The 'Costly Lesson' of One Laptop per Child Birmingham

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The One Laptop per Child (OLPC) program is one of the most ambitious educational reform initiatives the world has ever seen. Announced in 2005, the program developed a low-cost laptop computer called the "XO" and aggressively promoted its plans to put the computer in the hands of hundreds of millions of children across the Global South. Though only two and a half million XO laptops were distributed, the initiative caught the attention of world leaders, influenced developments in the global computer industry, and sparked debate about the best ways to improve the lives of the world's poor. According to the project's leaders, little could stand in the way of a child with an XO computer: the machine would inspire children to "take charge" of their learning, harness creative thinking to become innovators, and ultimately reform their local or national economies.

In 2008, OLPC launched its first major implementation in the U.S. with the distribution of 15,000 XO computers to elementary school students and teachers in Birmingham, Alabama, with the goals of eliminating the digital divide in Birmingham and preparing children to be active participants in the country's information society. Though the Birmingham project is in some ways an outlier within the broader OLPC initiative, which was originally targeted for developing countries, the program adhered to a number of key OLPC principles, and this chapter explores the implications of these principles when they are put into practice. Our findings – which include problems of design, infrastructure, training, support, and breakage – were typical of those reported in other OLPC implementations, so examining how and why the program backfired is thus worthy of close attention. This chapter[1] first discusses how OLPC's laptops

were intended to function. It then details how those intentions unraveled in the Birmingham OLPC program. It concludes with lessons for similar laptop programs.

OLPC's Promises of Educational Revolution

The vision behind the One Laptop per Child (OLPC) project was shaped by two complementary forces: the utopian beliefs of project founder Nicholas Negroponte,[2] founding director of the MIT Media Lab, and the learning philosophy of constructionism developed over some 40 years by Seymour Papert,[3] Negroponte's MIT colleague. Negroponte announced One Laptop per Child (formerly the "$100 laptop") in 2005 and remains the public face of the project. His hyperbolic style lent both fame and notoriety to OLPC, as it had for the MIT Media Lab.[4] His unwavering digital utopianism also inflected the project from its earliest days. In both his column for *Wired Magazine* (for which he was also a founding investor) and his book *Being Digital*, he discussed complete digitization worldwide not in terms of *if*, but *when*: 'like a force of nature,' he asserts, 'the digital age cannot be denied or stopped.'[5]

While Negroponte served as OLPC's public face, Papert was the project's intellectual father,[6] up until a tragic accident took him out of its leadership in 2007. Particularly important were Papert's 1980 book *Mindstorms*,[7] where he describes constructionism in detail and proposes having a computer for every child, and his 1993 book *The Children's Machine*,[8] where he pushes the idea of one computer per child more strongly. Blending Piaget's constructivism (with a 'v') with MIT's computer-centric culture,[9] constructionism (with an 'ion') advocates child-driven learning assisted by an 'object to think with'[10] such as a computer, which Papert describes as a versatile 'Proteus of machines.'[11] Papert situates constructionism in opposition to traditional schooling, or 'instructionism,'[12] which he claims turns children from 'yearners' who are naturally curious into 'schoolers' incapable of creative thought.[13] He argues that reforming

schools is difficult, if not impossible; instead, children should be given the tools to learn on their own, outside of school.[14]

Constructionism's commitment to child-driven learning and its view that teachers are just another (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 stated in a 2006 interview for OLPC.[15] In another interview, Negroponte stated 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. And some percent show up drunk. So really, if you are going to affect education, you cannot just train teachers and build schools.[16]

In the project's later years, these views were challenged by some in OLPC.[17] Nevertheless, they remain important because they influenced the development of OLPC's core principles, which focus on self-directed student learning rather than a strong teacher role, and influenced a number of OLPC projects, including the one considered here in Birmingham.

