at the conceptual level. Nevertheless, future programs with similarly lofty goals must be careful to consider how those efforts may reflect unintended traits of paternalism and neocolonialism.

Languages of deployment represent another area of paternalism and neocolonialism in the OLPC program. Because language plays such a significant role in preserving cultures, the program's use of former colonial languages demonstrated insensitivity at best. To be fair, OLPC could not possibly translate every XO software program into every local language, and volunteers strove to translate as much of the software as possible. Nevertheless, OLPC fell short of the spirit of UNESCO's Promotion and Use of Multilingualism and Universal Access to Cyberspace, which sought "to ensure that all cultures can express themselves and have access to cyberspace in all languages, including indigenous ones" (UNESCO, 2003, p. 2). Linguistic insensitivity was especially apparent in a 2012 publicity stunt, when Negroponte attempted to prove computers alone were sufficient for teaching children – without any intervention at all from educators – by dropping XO tablets from a helicopter into two remote Ethiopian villages (Venkatraman, 2011). When OLPC team members visited the villages six months later, they hailed the experiment as a triumphant success (and worldwide press uncritically echoed the claims of success) in large part because village children had begun learning English from the tablets, including learning how to sing the "ABCs" in English (Mitchell, 2012; Straziuso, 2013). Not only was the evidence of achievement anecdotal at best, but the question remains of whether

learning English was the best possible outcome of the experiment. Reports made no mention of whether children learned to read and write in local languages.

CONCLUSION

The OLPC program was well intended, though not well thought out and not well executed. Negroponte and his partners came mostly from technological backgrounds, initially neglecting to seek the advice of educators, development scholars, and logistical experts. OLPC's leadership also failed to listen to criticism until too late. The original XO laptop was a technological marvel at the time, deserving of credit for helping to spur the proliferation of low-cost, no-frills "netbook" computers. However, for-profit competitors proved to be more agile, and the introduction of tablet computers soon left the OLPC program playing from behind rather than continuing to lead in terms of innovation. The OLPC program had attempted to accomplish too much too quickly, spreading resources too thin and eventually accomplishing much less than otherwise may have been possible.

Unfortunately, I faced certain limitations in this study of the OLPC program. I would have liked to interview key actors within the program, such as founder Nicholas Negroponte and early collaborators (and later defectors) such as Walter Bender. If possible, interviewing participants in various OLPC deployments around the globe – organizers, volunteers, teachers, students, and parents – would have likewise shed considerable light on the program. Optimally, I would have conducted those interviews during or shortly after the program's activity in a given country. Naturally, the sheer scope of OLPC's reach makes a complete survey of the program's efforts nearly impossible, especially to the extent that international travel would have been required. A more thorough investigation would also require knowledge of many languages,

although Google Translate was immensely helpful in translating reports written in languages other than English (most notably documentation about Uruguay's Plan Ceibal program).

Future research on the OLPC program should attempt to address as many of the above limitations as possible while also delving deeper into specific aspects of the program. For example, as a non-profit organization attempting to operate in developing countries worldwide, the OLPC program would make an excellent business case study. From an educational standpoint, further research into the program's use of constructionism could also provide insight into the pros and cons of introducing new pedagogical theories in the developing world. Furthermore, follow-up studies on former OLPC deployments could help educators better understand the long-term effects of technological interventions. Similarly, further research could investigate similar programs that may have taken place, both to study those programs' success relative to the OLPC program and to determine which factors either helped or hindered in specific environments. And if similar efforts have been successful on a smaller scale, what prevented those programs from scaling up or expanding to other countries? Ultimately, it seems likely that technological interventions such as the OLPC program accomplish little more than to amplify the conditions already present. Despite the best of intentions, such programs must be culturally appropriate and specifically adapted to local conditions to be truly successful.

REFERENCES

Barrera-Osorio, F., & Linden, L. L. (2009). The use and misuse of computers in education: Evidence from a randomized experiment in Colombia. *World Bank Policy Research Working Paper*. Retrieved from http://documents.worldbank.org/

Benavot, A., Moseley, S., Wiking, D., Phiri, F., Archer, D., Mundy, K., & Archer, D. (2010). International aid to education. *Comparative Education Review, 54*(1), 105-124.

Bender, W. Kane, C., Cornish, J., & Donahue, N. (2012). *Learning to change the world: The social impact of One Laptop Per Child*. New York: Macmillan.

Birchler, K., & Michaelowa, K. (2016). Making aid work for education in developing countries: An analysis of aid effectiveness for primary education coverage and quality. *International Journal of Educational Development, 48*, 37-52.

