

One Laptop per Child Birmingham: Case Study of a Radical Experiment

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Abstract

The One Laptop per Child (OLPC) program has sought to transform education by developing and distributing to low-income children around the world an inexpensive computer with an innovative interface and applications. This article investigates the implementation of OLPC in Birmingham, Alabama, where some 15,000 of the group's XO laptops were distributed to all first- through fifth-grade public school students and their teachers. Surveys were collected from a representative sample of children before and after they received their laptops, supplemented by observations and interviews in a Birmingham school. The use of the XOs by teachers and schools, the ways social and technical infrastructure affected program implementation, and the types of XO use by students are examined. The disappointing results of the Birmingham program, which has been discontinued, are analyzed in relationship to OLPC's technocentric approach, the organization's principle of child ownership, and the design elements of the XO hardware and software.

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Introduction

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, focusing on those in the most impoverished nations. Though fewer than two million of the 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 ways to improve the lives of the world's poor.

In 2008, OLPC launched its first major implementation in the United States with the distribution of 15,000 XO computers to students in grades 1–5, teachers, and administrators in Birmingham, Alabama. Imposed on the local school district by the Birmingham City Council, the program was mired in controversy from the beginning. Much of this controversy was related to the mayor of Birmingham, a contentious figure in Alabama politics and the one who initiated the OLPC program in the city. The XOs were seldom used in class and broke down at a rapid rate. After the two people responsible for launching the program, the mayor and city council president, were imprisoned for unrelated corruption, the new city leadership faced financial deficits and cut off further funding for the OLPC program, leading to its demise.

Though the Birmingham project is in some ways an outlier within the broader OLPC initiative, which originally targeted developing countries, in a number of ways the program faithfully adhered to key OLPC principles, and the problems that surfaced were typical of those reported in numerous OLPC implementations. How and why the program failed are thus worthy of close attention.

Overview of OLPC

The vision behind the OLPC project has been shaped by two complementary forces: the digital utopian beliefs of project founder Nicholas Negroponte (1995), former director of the MIT Media Lab, and the do-it-yourself learning philosophy of constructionism developed by Seymour Papert (1980, 1993), Negroponte's MIT colleague.

Negroponte joined MIT's faculty in 1966 after earning a master's degree in architecture from the same institution. The next year he founded the Architecture Machine Group, a future-leaning technology laboratory, which in 1980 he converted into the MIT Media Lab (formally opened in 1985). He provided start-up funding for many companies, including the technology magazine *Wired*. He wrote a column for *Wired* from 1993 to 1998 about many of his expectations for digital technologies. In 1995, he published *Being Digital*, which echoes many of the same dreams. In both his *Wired* column and in *Being Digital*, he discusses complete worldwide digitization not in terms of *if* but *when*: “[L]ike a force of nature,” he asserts, “the digital age cannot be denied or stopped” (Negroponte 1995, p. 229).

Negroponte and others in OLPC's leadership acknowledge that constructionism, a learning theory developed by Papert, inspired OLPC. Particularly important were Papert's 1980 book *Mindstorms*, where he describes constructionism in detail and proposes having a computer for every child, and his 1993 book *The Children's Machine*, where he pushes the idea of one computer per child more strongly. In 1982, Negroponte and Papert collaborated on a project to create labs with Apple II computers and constructionist software for children in Senegal and other countries, though the project was shut down after just a year because of infighting (Lawler 1997).

Blending Piaget's constructivist (with a *v*) learning approach with MIT's computer-centric culture, constructionism (with an *n*) advocates independent, playful learning that is assisted by a tool to think with (Papert 1993). Papert advocates the computer, the “Proteus of machines” (Papert 1980, p. xxi), as a particularly versatile tool that can ignite a passion for self-directed learning. Papert situates constructionism in opposition to traditional schooling, which he calls “instructionism” (1993, p. 137). According to Papert, instructionism turns children from “yearners,” who are naturally curious and passionate about learning, to “schoolers” incapable of creative thought (Papert 1993, p. 1). Papert argues that reforming schools is difficult, if not impossible. Instead, children should be given the tools to learn on their own, outside of school, and their progress cannot and should not be evaluated with traditional tests.

Constructionism's commitment to child-driven, child-centered learning and its view that teachers are just another (and sometimes less-adept) member of

the learning community were initially taken up by OLPC as a reason to downplay teacher training and other curricular support. “The role of the teacher is to become a co-learner,” Papert (2006) states in an interview for OLPC. Negroponte states his views of teachers more forcefully: “Now when 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 of as one-third of the teachers never show up at school” (Negroponte 2006). More recently, these views have been challenged by some in OLPC, but they influenced the development of OLPC’s core principles, which focus on self-directed student learning rather than a strong teacher role.

Core Principles

Papert’s constructionism and Negroponte’s digital utopianism are reflected in OLPC’s five core principles: child ownership, low ages, saturation, connection, and free and open source (One Laptop per Child 2010c). The first core principle expresses OLPC’s requirement that deployments be one-to-one programs, where students own their laptops and are allowed to take them home. In the second core principle, OLPC demonstrates a commitment to reaching young children. Their laptop is designed for children ages 6 to 12 and, because of screen size, keyboard size, and general design, is often difficult for adults to use.

OLPC’s third and fourth core principles—saturation and connectivity—are in line both with constructionism and with OLPC’s interest in radical, technologically driven change. If all children have these tools and they can communicate with one another, the organization posits, a massive shift in competencies and creativity can take place in only one generation. In its fourth core principle, OLPC explicitly equates its XO laptops with vaccinations in the kind of rapid, life-altering change they can create—all by themselves, with no need for additional social support (Ames 2008; One Laptop per Child 2010c). In a video posted to OLPC’s YouTube channel (<http://www.youtube.com/user/OLPCFoundation>), Negroponte states, “[The XO laptop] is probably the only hope. I don’t want to place too much on OLPC, but if I really had to look at how to eliminate poverty, create peace, and work on the environment, I can’t think of a better way to do it” (Vota 2007, n.p.). In this principle and elsewhere, OLPC promises a quick

fix to endemic problems in educational infrastructure and, ultimately, a shortcut to economic development. For these reasons, in the first years of OLPC Negroponte and other OLPC leadership would allow only governments in developing countries to place orders for the XO laptops—and only if they ordered at least 1 million units (see Kraemer, Dedrick, and Sharma 2009). Not until the organization found that such requirements resulted in few buyers did it begin to allow smaller deployments. Moreover, because OLPC’s leadership believed laptops themselves could create these changes, it focused only on deploying the XO laptops, not on technical support, curriculum, or training. The fifth core principle reflects OLPC’s commitment to using open-source software, which they place in a broader framework of open learning.

Though these five core principles illustrate the motivations of the OLPC project and demonstrate how both constructionism and digital utopianism have influenced it, the extent to which these principles are implemented in practice varies from site to site, depending on the approach of the organizations running the local or national program.

Deployments

Negroponte first announced the OLPC initiative, then called the \$100 Laptop Project, at the World Economic Forum in Davos, Switzerland, in February 2005. Later that year, he projected that 100–150 million laptops would be distributed by 2008 (Negroponte 2005). As of June 2011, an estimated 1.5 to 1.8 million XOs had been distributed or ordered, about two-thirds in Uruguay and Peru. Rwanda has received about 100,000, Argentina 60,000, and other countries, including Mexico, Mongolia, Nepal, Nicaragua, and Paraguay, have tried the XOs one city, district, or school at a time, generally with deployments of a few hundred to a few thousand computers. The Birmingham, Alabama, program represents, as of this writing, one of only a handful of XO laptop implementations of more than 10,000 computers.