OLPC's Core Principles

Papert's constructionism and Negroponte's digital utopianism were reflected in OLPC's Five Core Principles: Child Ownership, Low Ages, Saturation, Connection, and Free and Open Source.[18] The first core principle expressed OLPC's recommendation that students own their laptops and are allowed to take them home, which would not only inspire deeper uses but give kids incentives to care for the machine.[19] In the second core principle, OLPC demonstrated a

commitment to reaching young children; their laptop was designed for children aged six to twelve and, due to screen size, keyboard size, and general design, is difficult for adults to use.[20]

OLPC's third and fourth core principles – saturation and connection – were in line with both constructionism and OLPC's interest in radical technologically-driven change. If all children have these tools and they can communicate with one another, the organization posited, there can be a massive shift in competencies in only one generation. OLPC equated their XO laptops with vaccines in the kind of rapid, life-altering change they can create, all by themselves – with no need for additional social support.[21] In this principle and elsewhere, OLPC promised a quick fix to endemic problems in educational infrastructure and, ultimately, a shortcut to economic development. Because they believed that laptops themselves could create these changes, OLPC's leadership focused only on deploying the XO laptops, not on technical support, curriculum, or training. The fifth core principle reflected OLPC's commitment to using open-source software.

Learning in One Laptop per Child Programs

Though the five core principles illustrate the motivations of OLPC and demonstrate how both constructionism and digital utopianism have influenced the project, the extent to which these principles are followed has depended on the organizations running each program. Even so, a consistent theme across existing evaluations of One Laptop per Child programs is that they have not lived up to the promise of OLPC's leadership. A study by the Inter-American Development Bank in 2010, for instance, found that Peru's program of over one million laptops was beset by difficulties.[22] Most schools lacked Internet and some even lacked electricity to charge the laptops (which, contrary to popular belief, are not powered by a hand crank). Only 10.5% of the teachers reported receiving technical support, and only 7.0% reported receiving

pedagogical support. As a result, only 40% of teachers who had the laptops at least two months reported using them three or more times a week. Some 43% of students did not take their laptops home as OLPC intended them to do, in many cases based on fears 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.[23] While there are local movements to co-opt the program,[24] there is not yet evidence of any effects in schools.

In Uruguay, over 650,000 XOs have been distributed to all primary and secondary students in the country. Uruguay, a much wealthier country than Peru, devoted considerably more funding to the technical and social infrastructure, extending Internet to schools across the country and offering teacher training through in-person, television, and online materials.[25] 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.[26] Nevertheless, a national evaluation indicated that the laptops there are lightly used in schools.[27] 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, only a year after most students received laptops.[28] Using statistical methods that compared test scores throughout the country from 2006 to 2012 to the dates that students received laptops, a team of economists found that the program had no impact on students' mathematics or language arts test scores across the board.[29]

While Peru and Uruguay are an order of magnitude larger than all other OLPC programs, others similar in size to Birmingham's have been examined as well. Of particular interest is a program of 10,000 laptops run by a local NGO in Paraguay, which followed Uruguay's model of

more intensive social and technical support than recommended by OLPC, and was deemed one of the best-run by several OLPC developers and community members.[30] Despite this support, this project experienced some of the same problems of disuse, breakage, and sustainability found elsewhere.[31]

Learning in Other One-to-One Laptop Programs: A Point of Contrast

The story of other laptop programs, on the other hand, has generally been much more positive. There has been a substantial amount of prior research on educational laptop programs, much of it on "one-to-one" laptop programs, where every student has a computer to use.[32] In most well-supported programs, students use computers frequently, teachers integrate technology into instruction, and programs are popular with both teachers and students, all of which result in greater learner engagement.[33] Students write more, get more feedback on their writing, and improve the quality of their writing.[34] They have greater opportunities to explore topics in depth and to receive individualized instruction.[35] A number of studies report modest positive effects on learners' technological proficiency[36] or academic achievement,[37] while others report no significant impact on academic outcomes.[38] A meta-analysis of experimental and quasi-experimental studies of one-to-one laptop programs found overall positive gains on measurable learning outcomes.[39]

Examining One Laptop per Child in Birmingham

Which of these fates will befall OLPC Birmingham? We see that one-to-one laptop programs are not inherently flawed – they can provide benefits, both academic and more intangible, to students. But is there something about OLPC's model, or the XO laptop's design, that tilts those programs toward failure? To answer these questions, this chapter draws on data from two different studies: (1) a pre-post survey in Birmingham carried out by Cotten and (2) a

multi-site case study carried out by Warschauer in Birmingham and two other districts. We first introduce the Birmingham research site and then explain the methodology of the two studies.