Central Intelligence Agency (CIA). (2017). *World Factbook.* Retrieved from https://www.cia.gov/library/publications/the-world-factbook/

Chen, W., & Wellman, B. (2005). Minding the cyber-gap: The internet and social inequality. *The Blackwell companion to social inequalities*, 523-545.

Cristia, J., Ibarrarán, P., Cueto, S., Santiago, A., & Severín, E. (2012). *Technology and child development: Evidence from the One Laptop Per Child program* (Inter-American Development Bank Report No. IDB-WP-304).

d'Aiglepierre, R., & Wagner, L. (2013). Aid and universal primary education. *Economics of Education Review, 37,* 95-112.

Derndorfer, C. (2012). An Interview with Miguel Brechner about all things Plan Ceibal. *OLPC News.*

Dreher, A., Nunnenkamp, P., & Thiele, R. (2008). Does aid for education educate children? *The World Bank Economic Review, 22*(2), 291-314.

Dutta, S., Geiger, T., & Lanvin, B. (Eds.). (2015). The global information technology report 2015: ICTs for inclusive growth. *World Economic Forum.* Retrieved from http://www3.weforum.org/docs/WEF_GITR2015.pdf

Freire, P. (1968). *Pedagogy of the oppressed*. New York: Bloomsbury Publishing.

Friesen, N. (2008). Critical theory: Ideology critique and the myths of e-learning. *Ubiquity, 8*(6).

Ganimian, A. J., & Murnane, R. J. (2016). Improving education in developing countries: Lessons from rigorous impact evaluations. *Review of Educational Research, 86*(3), 719-755.

Grint, K., & Woolgar, S. (2013). *The machine at work: Technology, work and organization.* Malden, MA: John Wiley & Sons.

Hamm, S., Smith, G. & Lakshman, N. (2008). Social cause meets business reality: The misadventures of One Laptop Per Child. *Inside Innovation, 4088*, 48-57.

Harris, D. (2014, March 17). One Laptop Per Child quietly closes Cambridge office. *Boston Business Journal.*

Heilbroner, R. L. (1967). Do machines make history? *Technology and Culture, 8*(3), 335-345.

Jones, Chris (2001). Do technologies have politics? The new paradigm and pedagogy in networked learning, paper presented at *Technology, Pedagogy and Politics* conference, Calgary, Canada, 3-6 May 2001. Retrieved from http://oro.open.ac.uk/33381/

Kraemer, K. L., Dedrick, J., & Sharma, P. (2009). One Laptop Per Child: Vision vs. reality. *Communications of the ACM, 52*(6), 66-73.

Lavinas, L., & Veiga, A. (2013). Brazil's One Laptop Per Child program: Impact evaluation and implementation assessment. *Cadernos de pesquisa, 43*(149), 542-569.

Luyt, B. (2008). The One Laptop Per Child Project and the negotiation of technological meaning. *First Monday, 13*(6).

Mitchell, G. (2012, November 18). One Laptop Per Child: Ethiopia. *BBC World Service.*

Nalder, J. (2012, January 25). One Laptop Per Child Australia flips the ICT in education deployment model. *Ubiquitous Learning*. Retrieved from http://ulearning.edublogs.org/

Näslund-Hadley, E., Kipp, S., Cruz, J., Ibarrarán, P., & Steiner-Khamsi, G. (2009). *OLPC pre-pilot evaluation report (Haiti)*. Inter-American Development Bank.

Norris, P. (2001). *Digital divide: Civic engagement, information poverty, and the Internet worldwide.* New York: Cambridge University Press.

Nugroho, D., & Lonsdale, M. (2010). *Evaluation of OLPC programs globally: A literature review.* Australian Council for Educational Research.

OECD (2016). *Aid fragmentation and aid orphans.* Retrieved from http://www.oecd.org/

OECD (2015). *Students, computers and learning: Making the connection.* OECD Publishing, Paris. Retrieved from http://www.oecd-ilibrary.org/

Oliver, M. (2011). Technological determinism in educational technology research: Some alternative ways of thinking about the relationship between learning and technology. *Journal of Computer Assisted Learning, 27*(5), 373-384.

One Laptop Per Child (OLPC). (2011). *Rwanda.* Retrieved from http://wiki.laptop.org/

One Laptop Per Child (OLPC). (2013). *Deployments.* Retrieved from http://wiki.laptop.org/

Owston, R. D., & Wideman, H. H. (2001). Computer access and student achievement in the early school years. *Journal of Computer Assisted Learning, 17*(4), 433-444.