Prior Research on Laptops and Learning

A substantial amount of research has been conducted on educational laptop programs. Most of this research has occurred in non-OLPC settings on what are typically referred to as *one-to-one laptop programs*.

One-to-One Laptop Programs

The first school laptop programs emerged in Australia in the early 1990s (Johnstone 2003), with U.S. programs launched a few years later. A national survey of U.S. school districts in 2007 indicates that about one quarter had launched one-to-one laptop programs as of that time and another quarter planned to launch them by 2010 (Greaves and Hayes 2008). The falling price of laptops, netbooks, smartbooks, and tablet computers suggests that one-to-one programs with some sort of mobile device will continue to grow.

An extensive body of research exists on one-to-one programs (for reviews, see Penuel 2006; Bethel et al. 2007; New South Wales Department of Education and Training 2009). Compared with classroom settings in which students have less access to technology, in classrooms where one-to-one programs have been implemented students use computers more frequently and teachers more easily integrate technology in instruction (Russell, Bebell, and Higgins 2004; Silvernail and Lane 2004; Warschauer 2006). Students also write more, get more feedback on their writing, and improve the quality of their writing (Russell, Bebell, and Higgins 2004; Jeroski 2008; Warschauer 2009). And students have greater opportunities to explore topics in depth and to receive individualized and differentiated instruction (Dunleavy, Dexter, and Heinecke 2007; Lowther et al. 2007; Grimes and Warschauer 2008). Programs are, for the most part, popular with both teachers and students, and interviews, surveys, and observations suggest greater learner engagement (Silvernail and Lane 2004; Warschauer 2008; Drayton et al. 2010). A number of recent studies report positive effects on learners' technological proficiency (Texas Center for Educational Research 2009) or academic achievement (e.g., Gulek and Demitras 2005; Suhr et al. 2010), while others report no significant impact on academic outcomes (e.g., Bernard et al. 2007; Dunleavy and Heinecke 2008).

One Laptop per Child Programs

Comparatively little research has been done on OLPC programs. The two largest OLPC implementations to date, however, have both been evaluated, and the results are informative. Peru distributed about 290,000 XO laptops from 2007 to 2009 and has since distributed about 200,000 more. A study by the Inter-American Development Bank in 2010 found a pro-

gram beset by difficulties (Santiago et al. 2010). Some of the schools lacked electricity and thus had difficulty deploying the computers. Almost all lacked Internet access, and the use of the XO's mesh networking to connect laptops was found to be limited. Only 10.5% of the teachers reported receiving technical support, and only 7.0% reported receiving pedagogical support. Amount of use in school appeared to fall sharply over time, and only 40% of teachers who had had the laptops for at least two months reported using them three or more times a week. Some 43% of students did not bring their laptops home as OLPC had originally intended them to do, in many cases because teachers or parents forbade it out of fear they would be held responsible if anything happened to the laptop. No significant differences were found on national test scores between students who received XOs and a comparable group of students who did not, but students who received the XOs expressed more negative opinions about school and schoolwork on a number of measures. The government of Peru recently announced that the program will be extended, but on a per school rather than per student basis, with new XOs deployed in technology resource centers to which groups of students will be brought (see discussion in Warschauer and Ames 2010).

In Uruguay, about 400,000 XOs were distributed in 2008–2009 to all primary school students in the country for individual use, and about 100,000 more have since been distributed to secondary students. Uruguay, a much wealthier country than Peru, devoted considerably more funding to the technical and social infrastructure, extending Internet access to almost all schools in the country and offering teacher training through a combination of in-person, television, and online materials (see Warschauer and Ames 2010). The program is widely supported by children, parents, and school directors and has provided computer access to many low-income children who previously lacked it (Martínez, Alonso, and Díaz 2009), with positive effects noted in rural areas (Hourcade et al. 2008). Nevertheless, a national evaluation indicates the laptops are still lightly used in Uruguayan schools, with only 21.5% of teachers reporting that their students use the XOs on a daily basis for individual work (Plan Ceibal 2009). In addition, in spite of the government devoting considerable resources for XO repair, a total of 27.4% of student XOs were unusable in 2010 because of hardware or software problems (Plan Ceibal 2010).

Reports of smaller pilot projects in New York (Lowe and Luhr 2008), the Solomon Islands (Solomon Islands Government 2010), and Haiti (Näslund-Hadley et al. 2009) tend to echo themes related to broken laptops, insufficient teacher training, and limited use by students in schools. But they also point to positive attitudes toward the laptops by children and the involvement of some children in promising constructionist learning activities.

Methodology

This article attempts to add to the small but growing body of research on OLPC programs by examining the Birmingham OLPC implementation. To do so, it draws on data from two different studies: (1) a pre-post survey in Birmingham carried out by the second author and some of her colleagues and (2) a multisite case study carried out by the first author in Birmingham and two other districts.

Research Site

The largest deployment of XO laptops in the United States to date occurred in Birmingham, Alabama, from 2008 to 2010. The former mayor of Birmingham, Larry Langford, a contentious figure in Alabama politics, contracted with OLPC to purchase 15,000 XO laptops for children in the first through eighth grades (later this became first through fifth grades) in Birmingham city schools. Over 95% of the students in Birmingham schools are African American, and poverty levels are very high, with 80% of students qualifying for free or reduced-price lunch. The mayor stated that he wanted to eliminate the digital divide in Birmingham and to prepare children to be active participants in the information- and technology-based society that currently exists in the United States (Leech 2007). While this is an admirable goal in many respects, an important contextual factor that affected the Birmingham deployment is that Langford did not consult with the school system to see whether they wanted computers, and particularly XO laptops, to be disseminated to their students. Langford also followed the principles of the OLPC philosophy and gave the laptops to the children, not to the school system. As he stated on the city website,

We need to put a laptop in each child's hands and step back and let them learn about the world and use their brilliant minds to come

up with solutions to the world's problems. If we give them these XOs and get out of their way, they'll be teaching us about the world. How many of us have questions about a computer and ask someone who is older how to fix it? None of us! You find the youngest person in the room and they'll have it fixed in a second. These kids get it, and we need to give them the tools that they'll need to succeed. ("Education Initiatives" 2009)

This lack of consultation with the school system and giving ownership to the students rather than the schools resulted in even more politicization of the XO purchase in Birmingham. The mayor wanted the schools to disseminate the laptops to the students. The school system noted that 15,000 was an insufficient number to supply all first- through eighth-grade students and teachers. The school system finally agreed to accept 1,000 XO laptops for distribution to first- through fifth-grade students and teachers at one elementary school in April 2008, approximately six weeks before school ended for the summer. The school system would review the results of this small pilot deployment before deciding whether to accept the remaining 14,000 XOs. In August 2008, the school system decided to accept the remaining 14,000 XOs to disseminate to first- through fifth-grade students, teachers, and administrators. Although the students own their XOs, the teachers and administrators do not; their XOs belong to the school system (a point that has been contentious among the teachers). Dissemination of the remaining 14,000 XO laptops took place between late August 2008 and March 2009. During this period, teachers were given, on average, two hours of training on the XO laptops.