The largest deployment of OLPC's XO laptops in the U.S. to date occurred in Birmingham, Alabama between 2008 and 2010. The then-mayor of Birmingham, Larry Langford, a contentious figure in Alabama politics, contracted with OLPC to purchase 15,000 XO laptops for children in kindergarten through eighth grade (later revised to first through fifth grades) in Birmingham City Schools.[40] Over 95% of students in Birmingham schools are African American, and 80% of students qualify for free or reduced-price lunch. Mayor Langford stated that he wanted to eliminate the digital divide in Birmingham and to prepare children to be active participants in the country's information society. While these are admirable goals in many respects, an important contextual factor that affected this deployment is that Langford did not consult with the school system to see if they wanted computers, and particularly XO laptops, to be disseminated to their students. Langford also gave the laptops to the children, not to the school system, following principles of the OLPC philosophy. 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.[41]

This lack of consultation with the school system and giving ownership to the students rather than the schools resulted in several complications. First, there were substantially more

students and teachers in first through eighth grades than purchased laptops. After some back-and-forth, the school system accepted 1000 of the XO laptops in April 2008, which were given to first through fifth grade students and teachers at one elementary school about six weeks before school ended for the summer. In August 2008, the school system accepted the remaining 14,000 XOs, which were given to first through fifth grade students, teachers, and administrators between late August 2008 and March 2009. Teachers were given, on average, two hours of training on the XO laptops during this time. While students owned their laptops, teachers and administrators did not, a point of contention.

To investigate the program, Cotten and colleagues conducted pre- and post-test surveys with fourth and fifth grade students in 2008 and 2009. Fourth and fifth grade students were chosen due to reading ability and ease of surveying, compared to lower grade levels. The goals of the student survey were to determine changes in technology use levels and types, attitudes towards technology and computing careers, educational and career intentions, and a range of social and psychological outcomes as a result of the XO laptop dissemination.

Cotten conducted the pre-test among 1,583 fourth and fifth grade students in 27 Birmingham primary schools and the post-test among 1,261 students in 25 Birmingham primary schools (two declined due to schedule conflicts). We matched 1,202 students from pre- to post-test surveys. Pre-test student surveying occurred just prior to XOs being distributed in each school, while post-test surveying occurred during the last six weeks of the school year after distribution, five to six months after many of the students had received their laptops. The surveys lasted about 45 minutes and were administered in a group format, where students were read the survey questions by a researcher and responded individually in writing. Research assistants were

available to help answer student questions. Here we report descriptive results of this survey that point to broad trends of XO use.[42]

These results are triangulated by a national study of K-12 laptop programs that Warschauer carried out in 2009-2010, focused on programs deploying netbook computers and open tools (meaning both open-source software and open educational resources). Research questions 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.

A purposely stratified sample – based on students' ethnicity and socio-economic status, type of computer use, and model of program implementation – of three districts was chosen for the study: Birmingham City Public Schools in Alabama, Littleton Public Schools in Colorado, and Saugus Union School District in California. 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 socioeconomic status (SES) neighborhood, which is demographically representative of the whole school system, was so designated. In both Littleton and Saugus, two schools were designated, one that was principally white and high-SES, and one that included large numbers of English language learners and students from low-SES families. Though this paper principally reports on the findings from the Birmingham portion of the study, it also makes reference, for comparative purposes, to the other two districts.

