One Laptop Per Child in Rural Kenya:

Student Perceptions about Computers, School and Self-Efficacy after One Year with XO Laptops and Constructionist Learning

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Abstract

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In 2009, the One Laptop Per Child (OLPC) non-profit organization ran a pilot program called OLPCorps Africa. The intention was to provide funds and one hundred of the group's iconic green and white XO laptops to volunteer teams partnering with established non-governmental organizations (NGOs) in order to deploy the computers in rural African locations. This paper reports evaluation data from one OLPCorps Africa deployment in rural Kenya and examines how a specific setting challenged assumptions about the nature of inducing educational change through technology introduction. Survey questions reveal significant decreases in students' perception of school as fun; questions about self-efficacy show no significant change; and responses about computers illuminate what students knew about computers before and after the intervention. These results raise provocative questions about the OLPC program, how OLPC's endeavor relates to its historic context, and a need for future research.

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A Personal Preface

Readers of this paper may wonder why a young American woman from Seattle ended up volunteering and collecting research in a rural village on the coast of Kenya, particularly when there are plenty of areas of need closer to home. In 2004, at a point of personal transition, I was seeking participation in meaningful work and some perspective on life in America, particularly its engulfing consumerism and emphasis on amassing material goods. The humble NGO started by a college friend offered just such a place to land and spend a few months assisting in the operations of the school and community center she was building on family land.

Once in Kenya, from my home base in an off-the-grid mud hut, I had the opportunity to spend time immersed in the life of this Swahili/Giriama community conversing with local families over plates of steaming ugali, and watching, listening and asking questions. In addition to general teaching and tutoring duties at the community center, I was involved in an education and technology project that introduced a small group of teenagers to cameras, laptops, social networking and digital storytelling. This technology project raised many questions for me at the time about how and why to introduce technology into a new place, the pedagogy that could best serve such a project, and how to navigate the complex ethics of international development. The experience eventually led me to pursue graduate study in education and technology in 2009, but not before employment at an educational software company and an art museum, as well as volunteer advocacy in the areas of media democracy, media literacy, technology access and fair trade, all of which informed my path and my interpretation of my experiences in Kenya.

When, at the beginning of my graduate studies, One Laptop Per Child put out the call for applications to the OLPCorps Africa program — a project aimed specifically at university students partnering with NGOs in rural African settings to deploy OLPC's XO children's computers — I leapt into action. I was determined to bring resources to the children of my friends in Kenya and determined to add to the surprisingly small body of knowledge about the effectiveness of One Laptop Per Child's strongly constructionist-based pedagogy. I wrote one of thirty successful proposals and worked with a small team of volunteers and Seaside Community Center (SCC)[1] staff to launch the XO laptops at the Shady Palms Junior School in Seaside Village, Kenya. Somewhat ill prepared for a robust data collection effort, I did what I could to bring home surveys, interviews and observations from which to glean insight into this much-hyped project. My goal was to understand the implications and effects of technology and educational interventions in Kenya.

When I arrived in Kenya in 2009 to train teachers and conduct "computer camp" with students as a part of our project deployment, I discovered that the technology landscape had changed dramatically since my previous visit. In 2004, cell phones were scarce, while in 2009, they were seemingly everywhere, from the pockets of fishermen to the leso satchels of women tending their farms to the work-worn hands of grandmothers. The peaceful bodibodi bicycle transport I had previously enjoyed was supplanted with speedier but noisier motor bikes, the local banks were pushing for members to sign up for debit cards, accessed through computerized ATM machines, and private companies had popped up to offer popular but over-priced and poor-quality training in Microsoft Office applications. Adeptness with these programs and basic computer literacy were emphasized as prerequisites for jobs and entry into higher education more than ever before.

[1] The names of the NGO, the school, the community center and the village have been changed to ensure the anonymity of those involved in the study.

Meanwhile, some meager efforts had been made to introduce computers into public and private schools, funded, for example, by the local Rotary organization. As an anecdote from a local public school teacher illustrated, however, the computers often sat unused in the corners of classrooms because teachers did not know what to do with them. The school at which I had previously worked and that was to receive the XO laptops had developed in many ways between 2004 and 2009, with stronger staff, extra-curriculars and enrichment activities, but it was still tied to the Kenyan national curriculum, and still employed a great deal of lecturing and drill-and-practice work.