Pre-post Surveys

The second author and colleagues obtained permission from the Birmingham city school system to conduct pre- and posttest surveys with fourth- and fifth-grade teachers and students. Fourth- and fifth-grade students were chosen because of reading ability and the relative ease of surveying these students rather than those at lower grade levels. The goal of the teacher survey was to assess baseline skill level and technology use in and out of the classroom, attitudes toward technology, training on the XO laptops, and teaching orientation, as well as to determine whether these changed as a result of the XO laptops being

distributed. The goals of the student survey project included determining changes in technology use levels and types, attitudes toward technology and computing careers, educational and career intentions, and a range of social and psychological outcomes as a result of the XO laptop dissemination.

School principals were contacted to obtain permission to survey their students and teachers. Twenty-seven principals allowed us to carry out the pre-survey; two chose not to participate in the post-survey because of scheduling conflicts. A Web-based survey was designed for the teachers. Principals were told about the survey and asked to relay the information to their teachers. In addition, fliers describing the survey and listing its website address were distributed to all the fourth- and fifth-grade teachers at each of the schools. Unfortunately, because of an extremely low response rate, the teacher survey results were not useful, and no posttest survey was administered.

Pretest student surveying occurred just prior to XOs being distributed in each school, while posttest surveying occurred during the last six weeks of the school year. The surveys lasted about 45 minutes and were administered in a group format. Students, either in individual classes or in larger group settings, were read the survey questions by a researcher and responded individually in writing.

For the pretest, 1,583 fourth- and fifth-grade students completed the survey. At posttest, 1,261 completed the survey. We were able to match 1,202 students from pre- to posttest surveys.

For the purposes of this article, we report descriptive results of the surveys that point to broad trends of XO use. For a more detailed report of quantitative findings focused on factors influencing variation in XO use, see Cotten and colleagues (2011).

Multisite Case Study

In 2009–2010, Warschauer (2010, 2011) carried out a national study of K-12 laptop programs deploying netbook computers and open tools (defined to mean both open-source software and open educational resources). A purposely stratified sample—based on students' ethnicity and socioeconomic status (SES), type of computer use, and model of program implementation—of three districts was chosen for the study: Birmingham Public Schools in Alabama, Littleton Public Schools in Colorado, and Saugus Union School District in California. Though

this article principally reports on the findings from the Birmingham portion of the study, it also makes reference, for comparative purposes, to the other two districts.

Research questions for the national study focused on the suitability of netbooks and open tools for school laptop programs, the relationship of netbook and open tool use to teaching and learning processes, and the best practices for implementing school laptop programs with netbooks and open tools. Each district was asked to nominate up to two focal schools as representative of the diverse demographic groups. In Birmingham, a principally African-American school in a low-SES neighborhood that is demographically representative of the whole school system was so designated. In both Littleton and Saugus, two schools were designated, one that is principally white and high SES and one that includes large numbers of Hispanics, English language learners, and students from low-SES families.

The research in Littleton and Saugus included at least 25 hours of classroom observation; at least 30 interviews of teachers, students, and staff; a district-wide survey of students and teachers in the laptop program; analysis of test score outcomes in laptop schools; and analysis of hundreds of student online writing samples. In Birmingham, the research was more constricted. This represents a limitation of the study, though one that is partially overcome by triangulating the lesser amount of qualitative data in Birmingham with the pre-post student survey. Data collected in the Birmingham portion of the multisite case study include observations, interviews, and artifacts.

Observations at a Focal School

Three classes were observed at the focal school—a fifth-grade class, a third-grade class, and a second-grade class—each for 45 minutes to an hour. During the class observations, the researcher was free to wander around the classroom, observe what children were doing, and talk informally with children and the teacher. Field notes were taken on the uses of XOs, the attitudes of teachers and students, and the comments made by teachers and students. The researcher was also given a tour of the school and spent substantial time walking through the school halls over a two-day period, observing the extent to which students were carrying or using XOs throughout the building.

Interviews

The researcher conducted 30–60-minute formal interviews with 12 people. These included the following people at the focal school, all selected by the site principal: the principal, two fifth-grade teachers, an English as a second language teacher, the library/media specialist, and two students. Briefer interviews were carried out with the second- and third-grade teachers during or right after the observation period. Additional people interviewed during the visit included a mayor's office staff person responsible for helping manage the OLPC project, a representative of the district instructional technology department, and two representatives of a consulting firm that was assisting with implementation of the OLPC program at the focal school and another district school. Interviews focused on the use of XOs and the perceived strengths and weaknesses of both the laptops and the OLPC program. Ten of the 12 interviews were digitally recorded. In two instances, the interviewee preferred not to be recorded, and careful notes were taken of responses.

Artifacts

A number of publicly available documents about the OLPC program in Alabama since the program's inception were collected by the researcher. These include statements published by the mayor's office and articles about the program published in local newspapers and magazines.

All observation and interview data, as well as student online writings about the netbook programs, were coded using a bottom-up approach. Codes were assigned with the assistance of qualitative analysis software, and code results were analyzed to seek patterns both within and across the three school districts. District and media artifacts were used to triangulate observation and interview data.

Findings

Triangulation of the qualitative and quantitative data analysis from the multisite case study and the data analysis of the pre-post surveys conducted in Birmingham yielded findings in three main areas.

Low Levels of Interest and Use by Teachers and Schools

Teachers were asked to participate in a pretest survey prior to the XO laptop dissemination. At that time,

the XO laptop program in Birmingham was controversial. Unfortunately, the response rate to the Web-based survey was poor: approximately 10% of the fourth- and fifth-grade teachers responded. We cannot determine whether this low level of teacher response was the result of a lack of teacher interest in and support for the OLPC program in Birmingham or the result of other factors such as lack of principal facilitation, low technology literacy skills among teachers and thus a reluctance to complete a Web-based survey, the politicized nature of the OLPC program in Birmingham, or lack of Internet access in classrooms. The online teacher surveys in the other two districts in the study had a high rate of teacher response: 86.8% in Littleton and 74.1% in Saugus. Both of those districts have Internet access in classrooms, and the laptop programs in these locations did not experience the types of controversy or problems noted in Birmingham.

A total of 80.3% of the Birmingham students surveyed indicated they either never use the XOs at school (20.4%) or use them a little (59.9%). Only 19.7% of students indicated they use them a lot at school. This stands in contrast to our surveys in other districts, where a majority of teachers and students indicated they use laptops for a substantial amount of the school day on a daily basis. For example, fourth-grade students in Saugus reported using the netbooks a mean of two hours per day in school, while fifth-grade students in Littleton reported using the netbooks a mean of 1.8 hours per day in school.

We suspect the classroom use figures reported by Birmingham students are actually overstated. Answers to other questions suggest that much of the reported school use occurs outside the classroom. For example, though only 20.4% of students indicated they never use the XO *at school*, 29.7% indicated on a separate question that they never use the XO *in class*. In Littleton and Saugus, students do not have access to the netbooks outside of class, so the reported numbers can refer only to school use in class.