In the two other districts in the study, our research team was welcomed into a wide range of schools and classrooms, and in each we conducted at least 25 hours of classroom observation; at least thirty interviews of teachers, students, and staff; a districtwide survey of students and teachers in the laptop program; analysis of test scores; and analysis of hundreds of student

writing samples. In Birmingham, the research was more constricted. We were informed by district leaders that we could only visit and collect data at one school as they were uncertain about the degree of implementation at other schools. At this school, we arranged for a two-day visit and asked to observe as many classes as possible during our stay, but were only allowed to observe three classes on the second day of our visit. These limits on our data collection, while indicative of the state of the Birmingham OLPC program, also represent a limitation of the study. We partially overcome this limitation by triangulating the lesser amount of qualitative data in Birmingham with the pre-post student survey. Data collected included the following:

(1) Observations at a focal school: Over two days, the researcher observed a fifth grade class, a third grade class, and a second grade class, each for 45 minutes to an hour. Observations took place about nineteen months after the initial laptop distribution at that school. The researcher was free to wander around the classroom, observe what children were doing, talk informally with children and the teacher, and take fieldnotes. The researcher also walked through the school halls, observing the extent to which students were carrying or using XOs throughout the building. We noted that 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.

(2) Interviews: The researcher conducted interviews with thirteen people associated with the OLPC Birmingham project. Formal interviews of 30-60 minutes were conducted with the principal, two fifth-grade teachers, an ESL teacher, the library/media specialist, and two students. Brief interviews were also carried out with the third- and second-grade teachers during or right after observations. Also interviewed were a staffperson in the Office of the Mayor who managed the OLPC project, a representative of the district instructional technology department, and two representatives of a consulting firm helping the OLPC program at the school and

another district school. Interviews focused on the use of XOs and perceived strengths and weaknesses of the XOs and the OLPC program.

(3) Artifacts: The researcher collected a number of publicly-available documents about the OLPC program in Alabama since the program's inception, including statements published by the mayor's office and articles about the program published in local newspapers and magazines.

Interviews were recorded and transcribed, and observation and interview data were coded using a bottom-up approach to seek patterns both within and across the three school districts. District and media artifacts were used to triangulate these data.

OLPC Birmingham's Problematic Results

Across these data sources, we found the OLPC Birmingham project beset by a number of problems including lack of use, ongoing social and infrastructural issues, and no provisions for sustainability. Collectively, these issues meant that the professed goal of the program – providing a technological means for improving students' learning experiences – ultimately backfired, harming the students it was meant to help.

Low Levels of Interest and Use

The XO laptops and software were promoted by the OLPC organization as specialized tools for 'exploring and expressing' which could engage students in 'constructing knowledge based upon their personal interests' and 'sharing and critiquing those constructions.'[43] We found little evidence from either our classroom observations and interviews or our survey results of how computers are used by children pre- and post- laptop distribution to indicate that these laudatory goals were met.

In fact, the XOs were not being used much at all, and especially not in class. A total of 80.3% of the students surveyed indicated that they either never use the XOs at school (20.4%) or

use them only a little (59.9%); only 19.7% indicated that they used them a lot at school. And even this low number is likely overstated: though 20.4% indicated that they never use the XO *at school*, 29.7% indicated that they never use the XO *in class*. In contrast, students averaged 2 hours/day every day on the computer in class in the other districts we surveyed.

Warschauer's site visit corroborated limited use in schools. While we witnessed XO use in the three classes we were allowed to observe (one of which was taught by an MIT consultant), we walked extensively throughout the school, passing every classroom several times, and saw virtually no XO use in any of them. Interviewees were unanimous in confirming that the XOs are little used across the district, and press reports in Birmingham noted that, although students said they liked the laptops, use was low in the classroom.[44]

Survey results suggest that the most frequently used XO applications while 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). It is unknown to what extent these results represent use inside or outside of class while at school, or exactly how these applications are being used.

Interviews and observations from the focal school indicated that when XOs are used, the program most often used was Memorize, which allows students to create digital flash cards. That was also the sole use 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 with them completing the exercise on index cards instead. 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, taught by a tech-enthusiast teacher, students used the much more creative Scratch computer programming language. The teacher told us that he usually only teaches Scratch in an after-school club and that other teachers do not regularly integrate the program in instruction. While the use of Scratch in an after-school club can be a very positive experience for students who participate,[45] it reaches only a small minority of students.

While classroom use is important to teachers, schools, and the wider educational community as a site to facilitate and assess learning, OLPC did not start out with the goal of supporting such use. What about children's use in their own time? Students with working XOs reported using them about one to two hours per day at home, according to survey results. Some 63% percent of students indicated that they also had access to a computer at home before they got the XO computers. On the post-test survey, 54% reported having a computer at home besides their XO 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 besides the XO. Eighty percent of students indicated that they had home access to the Internet on the pre-test survey. In the post-test survey, only 47.0% of students indicated that they were able to access the Internet at home from their XO.