With such a mismatch between the rapidly changing technological landscape and few opportunities to learn how to use computers, especially in a rural area, the idea of introducing bright new laptops and learning principles that emphasized hands-on experience seemed like a good idea, especially in a school where other basic needs were being addressed (for example, through the school feeding program).

Although I was skeptical of OLPC's untested claims and lack of support for teachers from the outset, the deeper I dove into the project, the more problematic I found their assumptions, approach to development, and interpretation of how children learn. For example, OLPC founder Nicholas Negroponte of MIT insisted that communities accept without question OLPC's principle of taking the laptops home, whether the community wanted their children to do so or not. In another instance, a project volunteer resisted putting files for the Bible and Koran onto the laptops even when the teachers asked. In short, I found a disregard for the rights and voices of the community's children, parents and teachers at every level — perhaps ironic from an organization ascribing to an educational philosophy of individual choice, personal meaning and empowered learning. At the same time, I saw this emphasis on individual choice and achievement to "get ahead" emanating from a Western privileging of the individual, poised to infringe upon non-western cultural values of collectivism and collaboration.

While at the heart of the project and my analysis lay One Laptop Per Child and OLPC's interpretation of MIT scholar Seymour Papert's constructionism, this look into one project in one location spurred a larger consideration of why the same phenomenon of seeing technology as a silver bullet to "fix" education keeps happening, despite a string of ill-fated results. Yesterday's laptop learning is today's mobile learning is tomorrow's as-yet-to-be-developed panacea for education as a way out of poverty.

My perspective evolved considerably throughout the project implementation and the writing of this paper as I have brought to bear my own learning on my experience in Kenya and my interactions with One Laptop Per Child. I have attempted to gather data and analyze it here, but foremost are my observations drawn from being in a particular place at a point in time and having a first-hand view of successes and failures of technology and pedagogy introduction where they were not previously known. In addition to the tales of teachers and in-school learning, I also witnessed instances of laptop learning at home that added depth to the more school-based picture. Our instantiation of OLPC's program diverged somewhat from OLPC's objectives; we did not insist students take laptops home because, when asked, the parents preferred the laptops stay at the school, at least during an initial period that allowed for the novelty to wear off and the community to acclimate to this new and potentially valuable collection of objects that not everyone received. In the homes of some of the families I shared meals and stories with in 2004 (whose children were four and five at the time), I had the opportunity in 2009 to witness laptop learning in action with then nine- and ten-year-olds, and to hear from parents, students and siblings outside the context of school.

With limited time and budget to prepare for the project deployment and the data collection, and not knowing which kinds of data would prove most valuable, I gathered a variety of surveys, interviews, video and observations. In this paper I have chosen to look in-depth at a few of these pieces, using the rest as context, and placing both in a larger framework of trends in information and communications technology for development (ICT4D), particularly in regard to the introduction of material culture, as well as changes in the landscape of learning theory.

Chapter 1: New Computers, Old Stories

For the past several decades, modern life has become increasingly intertwined with electronic devices, from the personal desktop computer to the iPod, just as Internet connectivity has swept first the wealthier regions of the world and, increasingly, the planet. Reliance on ubiquitous technology and must-have gadgets is merely the most recent iteration of a larger trend toward dependence on material goods in the Western world. New technologies emerge and hit the market seemingly before even the earliest adopters (or rather, their pocket books), can keep up. Educational institutions, from kindergartens to universities, are subject to the same pressures to not only outfit classrooms and libraries with up-to-date hardware and software, often at great expense, but also to equip young learners to navigate the technology saturated world around them. Parents, teachers, educational administrators, museum staff and librarians alike have rushed to provide students with technology offering opportunities to gather, assess, use, and distribute information, as well as to engage in multimedia expression using images and sound.[2] Representatives of the United Nations and other global entities concerned with education in the developing world have also looked to the potential of computers to advance the desire to learn, create, and communicate among children, rural and urban.