Limited use in schools was also confirmed by Warschauer's (2010, 2011) case study research. In the two other districts in the study, our research team was welcomed into a wide range of schools and classrooms. In Birmingham, we were informed by district leaders that we could visit and collect data at only one school, because officials were uncertain about the degree of implementation at other schools. At this one school, we arranged for a two-day visit and asked to

observe as many classes as possible during our stay, especially at the fourth- and fifth-grade levels. We were not allowed to observe any classes during the first day, however, and only one of the 10 fourth- and fifth-grade classes at the school the second day. We observed two additional classes, for a total of three out of the 30 classes at the school, but one of the three classes we observed was taught by a consultant from MIT who was using the XO in the classroom rather than the classroom teacher. Over the two days, we walked extensively throughout the school, though, passing every classroom several times, and saw almost no XO use.

Interviewees were unanimous in confirming that the XOs are little used in the district, and press reports in Birmingham note that, although students love the laptops, use is low in the classroom (Crowe 2009; Leech 2010). Though the school district was never enthusiastic about the program, it felt even less obligation to support it after the two men who negotiated the XO purchase, former mayor Langford and former city council president John Katopodis, were convicted and imprisoned on bribery and fraud charges. In Langford's case, the charges related to steering county business to particular companies in exchange for bribes (Dewan 2009), and in Katopodis's case they related to misappropriation of funds from a charity he had formed called Computer Help for Kids (DeButts 2009). Though the convictions were not related to the OLPC program, they did result in questions in the Birmingham press about Langford's and Katopodis's motivations in initiating the program (see Crowe 2009).

Inadequate Social and Technical Infrastructure

The second pattern noted in the qualitative and quantitative data was the inadequate social and technical infrastructure for an educational laptop program. Prior to the full XO dissemination, two hours of paid professional development time, on average, were made available per teacher. All the educators we interviewed indicated this was insufficient, but some also added that teachers felt little enthusiasm to pursue additional professional development opportunities in their free time. As one teacher—an educational technology enthusiast who had been involved in offering professional development workshops—explained to us,

The XO is not really teacher-friendly. It's added to what teachers already have to do,

it doesn't function as well as a regular laptop, and it's smaller, and all the other things that come with that, so it takes time to learn. The training they gave us was not adequate though. I've been trying to provide [supplementary and voluntary] professional development on the XOs, but there hasn't been much turnout. Teachers come to the required days, but unless it was a professional development day when people are required to come they tend not to come.

In addition to providing professional development, many other laptop programs appoint teacher mentors in each school. The mentors get instructional release time in exchange for assisting other teachers with technology integration and answering their questions. No such system was in place in Birmingham.

We found not only the social infrastructure but the technological infrastructure in the Birmingham schools to be seriously lacking. Unlike more traditional one-to-one programs in which schools own and maintain the laptops, responsibility for maintenance of the XO hardware and software lies with children and their families. Many—whether for lack of motivation, expertise, money, or simply knowledge about how and/or where to get the laptops repaired—have not kept them in working condition.

Although parents and students supposedly had access to a hotline they could call with questions about their XO laptops, Cotten (2010) found that few students who had problems knew anything about this resource. Teachers also reported not knowing what to tell parents and students about how to get their computers repaired.

At the time of the posttest survey for students, which took place approximately five to six months after they received the laptops, 70% of respondents reported having had problems with their XOs, and 16% reported problems that had not been fixed. In each school, some students interrupted the posttest survey to ask us whether we could fix their XOs.

We witnessed these problems firsthand at the focal school we visited, approximately 19 months after the initial laptop distribution at that school. In the three classrooms we observed, only 23 of 57 students had working laptops. When asked, almost all whose laptops were not present reported their XO was broken and no longer functioning. We were again asked by students whether we knew how to repair their XOs.

(Though efforts were being made at the focal school and at other schools to teach the children how to make repairs, at the time of our visit only one full-service repair shop for XOs existed in Birmingham; it had been established by an enterprising city councilor who had voted to fund the laptop program in the first place.) The school was not an anomaly. Another survey conducted in fall 2010 found that less than half the fourth- and fifth-grade students in the district still had working XOs (Cotten et al. 2010).

Lack of wireless Internet access presented another serious infrastructure problem. In December 2009 we were told that fewer than one-third of the elementary schools in Birmingham had wireless Internet access. Among the small number of schools with such access, wireless networks were mostly extended only from one or two hotspots in the school, such as in the library. Although the focal school reportedly had Internet access in all its classrooms, one teacher explained that she shied away from Internet-based activities because her students would frequently need to walk out to the hallway to gain wireless access. In Cotten's (2010) student survey in April–May 2009, only 20.7% of students indicated they were able to access the Internet using their XO at school.

Finally, we found among teachers a general level of frustration with the XOs and broader infrastructure that persisted even when the computers and Internet both functioned. As one teacher explained,

They are slow. They are sluggish. They can't connect to the printers. I don't teach writing with them because I have no way to access students' written work other than walking around the classroom and looking at it. We even tried to set up student email accounts in my class, but the system blocked everything.

In one of our classroom observations, we witnessed firsthand how the limited capacity of the XOs, combined with the school's lack of other infrastructure, frustrated effective instruction. A teacher wanted one student to show the rest of the class what she was doing on her computer. But because the XOs have no external monitor port, the student could not connect her computer to the classroom video projector. Instead, she held her computer under a document camera, and the rest of the class squinted to see what was projected from the picture of her screen.

Types of XO Use

The XO laptops and software are promoted by the OLPC organization as specialized tools for “exploring and expressing” that can engage students in “constructing knowledge based upon their personal interests” and “sharing and critiquing those constructions” (One Laptop per Child 2010b). We found little evidence—either from classroom observations and interviews or from survey results of how computers were used by children pre- and post-laptop distribution—to indicate that these laudatory goals are being widely met.

Survey results suggest that the most frequently used XO applications at school, beyond the automated file record system called Journal, are, in order, Chat (a text-based messaging system), Record (which captures pictures, audio, or video), Memorize (for making or playing memorization games), and Write (for word processing). To what extent these results represent use inside or outside of class while at school is unknown, as is exactly how these applications are being used. Interviews and observations from the focal school indicate that a principal use of the XOs in classes at the school is creating digital flash cards with Memorize. That was the sole use of the XO we observed in two of the three classes we visited. In one class, students opened their textbooks and copied words on one side of electronic flash cards and the words' definitions on the other side (with the majority of students who did not have working laptops completing the exercise on standard index cards instead of on the computer). In another class we observed, students wrote possessive phrases provided by the teacher on one side and rewrote the same phrase using an apostrophe on the other side. In the third class we observed, students used the much more creative Scratch computer programming language, but the teacher told us he usually teaches Scratch only in an after school club and that teachers in the school do not regularly integrate the program in instruction. The use of Scratch in an after school club can be a positive experience for students who participate (see, e.g., Peppler and Kafai 2007), but thus far it reaches only a small minority of the children in the Birmingham focal school.

Students with working XOs typically use them about one to two hours per day at home, according to survey results. Some 63% of students indicated they also had access to computers at home before they got

the XO. On the posttest survey, 54% reported that besides their XO they had a computer at home that they shared with others, 26.5% had a computer besides the XO that only they used, and 20% reported not having another computer at home. Eighty percent of students indicated that they had home access to the Internet on the pretest survey. In the posttest survey, only 47.0% of students indicated they were able to access the Internet at home from their XO.