Post-test survey results indicate that over half the students (52%) reported spending one to two hours per day and 14% reported spending three to four hours per day using their XO laptop. The amount of time that students spent per day using computers and the Internet increased after receiving 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, do homework, create webpages, or share their creations online all decreased slightly from the pre-survey (before XO ownership) to the post-survey (after XO ownership).

Inadequate Social and Technical Infrastructure

The second pattern that emerged across data sources was inadequate social and technical infrastructure. Before XOs were handed out, an average of two hours of paid professional development time was made available per teacher to familiarize themselves with the laptop. All the educators we interviewed indicated that this was insufficient, and some also added that there was little enthusiasm by teachers to pursue additional (unpaid) professional development in their free time. As one teacher – an educational technology enthusiast who had helped offer 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.

Beyond professional development, other laptop programs appointed teacher mentors in each school who get instructional release time in exchange for assisting other teachers with technology integration and answering their questions. No system like this was in place in Birmingham.

In addition to the social infrastructure, the technological infrastructure was found to be seriously lacking. Unlike other one-to-one programs, in which schools own and maintain the laptops, responsibility for maintenance of the hardware and software lay with children and their families, and many were not able to keep them in working condition. Although there was supposedly an XO hotline that parents and students could call with questions about their XO laptops, Cotten found that very few students knew about this hotline. Teachers also reported not knowing what to tell parents and students about how to get their computers repaired. At the time of the post-survey for students, about six months after they received laptops, 70% of respondents reported having had problems with their XOs, and 16% reported that these problems were not fixed. In each school, some students interrupted the post-survey to ask if we could fix their XOs.

We also witnessed these problems at the focal school we visited, a year and a half after laptops were distributed. In the three classrooms we observed, only 23 of 57 students (40%) had working laptops with them. Almost all whose laptops were not present reported that they were broken and no longer functioning, and again, some students again asked us if we could repair them. Though efforts were being made at that school and other schools to teach children themselves how to make repairs, at the time of our visit, there was only one full-service repair shop for XOs in Birmingham, established by an enterprising city councilor who had voted to fund the program in the first place. The school was not an anomaly. Another survey conducted by Cotten and colleagues in fall 2010 found that less than half the fourth and fifth grade students across the district still had working XOs.

Lack of wireless Internet access presented another serious infrastructure problem. In December 2009 we were told that less than one-third of the elementary schools in Birmingham had any wireless Internet access at all, and in most cases that extended only from one or two

hotspots, such as at the library. Although the focal school reportedly had Internet access in all its classrooms, one teacher explained that her students would have to walk out to the hallway for sufficient signal strength, so she tended not to use the Internet in activities. In Cotten's post-test in April-May 2009, only 20.7% of students indicated that they were able to access the Internet using their XO at school.

Finally, even if both computers and the Internet were functioning, there was a general frustration level among teachers with the XOs and broader infrastructure. During a classroom observation, for example, the lack of external monitor port on the XO meant that the teacher had to hold a student's computer under a document camera to attempt to show the class the student's screen. 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.

Lack of Sustainability

Though the school district was never enthusiastic about the program, imposed as it was from outside with little support, 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, Langford for steering County business to particular companies in exchange for bribes[46] and Katopodis for misappropriation of funds from a charity he had formed called Computer Help for Kids.[47] Though the convictions were not directly related to the OLPC program, they did result in questions in the Birmingham press about Langford's and Katopodis's motivations in initiating it.[48]

In 2010, with a new Mayor in office, the Birmingham City Council cut off further funding from the OLPC program as part of broader cuts due to budget deficits. Though XOs remained with students, the school superintendent moved the XO program 'to a subordinate position' as he emphasized other uses of technology.[49] In spring 2011, Birmingham City Schools announced that they were moving away from using XO laptops in the schools given the lack of funding from the city council and problems with reliability of the XOs. Thus, three years after it started, the program met its demise.