From the beginning of this technology explosion, computers have been at the center of expectations that the affordances of this kind of electronic device would bring benefits to learners around the world, continuing a legacy of imbuing new technologies with the power to supply a shortcut to educational change that can be traced back through the introduction of

[2] The Pew Internet and American Life Project (www.pewinternet.org) has tracked many of these trends over the past few years. See for example Rainie and Horrigan, 2005; Lenhart, 2009; Thomson, Purcell and Rainie, 2013; Pew Internet n.d., a, "Teen Tech Usage Over Time", n.d., b, "Teen Gadget Ownership," 2010; Sullivan, Vander Leest and Gordon, 2008; Becker, et al., 2011.

overhead projectors, television, film, Skinner's teaching machine, the Chautauqua desk and even the chalkboard. Perhaps most parallel to the Chautauqua desk or, more simply, the textbook, the personal computer, desktop or pocket sized, promised a self-contained learning solution through which the world's poor could learn independently, without regard for the quality of local schools. The modern-day influx of computers brought into developing regions by largely Western organizations also continues a pattern of introducing material goods in the hopes of creating behavioral change.

In the early days of the personal computing revolution, mathematician and computer scientist Seymour Papert, professor at Massachusetts Institute of Technology (MIT) in Cambridge, Massachusetts, proposed a theory of "constructionism" designed initially as a way to describe how children can best learn math and computer programming. His theory pushed against the transmission or "banking" model of schooling that he termed "instructionism," in which experts transmit information to novice learners. Instead, he argued, children learn by "constructing" new knowledge from existing knowledge via experience and experimentation with making physical and virtual objects. Constructionism derived in part from ideas put forward decades earlier by Papert's mentor, Jean Piaget, as well as John Dewey, who extolled experience as foundational to learning. Inspired by studio art class and the power of programming for "constructing" and experimenting with mathematical concepts, Papert's theory complemented his work developing the Logo programming language for children and, later, his vision of the Children's Machine.

Throughout the 1980s and 90s, Papert, Alan Kay and Nicholas Negroponte worked through several versions of the Children's Machine, toward their vision of ubiquitous, one-to-one computing for children. As early as 1982, this endeavor included exporting computers and constructionism to developing nations, such as their project to send Apple II computers to Francophone Africa (Roper, 1983; One Laptop Per Child, n.d., e). In 2005 at the World Economic Forum, Negroponte announced his plans to develop a laptop specifically for children living in poor nations for the target cost of $100. The not-for-profit organization One Laptop Per Child, based out of the MIT Media Lab, distributed the first XO laptops in 2007. The machines came with the Sugar operating system and were accompanied by OLPC's own brand of constructionist principles.

From the earliest years of Papert's development of his theory of constructionism, he maintained that computers would and should become instruments of creativity as well as information access and communication. At the heart of Papert's notions, however, lay fundamental presuppositions about the nature of how people learn, a point of debate between Papert and scholars such as Roy Pea throughout the 80s (Pea, 1987).

Papert viewed learners as individuals who constructed knowledge on their own — a view that fed into the idea of Negroponte and Kay that children should have access to computers not only in their schools but also at home. One Laptop Per Child's mandate that children take computers home encountered several problems, however, both practical and conceptual, in the day-to-day lives of children living in poverty, including unreliable sources of electricity and pressures on children to work and directly or indirectly contribute to the family's income, both of which limited children's practice and playtime with the computers. Variability in parental educational attainment and home cultures that supported learning set the stage for a range of outcomes for different students learning at home. Further, despite OLPC's protests to the contrary, safety of children remained a concern when children walked to and from school and home with their computers in tow, leading schools and parents to make the judgment that computers should stay locked securely in the schools.

Added to these complications of individual learners were the realities of religious and cultural beliefs that stress communal values over individual assertiveness. Although OLPC held collaboration as a goal of its program, an individualist educational philosophy and unequal distribution of material goods contained an inherent degree of competition. All over the developing world, keeping the acquisition of either material goods or notable achievements relatively level has long contributed to local peace and harmony. In numerous societies the introduction of material wealth means sharing with all others in one's kin group, clan or village. Thus competition to get ahead or to outpace another is proscribed not only by religious doctrine but also by a sense of self-preservation. The complexities of these means of ensuring equity among villagers in rural societies is known as the "theory of the limited good" (Foster, 1965; 1967).