More than half the students (52%) who responded to the posttest survey reported spending 1–2 hours per day using their XO laptop, and 14% reported spending 3–4 hours per day. The amount of time students spent per day using computers and the Internet increased after receiving the XOs. However, ownership of an XO did not increase use of computers for academic or content-creation purposes. The frequency with which students used a computer to create or listen to podcasts, do research, or do homework all decreased slightly from the pretest survey (before XO ownership) to the posttest survey (after XO ownership). The percentage of students who reported creating a Web page or sharing creations online, low to begin with, also decreased slightly after XO ownership.

Discussion

In 2010, the Birmingham City Council cut off further funding for the XO program as part of a broader package of cuts made in response to budget deficits. Though XOs remained in the schools, the school superintendent moved the XO program “to a subordinate position” and began to emphasize other uses of technology (Birmingham News Editorial Board 2010). In spring 2011, Birmingham City Schools announced they were moving away from using XO laptops in the schools because of the continued lack of funding from the city council and problems with reliability of the XOs.

The Birmingham program stands in marked contrast to other one-to-one programs in the United States, which have shown broadly positive results. Laptops are widely used in these programs on a daily basis (see, e.g., Silvernail and Lane 2004; Warschauer 2006), and educational leaders are satisfied with their impact on teaching and learning processes (Greaves and Hayes 2008). Though a small number of laptop programs have been discontinued either because of lack of funding or lack of impact on test score out-

comes (Hu 2007), we know of no other large laptop program in the United States where the computers themselves are seldom used in the classroom. In the two other programs using netbooks and open source software investigated as part of Warschauer’s (2011) broader study, both districts experienced teacher and student satisfaction, improved learning processes, and gains in student test scores.

What, then, accounts for the low levels of use and unimpressive results of the OLPC program in Birmingham? Analysis of the program suggests that three fundamental characteristics of the implementation, all of which correspond to the broader OLPC approach, differ from other school laptop programs in the United States and are closely connected to the results achieved. One of these characteristics, a technocentric approach, has been broadly criticized elsewhere (see, e.g., Ames 2008; Vota 2009). The second, child ownership, has been little discussed. The third, the XO computer, has been generally praised.

Technocentric Approach

The OLPC approach is noted for its technocentrism and, in particular, the notion that the mere provision of technology, outside a broader social reform effort, will bring about wide-scale positive educational effects. In Birmingham, this took the shape of the mayor and city council supplying laptops to children with little funding for the school system for installation of Internet access, computer repair, maintenance of computers, or teacher professional development, and without giving the school system time to develop particular curricular or pedagogical plans for using the laptops in instruction. This is consistent with the overall OLPC approach as articulated by Negroponte (see, e.g., 2009), who emphasizes the transformative effect of the XO itself on children’s lives and deemphasizes or opposes the use of funds for pilot programs, formative or summative evaluation, and professional development. Most recently, for example, Negroponte suggested at the Social Innovation Summit, New York, that OLPC plans to “literally or figuratively, drop out of a helicopter . . . with tablets into a village where there is no school” and then disappear for a year before returning to see how children have taught themselves to read (Vota 2011, n.p.).

An unrealistic faith in the power of a new technology to bring about fundamental educational transformation, in and of itself, is nothing new. Cuban

(1986), for example, documents how similar beliefs in the transformative power of film, radio, and television did little to transform education. Though we are more optimistic than Cuban about the educational potential of computers (see his discussion in Cuban 2001), we do think positive changes will require not a focus on the provision of technology itself but a broad approach in which technology serves curricular and pedagogical ends.

The problems with the technocentric approach are shown in recent studies on the impact of gaining access to computers and the Internet (for a review, see Warschauer and Matuchniak 2010). Whether at home or at school, physical access to new technology outside of other forms of social support or educational improvement may have more negative than positive results, with the worst outcomes being achieved by those who are already disadvantaged. For example, a study by two economists at Duke University indicates that increases in access to home computers or Internet service providers in North Carolina results in lower math and reading test scores for youth in grades 5 to 8, with African-American youth suffering the worst results (Vigdor and Ladd 2010). As for school access and use, Wenglinsky's (2005) analysis of test score data found a consistently negative interaction between technology use and test score outcomes in math, science, and reading. Again, as at home, these negative interactions were strongest for low-SES students. Wenglinsky's research and that of others (e.g., Kulik 2003) show benefits of computer use when implemented in a well-planned educational initiative, but little evidence exists that simple distribution of computers to children has much positive effect.

The results in Birmingham are also consistent with what has been found through prior in-depth study of teaching in technology-rich schools (e.g., Cuban, Kirkpatrick, and Peck 2001; Windschitl and Sahl 2002; Zhao and Frank 2003). These and other studies have found that merely placing technology in schools does not result in its extensive use by teachers but rather that use depends on the broader ecology of the implementation (Zhao and Frank 2003), including existing norms (Cuban, Kirkpatrick, and Peck 2001) and teacher beliefs (Windschitl and Sahl 2002).

Whether in response to disappointing outcomes in Birmingham and elsewhere, or for other unknown reasons, recent events suggest that technocentrism may be becoming more contested within OLPC. The original organization split in two in 2010, with the

OLPC Foundation led by Negroponde and the OLPC Association with other leadership. At least one prominent person involved with the OLPC Association, former OLPC president of software and content Walter Bender, is publicly calling for a more holistic emphasis on infrastructure, logistics, training, pedagogy, and community involvement (Buderi 2010). Other elements of the OLPC approach, however, such as the principle of child ownership, have not been similarly challenged within the organization.

Child Ownership

For OLPC, the notion of child ownership flows directly from Papert's constructionist view of the laptop as a children's learning machine. Placing this "portable learning and teaching environment" in children's hands and under their ownership thus naturally seemed like a way to create "a new human environment of a digital kind" (One Laptop per Child 2010c). Such thinking is consistent with the technocentric approach, which views children's tinkering with their own digital tools as critical to their educational and technological development.

As seen in Birmingham, though, the notion of child ownership comes into conflict with another of Papert's principles, that of one-to-one use in schools. Papert belittles the idea that children should have to share computers in schools, calling it as unproductive as sharing pencils (Kyle 2000). He points out—correctly, we believe—that educational use of digital media will be far more productive when all students have regular access to their own tools. Research bears this out: When students have individual and daily access to laptops at schools, they use them for more productive educational purposes than when laptops are shared (e.g., Russell, Bebell, and Higgins 2004).

What we witnessed in Birmingham, though, is similar to what has occurred in many OLPC deployments: When children own their own laptops and are responsible for maintaining them, over time many of them break down and go unrepaired (see, e.g., Plan Ceibal 2010). Moreover, the poorest children and families are most likely to be unable to repair their laptops (Plan Ceibal 2010). This results in a situation, confirmed by our classroom observations, in which large numbers of students do not have working laptops to bring to school. This is one reason, together with other reasons inherent in the technocentrist approach and the design of the XO itself, that OLPC programs

result in low laptop use in school. In contrast, programs that make use of the XO computer but eschew child ownership tend to have few breakages and much higher rates of use in school (see, e.g., Ardito 2010; Quirk-Garvan 2010). Productive use *can* be made of school computers in shared-use situations. However, a shared-use situation in which some students have individually owned computers and other students do not have functioning computers is far from ideal.