Lessons Learned from OLPC's Backfire in Birmingham

These findings show that the Birmingham OLPC program backfired in a major way – rather than enabling student-driven learning with laptops, it largely introduced frustration, infrastructural problems, and breakage, and failed to affect student learning in any appreciable way. Though typical of OLPC programs, this stands in marked contrast to well-supported one-to-one programs in the US, which have shown broadly positive results. Indeed, the two other programs using netbooks and open educational tools that Warschauer observed enjoyed teacher and student satisfaction, improved learning processes, and better student test scores.[50]

What then accounts for the low levels of use and unimpressive results of the OLPC laptop program in Birmingham? Analysis of the program suggests that there were three fundamental characteristics of the implementation, all of which correspond to the broader OLPC approach, that differ from other school laptop programs in the U.S. and are closely connected to how badly it backfired: a technocentric approach, child ownership, and the XO computer itself. We next discuss the lessons we can learn in each of these areas.

OLPC Birmingham's Technocentric Approach

The OLPC approach is noted for its technocentrism, the notion that the mere provision of technology, outside of a broader social reform effort, will bring about wide-scale positive educational effects.[51] Birmingham's mayor and city council believed this claim, supplying laptops to children with little funding for Internet access, computer maintenance and repair, or teacher professional development, and without giving the school system time to develop pedagogical plans for them. This is consistent with the overall OLPC approach as articulated by Negroponte and Papert,[52] which emphasizes the transformative effect of the XO itself on children's lives and de-emphasizes or opposes pilot programs, formative or summative evaluation, and professional development. In 2011, for example, Negroponte boasted that OLPC would "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.[53]

An unrealistic faith in the power of a new technology to bring about fundamental educational transformation, in and of itself, is certainly nothing new. Tyack and Cuban, for example, have documented how similar beliefs in the transformative power of film, radio, and television all failed to actually transform education.[54] Though we are optimistic about the educational potential of computers, we do think it evident that positive changes will require a broad approach in which technology serves curricular and pedagogical ends, rather than through a focus on provision of technology itself. Technology is only a tool, not a magic bullet for larger structural issues in schools and school systems.

Moreover, not only is technology not a magic bullet, its indiscriminate deployment can actually backfire, harming the very students it was meant to help. The problems with a technocentric approach are shown in recent studies on the impact of gaining access to computers

and the Internet.[55] Whether at home or at school, physical access to new technology without social or educational support may have more negative rather than positive results, with the worst outcomes being achieved for those 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 resulted in lower math and reading test scores for youth in grades five to eight, with African-American youth suffering the worst results.[56] An analysis of a computer voucher program for low-income families in Romania also showed significantly lower school grades among those in the program in math, English and Romanian.[57] In the classroom, Wenglinsky found that technology use among the tech-centric programs he studied resulted in lower test scores in math, science, and reading, with the worst outcomes among students from low socioeconomic families.[58] Wenglinsky and others show benefits of computers when part of a well-planned educational initiative, but there is little evidence that simply distributing 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. The possibility of benefits depends on the broader ecology of the implementation,[59] including existing norms[60] and teacher beliefs.[61]

The Problems with 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, and is consistent with the technocentric approach that views children's tinkering with their own digital tools as critical to their educational and technological development. Papert often belittled the idea that children should have to share computers, calling it as unproductive as sharing pencils.[62] He asserted that educational use of digital media would be far more productive when all students had regular

access to their own tools. And research backs this: when students have individual and daily access to laptops at schools, they use them for more productive educational purposes than when laptops are shared.[63]

In Birmingham, however, the notion of child ownership backfired when it came into conflict with another of OLPC's principles: one-to-one access. What we witnessed in Birmingham is that when children owned their own laptops and were responsible for maintaining them, the laptops broke down over time, and there was little knowledge or infrastructure in place to repair the specialized machines. This resulted in large numbers of students without working laptops, which in turn meant low laptop use, consistent with other OLPC programs.[64] In contrast, programs that used XO laptops without child ownership tended to have few breakages and higher rates of use in school.[65] While it is still possible to productively share school computers, a 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. That is because educational leaders are beginning to consider *bring-your-own* programs, in which families are responsible for purchasing and maintaining laptop, handheld, or tablet computers that children will then bring to school.[66] These programs 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 can backfire, even in cases where the device is initially purchased for, rather than by, the family. We instead recommend modified bring-your-own programs, in which schools provide devices to children who do not have working computers.