Engineers, educators and technology experts of the Western world find it difficult, if not impossible, to fathom what they regard as the kinds of restrictions on learning the conditions above indicate, although anthropologists have noted how the competition-based individual achievement orientation of the Western world contradicts the values of many other cultures. In addition, from global entities such as the International Monetary Fund and UNICEF to national foundations, such as Ford and Rockefeller, listening to local wisdom about necessary adaptations of "betterment" plans developed in the Western world has never come easily. Moreover, Westerners tend to develop theories they believe will bring forth practices that are universally beneficial.[3]

This paper takes a close look at one instance of attempts to introduce the One Laptop Per Child initiative into one rural village in Kenya between 2009 and 2010. As the personal introduction indicates, the author was an observing participant during implementation of the plan. Chapter one describes the background of the project, presuppositions fundamental to implementation, and the process of introducing the computers to the children in one village. Chapter two lays out the methods of research used to collect data between June 2009 and June 2010 and limitations of the research. The final chapter considers how any single case study of the implementation of material items and an externally developed theory of explanation has inherent limitations. The chapter concludes by exploring several theories of learning that developed simultaneously with the One Laptop Per Child implementation. These theories came about in relation to the strong push in U.S. universities for interdisciplinarity and to greater understanding of "everyday practices" in comparative perspective around the world.

Context Far and Near

Context far and near refers to the inherent gap between a material technology, along with its accompanying pedagogy, developed at the MIT Media Lab in Massachusetts, and the specific nature of the local context for which it was destined, distant in both physical space, cultural values, and daily realities.

[3] When in the 1990s, the expression "it takes a village to raise a child" became widely (and even wildly) popular, Westerners assumed the expression meant that children needed to be supported by sources beyond parents. Those in the developing world knew the expression was based in the localness of "village" and the merits of having those who know the context in which the child will come into adulthood raise the child.

One Laptop Per Child's concept of a widely distributed low-cost computer for children comes from Seymour Papert's vision from the 1980s of the Children's Machine and the educational benefits he saw for ubiquitous 1-to-1 computing (One Laptop Per Child, n.d., c; 2009, June). The vision is further elaborated in Nicholas Negroponte's 1995 book *Being Digital* (OLPC, n.d., c). OLPC's mission sets out the goals of the organization Negroponte launched in 2005:

> To create educational opportunities for the world's poorest children by providing each child with a rugged, low-cost, low-power, connected laptop with content and software designed for collaborative, joyful, self-empowered learning. When children have access to this type of tool they get engaged in their own education. They learn, share, create, and collaborate. They become connected to each other, to the world and to a brighter future. (OLPC, n.d., e)

Figure 1: The XO laptop

Although Negroponte's work with OLPC is based on previous experiences introducing computers to children in developing nations (Roper, 1983; One Laptop Per Child, n.d.; Negroponte, 1995), as OLPC has scaled-up Negroponte's ideas, it has done so on the assumption that what works with one group of impoverished children will work for all. Furthermore, that what appears to work for a short time equates to a long-term solution and that a few limited examples of student learning stand in for all children. Without reliable experimental data on the effects of OLPC, at home or abroad, the assumptions on which the organization is based remain just that; extrapolations from a limited body of field experience and a perspective embedded in the culture of elite educational institutions and the field of computer science.

At issue in this paper in particular are the implications within the mission statement that children in developing nations are not engaged in their own education; that their learning is not joyful, self-empowered or collaborative; that an inherently individual tool saturated in an individualist learning philosophy will lead to collaboration; that such independent learning will be equitable for all children; and that introducing a computer, used at home or at school, will be able to "eliminate poverty" (Cellan-Jones, 2007).

In 2009, OLPC ran a pilot program called OLPCorps Africa. The intention was to provide funds and one hundred of the group's iconic green and white XO laptops to volunteer teams partnering with established NGOs in order to deploy the computers in rural African locations.