The issue of child and family ownership is important to consider beyond the OLPC program itself. Many educational leaders are beginning to consider *bring-your-own* programs in which families take principal responsibility for purchasing and maintaining laptop, handheld, or tablet computers that children will then bring to school (see discussion in Lee and Ryall 2010). We are sympathetic to the idea behind such programs, which seek to leverage extant home resources to support cost-effective use of technology in schools, and we suspect such programs will grow. But as evidenced in Birmingham and other OLPC initiatives, bring-your-own programs have limitations, even in cases where the device is initially purchased for, rather than by, the family. We instead support the recommendation for modified bring-your-own programs in which the school or district provides devices to children who do not have computers or whose computers are broken (see discussion in National Educational Technology Plan Technical Working Group 2010).

The XO Computer

Though the OLPC implementation approach has been widely criticized (see, e.g., Kraemer, Dedrick, and Sharma 2009), the XO laptop has not. Rather, it has been hailed, even by many OLPC critics, as a groundbreaking technological marvel. Data from Birmingham and elsewhere (e.g., Plan Ceibal 2010; RAP Ceibal 2010; Warschauer and Ames 2010), however, suggest that the XO laptop, while innovative, is not a technological miracle and is experimental and buggy. Although many of the activities available on the XO focus on getting children excited about using computers and learning computer programming without anxiety and fear, the XO is like other computers in that it can be easily broken, and its relatively low power usage comes at a cost of limited functionality. Some of its more interesting features, such as mesh networking to connect individual XOs without use of

a router, proved more useful in the laboratory than in practice and reportedly have been dropped from product updates (see discussion in Warschauer and Ames 2010).

For us, what was especially troubling about the XO laptop is its relative inaccessibility to teachers. With a 7.5-inch display and tiny keyboard, the XO is difficult for most adults to use. Though external keyboards can be attached, we witnessed no teachers using the XO in that fashion. No ports are available for external monitors. In addition, the Sugar interface on the XO is unfamiliar to anyone who has used Windows, Macintosh, or even most Linux operating systems. And although an XO emulator exists that in theory allows teachers to install the Sugar interface on Windows and Macintosh computers, the process for doing so is complex without training (see One Laptop per Child 2010a), and no teachers we interviewed in Birmingham reported using it. The only other way for teachers to become familiar with Sugar is by spending a lot of time working on the small XOs, something that requires a great deal of effort and motivation. This perhaps helps explain why OLPC implementations feature less classroom laptop use than in other laptop programs, where the hardware and software are more familiar to teachers.

The XOs in Birmingham were inaccessible to teachers in another way as well. Because of the lack of connectivity, teachers found they had difficulty accessing student work on the XOs other than by walking around the classroom and observing student work on the laptop's small screen. In other laptop programs we have investigated (see, e.g., Warschauer 2006), an important benefit was increased exchange of work (e.g., drafts of papers) between students and teachers.

For a program that emphasizes what children can accomplish with computers without adult mentoring or assistance, the inaccessibility of the hardware and software to adults is not a problem. After all, the XO was designed for children, not adults. However, other laptop implementations have chosen hardware and software that is not only suitable for children but is more accessible for adults, with better results (see, e.g., Warschauer 2011).

Conclusion

OLPC's research and development efforts broke much new ground in the area of low-cost, low-power computing. But, as noted by an educational leader we

interviewed for this study, “The XO is great as a research project. It has lots of innovative features. But there is a big gap between a great research project and large-scale production, distribution, and implementation in schools.”

The Birmingham OLPC project illustrates just how wide that gap is. Though the computers it used are the least expensive of any deployed in a U.S. laptop program, the benefits achieved at the time of our data collection appear to be minimal, thus resulting in a high cost-benefit ratio. The children of Birmingham deserve better. And they could have had better. If the city and district had used the same amount of funds for a smaller but better-planned program—for example, one with individual laptops for all students in fourth and fifth grades, shared laptop carts in second and third grades, and greater funding committed to Internet access, teacher training, and curriculum development—they might have had one of the better elementary school laptop programs in the United States, instead of what has been called a “costly lesson” (Crowe 2009).

What does the Birmingham initiative say about the broader OLPC program? In some ways Birmingham is unusual among larger OLPC projects; for example, it is based in the United States, although the original target of OLPC was developing countries. In other ways, though, Birmingham represents one of the purest implementations of the OLPC approach, at least as articulated by its founder. The Birmingham program closely adhered to all OLPC principles, including child ownership, starting at young ages, and mass distribution of the XO computer. Following the recommendations of Negroponte, the program eschewed a lengthy pilot program or any formal summative or formative evaluation, and devoted little resources to repairs, infrastructure, and professional development. And the types of problems that have occurred in Birmingham have been reported in many other deployments around the world (see summary in Warschauer and Ames 2010).

Our investigation of the Birmingham OLPC program suggests that the technocentrist approach is counterproductive and that any educational reform effort with digital media needs to be grounded in solid curricular and pedagogical foundations, include requisite social and technical support, and be carried out with detailed planning, monitoring, and evaluation. As school districts strive to increase access to and use of digital media in schools, they will do

well to bear in mind these lessons from Birmingham OLPC.

References

- Ames, M. 2008. Hacker learning? The social meanings of One Laptop per Child. Major project, Department of Communication, Stanford University.
- Ardito, G. 2010. The shape of disruption: XO laptops in the fifth grade classroom. PhD diss., Pace University, New York.
- Bernard, R. M., E. C. Bethel, P. C. Abrami, and C. A. Wade. 2007. Introducing laptops to children: An examination of ubiquitous computing in grade 3 reading, language, and mathematics. *Canadian Journal of Learning and Technology* 33 (3):49–74. <http://www.cjlt.ca/index.php/cjlt/article/view/158/152> (accessed October 3, 2011).
- Bethel, E. C., R. M. Bernard, P. C. Abrami, and A. C. Wade. 2007. The effects of ubiquitous computing on student learning: A systemic review. In *Proceedings of the World Conference on E-Learning in Corporate, Government, Healthcare, and Higher Education 2007*, ed. T. Bastiaens and S. Carliner, 1987–92. Chesapeake, VA: AACE.
- Birmingham News Editorial Board. 2010. Our view: It's no laughing matter that Birmingham superintendent Craig Witherspoon has a whole lot on his hands and a school board that doesn't really get it. *Birmingham News*, November 22. http://blog.al.com/birmingham-news-commentary/2010/11/our_view_its_no_laughing_matte_1.html (accessed December 17, 2010).
- Buderi, R. 2010. One ecosystem per child: Walter Bender and OLPC reunite to enhance learning and grow economies in developing nations. *Xconomy*, October 5. <http://www.xconomy.com/boston/2010/10/05/one-ecosystem-per-child-walter-bender-and-olpc-reunite-to-enhance-learning-and-grow-economies-in-developing-nations/> (accessed October 3, 2011).
- Cotten, S. R. 2010. XO laptops, education, and connection: Results from the Birmingham youth and technology study. Paper presented at the Texas A&M Race and Ethnic Studies Institute.
- Cotten, S. R., T. M. Hale, M. Howell Moroney, L. O'Neal, and C. Borch. 2011. Using affordable technology to decrease digital inequality. *Information, Communication and Society* 14 (4):424–44. doi:10.1080/1369118X.2011.559266.
- Cotten, S. R., M. Howell Moroney, J. Gray et al. 2010. Integrating computing across the curriculum. Paper presented at the National Science Foundation Discovery Research K-12 Meeting, Washington, DC.
- Crowe, C. 2009. A costly lesson: A closer look at Birmingham's curious commitment to the XO laptop. *Black and White*, November 26. http://www.bwcitypaper.com/Articles-i-2009-11-26-232786.113121_A_Costly_Lesson.html (accessed October 3, 2011).