Penuel, W. R. (2006). Implementation and effects of one-to-one computing initiatives: A research synthesis. *Journal of Research on Technology in Education, 38*(3), 329-348.

Plan Ceibal. (2017). *Acerca de Plan Ceibal.* Retrieved from http://www.ceibal.edu.uy/

Radelet, S., & Levine, R. (2008). Can we build a better mousetrap? Three new institutions designed to improve aid effectiveness. *Reinventing Foreign Aid*, 431-460.

Riddell, A., & Niño-Zarazúa, M. (2016). The effectiveness of foreign aid to education: What can be learned? *International Journal of Educational Development, 48*, 23-36.

Raghavan, S. (2014, April 4). 20 years after the genocide, Rwanda looks to a tech revolution to create an equal society. *Washington Post*

Ricciuti, M. (2005, September 28). The $100 laptop moves closer to reality. *CNET*.

Rogers, E. M. (1962). *Diffusion of innovations*. New York: Simon and Schuster.

Salomon, G., & Perkins, D. N. (1996). Learning in wonderland: What computers really offer education. In S. Kerr (Ed.). *Technology and the future of education* (pp. 111-130). NSSE Yearbook. Chicago: University of Chicago Press.

Servaes, J. (2015). *Technological determinism and social change: Communication in a tech-mad world.* New York: Lexington Books.

Smith, M. R. (1986). Technology, industrialization, and the idea of progress in America. In K. B. Byrne (Ed.), *Responsible science: The impact of technology on society* (pp. 1-30). San Francisco: Harper & Row.

Straziuso, J. (2013, January 18). Ethiopian kids teach themselves with tablets. *Washington Post.*

Tabb, L. S. (2008). A chicken in every pot; One Laptop Per Child: The trouble with global campaign promises. *E-Learning and Digital Media, 5*(3), 337-351.

Tashobya, A. (2015, March 19). Government to revamp One Laptop Per Child programme. *The New Times*.

Tiene, D. (2004). Bridging the digital divide in the schools of developing countries. *International Journal of Instructional Media*, *31*(1), 89.

Toyama, K. (2011, February). *Technology as amplifier in international development.* In Proceedings of the 2011 iConference (pp. 75-82).

Toyama, K. (2015). *Geek heresy: Rescuing social change from the cult of technology.* New York: Public Affairs.

United Nations (UN). (2015a). *Millennium development goals and beyond.* Retrieved from http://www.un.org/

United Nations (UN). (2015b). *World population prospects, the 2015 revision.* Retrieved from https://unstats.un.org/

United Nations Educational, Scientific and Cultural Organization (UNESCO). (2003). *Promotion and use of multilingualism and universal access to cyberspace.* Retrieved from http://www.unesco.org/

Van Deursen, A. J., & Van Dijk, J. A. (2014). The digital divide shifts to differences in usage. *New media & society*, *16*(3), 507-526.

Vázquez, T. (2009). Digital democracy. *Americas Quarterly*, *3*(1), 50-54.

Venkatraman, V. (2011, December 7). I want to give poor children computers and walk away. *New Scientist.*

Warschauer, M., Zheng, B., Niiya, M., Cotten, S., & Farkas, G. (2014). Balancing the one-to-one equation: Equity and access in three laptop programs. *Equity & Excellence in Education*, *47*(1), 46-62.

Wessels, B. (2013). The reproduction and reconfiguration of inequality: Differentiation and class, status and power in the dynamics of digital divides. In M. Ragnedda & G. W.

Muschert (Eds.), *The digital divide: The internet and social inequality in international perspective* (pp. 17-28). New York: Routledge.

Windschitl, M., & Sahl, K. (2002). Tracing teachers' use of technology in a laptop computer school: The interplay of teacher beliefs, social dynamics, and institutional culture. *American Educational Research Journal, 39*(1), 165-205.

Winner, L. (1980). Do artifacts have politics? *Daedalus, 109*(1), 121-136.

World Bank (2011). Can computers help students learn? *From Evidence to Policy, 4*. Retrieved from https://openknowledge.worldbank.org/

World Bank. (2016). *Educational statistics.* Retrieved from http://databank.worldbank.org/

Yujuico, E., & Gelb, B. D. (2011). Marketing technological innovation to LDCs: Lessons from One Laptop Per Child. *California Management Review, 53*(2), 50-68.

Zucker, A., & Light, D. (2009). Laptop programs for students. *Science, 323*(5910), 82-85.