The computers distributed to the OLPCorps teams in 2009 included the Sugar operating system and a slate of applications designed for children, termed "Activities." Sugar is an open-source Linux-based operating system first developed by OLPC and now under the organization Sugar Labs, that is designed to be simple and non-verbal, both for use across languages and for users who cannot yet read. Activities include simplified versions of word processing (Write) and painting/drawing software (Paint), a calculator (Calculate), a memory game (Memorize), music generation and music sequencing programs (TamTam Mini and TamTam Edit), a distance measuring program that utilizes the computer's audio inputs and outputs (Distance), an instant messaging program (Chat), an Internet/stored-content browser (Browse), and video capabilities. In addition to these specialized versions of a fairly standard suite of personal computing software, the XOs included a handful of unique programs that also originated at the MIT Media

Lab. These included Pippy, Etoys, Scratch and Turtle Art.

Pippy: A programming environment for children that uses the Python language and allows users to execute math scripts (such as for the Fibonacci sequence).

Etoys: An object-oriented programming environment for children developed by Alan Kay based on the Squeak programming language.

Scratch: A block-based drag-and-drop programming environment that lets users animate characters. Scratch was developed by Mitch Resnick's Lifelong Kindergarten group at the MIT Media Lab.

Turtle Art: A drawing program developed by Seymour Papert. Users input commands to have the virtual "turtle" move in different directions and draw an image. Turtle Art evolved from Papert's earlier computer-controlled "floor turtle" that drew pictures in physical reality. Both Turtles use the Logo programming language.

These software selections were intended to complement the constructionist learning environment in which XO use was meant to take place, emphasizing learning to program a computer as a means to "learn how to learn" (Papert, 1993).

Context Near and Local

Seaside Village, where the SCC team deployed the XO laptops in 2009, is on the Kenyan Coast north of Mombasa in Kilifi District, Coast Province. Kenya has a Gross National Income (GNI) Per Capita of $810 per year or $2.25 per day[4], a nearly 50 percent poverty rate and a 40 percent unemployment rate (World Bank, 2012b; International Fund

[4] This number is for 2010 and is up from a GNI per capita of $780 in 2009 (World Bank, 2012b). The Rural Poverty Portal listed GNI per capita for *rural* Kenyans at only $530, while it cited $790 for overall GNI per capita (n.d.).

for Agricultural Development, 2012; CIA World Factbook, 2012). Seaside Village is a rural and impoverished area of the country; most of the residents engage in subsistence farming and fishing and likely live on considerably less than the national average. The World Bank lists the poverty rate for the Kilifi District at 66 percent. The national census on population and housing states that 85.8 percent of the rural households in this district have dirt floors and only 3.9 percent of these households have electric lights (Kenya National Bureau of Statistics, 2010). According to a report from Uwezo on education for Coast Province, which also includes the city of Mombasa, "the proportion of mothers who have never been to school (43%) was twice the national average (21%). Only 1 out of 12 mothers have secondary education" (2010a, p. 53).