- Cuban, L. 1986. *Teachers and machines: The classroom use of technology since 1920*. New York: Teachers College Press.
- Cuban, L. 2001. *Oversold and underused: Computers in classrooms, 1980–2000*. Cambridge, MA: Harvard University Press.
- Cuban, L., H. Kirkpatrick, and C. Peck. 2001. High access and low use of technology in high school classrooms: Explaining an apparent paradox. *American Educational Research Journal* 38 (4):813–34. doi:10.3102/00028312038004813.
- DeButts, J. 2009. Former JeffCo commissioner Katopodis convicted of fraud. *Birmingham Business Journal*, July 1. <http://www.bizjournals.com/birmingham/stories/2009/06/29/daily23.html> (accessed June 24, 2010).
- Dewan, S. 2009. Birmingham mayor convicted on all counts. *New York Times*, October 28. <http://www.nytimes.com/2009/10/29/us/29birmingham.html> (accessed June 24, 2010).
- Drayton, B., J. K. Falk, R. Stroud, K. Hobbs, and J. Hammerman. 2010. After installation: Ubiquitous computing and high school science in three experienced, high-technology schools. *Journal of Technology, Learning, and Assessment* 9 (3):1–56. <http://escholarship.bc.edu/jtla/vol9/3/> (accessed October 3, 2011).
- Dunleavy, M., S. Dexter, and W. F. Heinecke. 2007. What added value does a 1:1 student to laptop ratio bring to technology-supported teaching and learning? *Journal of Computer Assisted Learning* 23 (5):440–52. doi:10.1111/j.1365-2729.2007.00227.x.
- Dunleavy, M., and W. F. Heinecke. 2008. The impact of 1:1 laptop use on middle school math and science standardized test scores. *Computers in the Schools* 24 (3/4): 7–22. doi:10.1300/J025v24n03_02.
- Education Initiatives. 2009. The official website for the city of Birmingham, Alabama. <http://www.birminghamal.gov/pdf/education.pdf> (accessed May 25, 2010).
- Greaves, T. W., and J. Hayes. 2008. *American's digital schools 2008: The six trends to watch*. Encinitas, CA: Greaves Group and Hayes Connection.
- Grimes, D., and M. Warschauer. 2008. Learning with laptops: A multimethod case study. *Journal of Educational Computing Research* 38 (3):305–32. doi:10.2190/EC.38.3.d.
- Gulek, J. C., and H. Demitras. 2005. Learning with technology: The impact of laptop use on student achievement. *Journal of Technology, Learning, and Assessment* 3 (2):4–35. <http://ejournals.bc.edu/ojs/index.php/jtla/article/view/1655> (accessed October 3, 2011).
- Hourcade, J. P., D. Beitler, F. Cormenzana, and P. Flores. 2008. Early OLPC experiences in a rural Uruguayan school. In *Proceedings of the 2008 Conference on Human Factors in Computing Systems*, ed. M. Czerwinski, A. Lund, and D. Tan, 2503–12. New York: ACM.
- Hu, W. 2007. Seeing no progress, some schools drop laptops. *New York Times*, May 4. <http://www.nytimes.com/2007/05/04/education/04laptop.html> (accessed June 24, 2010).
- Jeroski, S. 2008. *Wireless Writing Program (WWP): Peace River North, summary report on grade 6 achievement, 2008*. Fort St. John, BC: Peace River North. <http://www.prn.bc.ca/wp-content/wwp2008grade6.pdf> (accessed February 2, 2008).
- Johnstone, B. 2003. *Never mind the laptops: Kids, computers, and the transformation of learning*. Lincoln, NE: iUniverse.
- Kraemer, K. L., J. Dedrick, and P. Sharma. 2009. One Laptop per Child: Vision vs. reality. *Communications of the ACM* 52 (6):66–73. doi:10.1145/1516046.1516063.
- Kulik, J. A. 2003. *Effects of using instructional technology in elementary and secondary schools: What controlled evaluation studies say*. Arlington, VA: SRI International. http://www.sri.com/policy/csted/reports/sandt/it/Kulik_ITinK-12_Main_Report.pdf (accessed October 3, 2011).
- Kyle, B. 2000. Acute pencil shortage strikes state lawmakers. *Bangor Daily News*, March 30. http://www.papert.org/articles/laptops/acute_pencil_shortage.html (accessed October 3, 2011).
- Lawler, R. W. 1997. *Learning with computers*. Exeter, UK: Intellect Books.
- Lee, M., and B. Ryall. 2010. Financing the networked school community: Building upon the home investment. In *Developing a networked school community: A guide to realizing the vision*, ed. M. Lee and G. Finger, 109–24. Camberwell, Australia: ACER Press.
- Leech, M. 2007. Langford signs deal for 15,000 computers. *Birmingham News*, December 4.
- Leech, M. 2010. XO laptops are loved, but use is limited. *Birmingham News*, March 18. http://blog.al.com/spotnews/2010/03/xo_laptops_are_loved_but_use_i.html (accessed October 3, 2011).
- Lowes, S., and C. Luhr. 2008. *Evaluation of the Teaching Matters One Laptop per Child (XO) pilot at Kappa IV*. New York: Institute for Learning Technologies, Teachers College/Columbia University.
- Lowther, D. L., J. D. Strahl, F. A. Inan, and J. Bates. 2007. *Freedom to Learn program: Michigan 2005–2006 evaluation report*. Memphis: Center for Research in Educational Policy. http://www.memphis.edu/crep/pdfs/Michigan_Freedom_to_Learn_Laptop_Program.pdf (accessed October 3, 2011).
- Martínez, A. L., S. Alonso, and D. Díaz. 2009. *Monitoreo y evaluación de impacto social del Plan CEIBAL: Metodología y primeros resultados a nivel nacional*. http://www.ceibal.org.uy/docs/presentacion_impacto_social221209.pdf (accessed June 21, 2010).
- Näslund-Hadley, E., S. Kipp, J. Cruz, P. Ibararán, and G. Steiner-Khamsi. 2009. *OLPC pre-pilot evaluation report (Haiti)*. Washington, DC: Inter-American Development Bank. <http://www.iadb.org/document.cfm?id=2062678> (accessed October 3, 2011).
- National Educational Technology Plan Technical Working Group. 2010. *Transforming American education: Learning*