The XO Computer: No Technological Marvel

Though the OLPC implementation approach has been widely criticized, the XO laptop is often still regarded as a groundbreaking technological marvel. Data from Birmingham and elsewhere, however, suggest that the XO laptop was experimental and buggy,[67] and this design contributed to the program's backfiring. Although many of the XO's activities were meant to engage children in using computers and learning computer programming without anxiety and fear, the XO was like other computers in that it could be easily broken, and its relatively low power usage came at a cost of severely limited functionality. Some of its more interesting features, such as mesh networking to connect XOs to one another without a router, never worked in practice and were dropped from product updates.[68]

Especially troubling was the XO laptop's relative inaccessibility to teachers. With a 7.5-inch display and tiny keyboard, the XO was difficult to use for most adults. Though external keyboards could be attached, we never witnessed any teachers doing so. No ports were available for standard external monitors. In addition, the "Sugar" interface on the XO was unintuitive and Sugar emulation software was technically difficult to install. Thus, teachers did not have a good way to familiarize themselves with the software except on the XOs themselves, something that required a great deal of effort and motivation. This helps explain why OLPC implementations feature less classroom laptop use than other laptop programs, where the hardware and software are more familiar to teachers.[69]

The XOs were inaccessible to teachers in another way as well. It was very difficult for teachers to get access to student work on the XOs other than walking around the classroom and observing it on small screens. In other laptop programs we have investigated, an important benefit was increased exchange of work such as paper drafts between students and teachers.

Of course, OLPC emphasizes what children can accomplish with computers without adult mentoring or assistance, so perhaps the inaccessibility of the hardware and software to adults is not a problem – after all, the XO was designed for children. However, other laptop implementations have chosen hardware and software that is not only suitable for children but also more accessible for adults, with better results for all.[70] Thus, the design of the machine itself – which was experimental, buggy, and ultimately frustrating – contributed to the program backfiring, hurting the students it was meant to help.

Avoiding Backfire in One-to-One Laptop Programs

OLPC's research and development efforts broke much new ground in the area of low-cost, low-power computing. But OLPC's projects have been plagued by problems stemming from the laptop's design and the project's technocentrist hubris. Far from revolutionizing Birmingham's educational system, closing the digital divide, or enabling students to "come up with solutions to the world's problems," as Mayor Langford hoped, OLPC Birmingham wasted scarce resources on a hard-to-use, easy-to-break laptop that not only did not help students learn better, but decreased education-oriented computer use in the home. 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 used were the least expensive of any deployed in U.S. laptop programs at the time, at just under $200 each,[71] they did not reap the benefits that other programs have, thus resulting in a high cost-benefit ratio. The children of Birmingham deserve better. And, indeed, they could have had better. If the city had used the same amount of funds for a smaller but better planned

program, for example, 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 could have had one of the better elementary school laptop programs in the U.S., instead of what the local press called a "costly lesson."[72]

What then does the Birmingham initiative say about the broader OLPC program? The Birmingham program closely adhered to all of OLPC's core principles, including child ownership, starting at young ages, and mass distribution of the XO computer. Following the recommendations of OLPC leadership, the program eschewed a lengthy pilot or formal evaluation and devoted few resources to repairs, infrastructure, or professional development. The ways in which this program backfired echoes reports from other OLPC deployments around the world.[73]

Our investigation of the Birmingham OLPC program shows that technocentrist approaches are at great risk of backfiring. Any educational reform effort with digital media needs to be grounded in solid curricular and pedagogical foundations, include social and technical support, and involve detailed planning, monitoring, and evaluation. It is also essential that school districts are involved in the conversations and planning; merely having it thrust upon them will not engender success. As schools and municipalities strive to increase access to and use of digital media in schools, they will do well to bear in mind this 'costly lesson' from Birmingham.

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