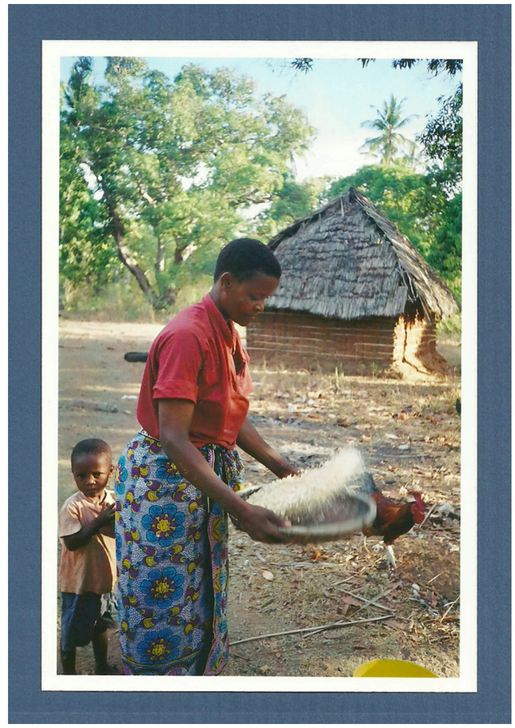

Figure 2: Typical mud home in Kilifi District

Public primary education in Kenya and in Seaside Village is free, but school quality and class size are challenges. Primary school encompasses standards (grades) one through eight, or roughly ages six to thirteen (UNESCO, 2010, p. 9). In 2003, the Kenyan government launched a Free Primary Education (FPE) initiative, the third in the nation's history, with mixed success (Oketch & Somerset, 2010). Overall, enrollment soared, but with differential effects —

Some schools limited their intake of new students to historic levels and did

> not expand significantly. In strong contrast, other schools accepted large numbers of new entrants without complementary increases in the number of teachers, teaching resources, and space. The impact of rapid and uneven growth on reduced quality is clear, if unintended. (Oketch & Somerset, 2010, p. vi)

The Kenyan government did not provide the attendant additional resources for the surge in enrollment that resulted from their 2003 policy change. The schools that were able to limit enrollment of new students, typically those schools that were previously high-fee schools serving students at a higher socio-economic level, "generally found ways to maintain the barriers, often through levies of various kinds for additional facilities or activities" (Oketch & Somerset, 2010, p. 8). Those schools were able to maintain quality and keep class sizes low by recreating the old system of a high barrier to entry, but, as Oketch and Somerset's survey of 17 Kenyan schools illustrates, schools that did not charge exorbitant extra fees suffered from teacher shortages, overcrowding, lack of materials and a reduction in quality. Oketch and Somerset write of the two schools in their study that saw the largest increases in enrollments, "This massive surge placed intense pressure on resources. Both schools, as it happened, had unutilized classrooms, but no additional teachers were posted to either. In consequence, class sizes burgeoned — in some cases reaching three-digit numbers. Desks, textbooks and other essential materials were all in critically short supply" (2010, p. 13). Similarly, Kinuthia writes of the change in policy, "most schools were not equipped to handle the large numbers of students in terms of the number of teachers, physical classroom space, and learning resources (Mukudi, 2004). In some schools, some classes now have as many as 80–100 students" (2009, "Introduction of Free Primary Education," para. 3). She goes on to report an estimated shortage of 60,000 teachers in Kenya ("Introduction of Free Primary Education," para. 4). An Uwezo report from 2010, based on 2009 data, noted at teacher ratio of 40:1 (2010b, p. 36). Although no data were collected for our study about the FPE schools in the Seaside Village area, these schools fit the pattern described above. Observation, anecdotal evidence and SCC reports suggest the ratio in the area is considerably higher than the government figure, closer to double that number.

Figure 3: A school in the Seaside Village area in 2004, shortly after the education policy change. The SCC has since rebuilt this school.

It was in this environment that the SCC established the Shady Palms Junior School in 2004, in response to the community's request for a higher-quality school for their children. In contrast to the nearby public schools, the accredited, private Shady Palms Junior School maintains class sizes of 30. The school is funded by American and international donors and grants, including the Bill and Melinda Gates Foundation and donations from individuals. Although there are some nominal school fees for students from families who can afford them, the SCC's fundraising model includes student sponsorships and most students have scholarships, as well as donated school uniforms and other items. The school serves breakfast to nursery school students and lunch to all students. An American program director oversees the school's operations, but the school is staffed by Kenyan teachers and a Kenyan headmistress (principal) and follows the Kenyan national curriculum. The SCC strives for a balance of Christian and Muslim teachers to reflect the makeup of the local community, as well as an even number of male and female teachers. In 2009, when the XO project began, the school included up to grade 5, with approximately 30 students per grade. Grade 6 was added in 2010.

As a part of the UN Education for All initiative, Kenya ascribes to the education principles set forth in the Dakar Framework for Action on Education for All (2000), with a particular focus on expanding access. Kenya's elimination of school fees in 2003 was a part of this effort. Kenya's more recent goals for education are also influenced by the UN's Child Friendly Schools and Basic Education in Africa Program (BEAP) for school reform.