- powered by technology. Washington, DC: Office of Educational Technology, U.S. Department of Education. <http://www.ed.gov/technology/netp-2010> (accessed October 3, 2011).
- Negroponte, N. 1995. *Being digital*. New York: Basic Books.
- Negroponte, N. 2005. The hundred dollar laptop: Computing for developing nations. Speech presented at the Emerging Technologies Conference, Massachusetts Institute of Technology, Cambridge, MA. http://www.olpctalks.com/nicholas_negroponte/negroponte_mit_world.html (accessed October 3, 2011).
- Negroponte, N. 2006. No lap un-topped: The bottom up revolution that could re-define global IT culture. Keynote address at NetEvents Global Press Summit, Hong Kong. http://www.olpctalks.com/nicholas_negroponte/negroponte_netevents.html (accessed October 3, 2011).
- Negroponte, N. 2009. Lessons learned and future challenges. Paper presented at the Reinventing the Classroom: Social and Educational Impact of Information and Communication Technologies in Education Forum, Washington, DC. http://www.olpctalks.com/nicholas_negroponte/nicholas_negroponte_lessons_learned_and_future_challenges.html (accessed September 12, 2010).
- New South Wales Department of Education and Training. 2009. *One-to-one computing: Literature review*. <http://www.curriculumsupport.education.nsw.gov.au/ict/assets/litreviewlaptops.doc> (accessed June 21, 2010).
- One Laptop per Child. 2010a. Emulating the XO/Quick Start/Windows. *The OLPC Wiki* [website]. http://wiki.laptop.org/go/Emulating_the_XO/Quick_Start/Windows (accessed September 17, 2010).
- One Laptop per Child. 2010b. Laptop software. <http://laptop.org/en/laptop/software> (accessed September 14, 2010).
- One Laptop per Child. 2010c. OLPC: Five principles. *The OLPC Wiki* [website]. http://wiki.laptop.org/go/Core_principles/ (accessed June 21, 2010).
- Papert, S. 1980. *Mindstorms: Children, computers, and powerful ideas*. New York: Basic Books.
- Papert, S. 1993. *The children's machine: Rethinking school in the age of the computer*. New York: Basic Books.
- Papert, S. 2006. USINFO webchat interview. http://www.olpctalks.com/seymour_papert/seymour_papert_usinfo.html.
- Penuel, W. R. 2006. Implementation and effects of one-to-one computing initiatives: A research synthesis. *Journal of Research on Technology in Education* 38:329–48.
- Peppler, K., and Y. Kafai. 2007. From SuperGoo to Scratch: Exploring digital media production in informal learning. *Learning, Media, and Technology* 32 (2):149–66. doi:10.1080/17439880701343337.
- Plan Ceibal. 2009. *Monitoreo y evaluación educativa del Plan Ceibal: Primeros resultados a nivel nacional*. http://www.ceibal.org.uy/docs/evaluacion_educativa_plan_ceibal_resumen.pdf (accessed June 21, 2010).
- Plan Ceibal. 2010. *Síntesis del informe de monitoreo del estado del parque de XO a abril de 2010*. http://www.ceibal.org.uy/index.php?option=com_content&view=article&id=222:sintesis-del-informe-de-monitoreo-del-estado-del-parque-de-xo-a-abril-de-2010&catid=43:novedades&Itemid=55 (accessed September 14, 2010).
- Quirk-Garvan, B. 2010. One Laptop-SC: A model for implementation of XOs in elementary schools. Paper presented at the Digital Media and Learning Conference, La Jolla, CA.
- RAP Ceibal 2010. *Encuesta a hogares: Informe preliminar*. http://www.reducativa.com/rap/informe_encuesta_hogares_sanjose.pdf (accessed October 3, 2011).
- Russell, M., D. Bebell, and J. Higgins. 2004. Laptop learning: A comparison of teaching and learning in upper elementary classrooms equipped with shared carts of laptops and permanent 1:1 laptops. *Journal of Educational Computing Research* 30 (4):313–30. doi:10.2190/6E7K-F57M-6UY6-QAJJ.
- Santiago, A., E. Severin, J. Cristia, P. Ibararán, J. Thompson, and S. Cueto. 2010. *Evaluación experimental del programa "Una Laptop por Niño" en Perú*. Washington, DC: Banco Interamericano de Desarrollo. <http://www.iadb.org/document.cfm?id=35370099> (accessed October 3, 2011).
- Silvernail, D. L., and D. M. M. Lane. 2004. *The impact of Maine's one-to-one laptop program on middle school teachers and students*. Portland: Maine Educational Policy Research Institute, University of Southern Maine Office.
- Solomon Islands Government. 2010. *Evaluation of OLPC in Solomon Islands*. Australian Council for Educational Research.
- Suhr, K., D. Hernandez, D. Grimes, and M. Warschauer. 2010. Laptops and fourth grade literacy: Assisting the jump over the fourth grade slump. *Journal of Technology, Learning, and Assessment* 9 (5):1–45. <http://ejournals.bc.edu/ojs/index.php/jtla/article/view/1610/> (accessed October 3, 2011).
- Texas Center for Educational Research. 2009. *Evaluation of the Texas Technology Immersion Pilot: Final outcomes for a four-year study (2004–2005 to 2007–2008)*. Austin, TX: TCER. http://www.tcer.org/research/etxtip/documents/y4_etxtip_final.pdf (accessed October 3, 2011).
- Vigdor, J. L., and H. F. Ladd. 2010. Scaling the digital divide: Home computer technology and student achievement. NBER Working Paper 16078. Cambridge, MA: National Bureau of Economic Research. <http://www.nber.org/papers/w16078> (accessed June 21, 2010).
- Vota, W. 2007. Is OLPC the only hope to eliminate poverty and create peace? *OLPC News*, November 30. http://www.olpcnews.com/people/negroponte/olpc_poverty_world_peace.html (accessed October 3, 2011).
- Vota, W. 2009. Corruption or charade? OLPC Ghana XO laptop purchase. *OLPC News*, June 23. http://www.olpcnews.com/countries/ghana/corruption_charges_olpc_ghana.html (accessed June 24, 2010).

- Vota, W. 2011. XO helicopter deployments? Nicholas Negroponte must be crazy! *OLPC News*, June 29. http://www.olpcnews.com/people/negroponte/xo_helicopter_deployments_nich.html (July 11, 2011).
- Warschauer, M. 2006. *Laptops and literacy: Learning in the wireless classroom*. New York: Teachers College Press.
- Warschauer, M. 2008. Laptops and literacy: A multi-site case study. *Pedagogies* 3 (1):52–67. doi:10.1080/15544800701771614.
- Warschauer, M. 2009. Learning to write in the laptop classroom. *Writing and Pedagogy* 1 (1):101–12. doi:10.1558/wap.v1i1.101.
- Warschauer, M. 2010. Netbooks and open source software in one-to-one programs. Paper presented at the Annual Meeting of the American Educational Research Association, Denver.
- Warschauer, M. 2011. *Learning in the cloud: How (and why) to transform schools with digital media*. New York: Teachers College Press.
- Warschauer, M., and M. Ames. 2010. Can One Laptop per Child save the world's poor? *Journal of International Affairs* 64 (1):33–51. http://www.gse.uci.edu/person/warschauer_m/docs/Warschauer_bluelines.pdf (accessed October 3, 2011).
- Warschauer, M., and T. Matuchniak. 2010. New technology and digital worlds: Analyzing evidence of equity in access, use, and outcomes. *Review of Research in Education* 34 (1):179–225. doi:10.3102/0091732X09349791.
- Wenglinsky, H. 2005. *Using technology wisely: The keys to success in schools*. New York: Teachers College Press.
- Windschitl, M., and K. Sahl. 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. doi:10.3102/00028312039001165.
- Zhao, Y., and K. A. Frank. 2003. Factors affecting technology uses in schools: An ecological perspective. *American Educational Research Journal* 40 (4):807–40. doi:10.3102/00028312040004807.