Kenya uses an 8-4-4 system. The primary grades, which are the focus of this paper, emphasize basic literacy, in Kiswahili and English, and basic numeracy. Subjects include Kiswahili, English, math, science, social studies, religious studies and creative arts. Social studies incorporates units on the local region, province and nation, covering topics such as local geography, natural resources and industries. Religious studies include Christian, Muslim or Hindu education. Sciences encompasses identification and declarative knowledge about topics such as the human body, animals or agriculture, combined with some hands-on activities that use local materials (for example, soil, sticks and water.)

Although teachers vary in their style, delivery is typically lecture-format with some initiate-respond-evaluate (IRE) interaction between teachers and students. The teachers at the Shady Palms Junior School observed for this study tended to read straight from the teacher guide to present their material. Lecture content and the information students were responsible for was often descriptive and declarative knowledge, mastered through repetition and rote memorization, for the purpose of passing exams.

The authors of Kenya's 2012 task-force report "Vision 2030" that evaluates the current education system and lays out goals for the future, note that "the curriculum is objective oriented and geared towards passing examinations. This approach hampers learning as learners are often drilled to pass examinations." In addition they mention that the "linkage with the world of work is weak" and that the curriculum does not address "local communities' needs and priorities," among other gaps (Ministry of Education, 2012, p. 52).

In addition to the challenges to the primary education system mentioned above, Kenya also suffers from an urban-rural technology gap. As in other nations, a divide exists between computer access and education in urban versus rural areas, with Seaside Village, a rural area, falling further behind as urban schools introduce their students to technology.

At the time the computers were introduced, the curriculum and the school day at the Shady Palms Junior School provided few opportunities for collaboration, creativity or question asking on the part of the students or hands on experience, although the school had participated in projects related HIV/AIDS education and the Human Rights Watch Red Hand Campaign on child soldiers. The curriculum also included a few creative arts classes each week.

Implementation

One Laptop Per Child provided the OLPCorps teams with $10,000, 100 laptops, 1 XS school server and limited training in Kigali, Rwanda. Structured as an internship, the OLPCorps program required that teams include at least four university students, two of which had to be at the deployment site for ten weeks over the North American summer of 2009. The causal reporting requirements included a site visit by OLPC staff members, blog posts, images, a deployment summary, and a report-back at a conference in Boston in October 2009. Teams could include travel expenses in the $10,000, and many did, but in the case of Seaside the team spent the funds beyond those needed for additional technology equipment (hard drives, wireless units, etc.) on building a classroom, wiring the entire school, covering travel expenses for two Kenyan teachers to attend the Kigali training, and contributing to teacher salaries. All American volunteers paid for their own travel and other expenses.

After a spring of frenzied preparations for the deployment, in June, two American volunteers and two teachers from the Shady Palms Junior School attended a week-long OLPC training in Kigali, Rwanda, that kicked off the OLPCorps project. At the training, participants learned about constructionist learning concepts and about technical aspects of the computers, and also visited schools that were using the XO computers in Kigali.

All Shady Palms teachers received an XO computer of their own. The American graduate student volunteers continued teacher professional development during July two to three times a week, with a follow-up meeting held once a week to answer questions and concerns. Each training session addressed a new software application and left a day in between trainings to allow teachers to practice at home and come up with ideas for how to incorporate that application into their curriculum. In addition to the graduate student volunteers, the team had help from the two teachers from the school who had attended the workshop in Kigali, and who were familiar with the XOs (these teachers will subsequently be referred to as the "technology teachers"). The concept was that the technology teachers who attended the Kigali training could teach the rest of the teachers at the school about teaching with the XO, although in practice the teachers did not take the lead on teaching their peers what they had learned.

While school was not in session, the teachers had intensive workshop-style professional development for approximately four hours per day, three days per week. These trainings continued skill building as appropriate; provided feedback, ideas and a place to discuss instructional techniques and classroom management ideas; covered lesson planning and ways to structure computer classes in the upcoming term; and began long-range planning.

The students received their XO computers the week of July 12, 2009. School was in session in July, and the volunteers conducted hour-long classes three to four times a week. Most of the time available was used to teach the students basic skills. The teachers followed team-designed basic lesson plans for the first few introductory lessons, and the volunteers continued improvising their own lessons where these left off. The topics tended to spread each software application over two or three class periods and covered basic introductions to software programs for word processing, painting/drawing, video recording, music generation and sequencing, basic programming and animation (Scratch), calculating, measuring distance, memory games, chatting, and browsing stored content.

At first, one of the volunteers taught the students and modeled the desired teaching techniques for the teachers, while the other volunteer and one of the technology teachers who had been to the Kigali training assisted students who had questions. Toward the end of July, responsibility shifted to this technology teacher, with the volunteers helping when needed.

During August, the students were on a break from school but the teachers, staff and OLPC project volunteers held computer "camp" for four hours two to four times per week. The topics included review of previously used programs and covered new lessons with the painting/drawing software, Scratch, Chat and Turtle Art. Each class period included verbal review, review using the XOs, practice, introduction of new material, practice time, and free time to use any software application. The technology teachers took the lead and did nearly all of the teaching, while volunteers assisted, provided clarification when needed and worked with the teachers on lesson planning behind the scenes. A third American volunteer continued to assist the teachers with the computer camp for the last half of August.

Throughout July and August, time with the computers was limited at first by the school schedule and in August by limitations on electricity. Although the plan was to have the school electrified by the time the computers arrived, and the team had begun working on this as soon as the award was announced, the power was not connected to the school until the middle of September. Instead, for July and August, the laptops were powered with a generator. Fuel cost, coordination, computer battery life, and generator failures all limited the time available to work with the computers during this period. Student absences for religious holidays and taking of the national census in August also affected the number of days for classes.

Although basic introductions to the computers and software applications and unstructured practice and experimenting time took up much of class, the students did participate in some more complex projects. The students used the audio software to generate music that played along to skits performed by other students during the closing ceremony for the school term (at the end of July). The students also used the video recording functionality of the computers to capture pictures and videos of the event and people. The students did smaller projects, as well, during the course of basic lessons on each software application, such as drawing assignments and Scratch projects. While using the word processing software, students wrote about their experiences with the computer so far, as well as on other topics of their choice, such as "My school," "My friends," etc.

After this initial teacher training, student lessons and student computer “camp,” the teachers were free to integrate the computers into the regular school day and after school activities as they saw fit. As of October 2009, the Program Director reported, “The kids have 6 computer classes a week now, incorporated into science, math, creative arts, etc.”

Chapter 2: Methods

Data Collection Methods

The project evaluation included student and teacher surveys, teacher interviews, classroom observations and short video observations. These data were collected in the same way and using nearly identical surveys and instructions in both a pre-assessment phase before the computers were distributed in 2009, and a post-assessment phase one year later in 2010.

Teacher Survey and Interviews

Teacher surveys and interviews asked questions both for the purposes of research and practical execution of the project. Questions sought to illuminate teacher attitudes toward the project, descriptions of how they used the laptops in their classrooms after the initial 10-week project launch, if and how they saw their own teaching or student learning change as a result of the project, support they might feel they needed and problems they were facing. Teachers filled out the surveys themselves, and the interviews were conducted in person and documented either with audio recordings or written notes.

Student Survey

The student survey, the results of which form the core of this paper, was composed of a variety of question types, including problem solving tasks, open-ended questions and Likert-type questions, and was written to be readable and accessible to fourth and fifth grade students for whom English was not their first language. Asking about computers directly could have been problematic, particularly on the pre-assessment, as students might have been inclined to tell researchers "what they wanted to hear." Therefore, questions attempted to get at information about computer use indirectly. For example, only one question on the evaluation mentioned the word "computer" at all, and this question was buried in the middle of the questionnaire to keep the students from guessing about what was being evaluated.

Student Perceptions about Computers

The evaluation included a written short answer question about what students thought computers were used for. The students answered the question both before they received their computers and one year later. This question was intended to illuminate how students' perceptions about computers changed as a result of their exposure to the XO computers in school.

The question "What do you think computers are used for?" employed grade-level appropriate language free of any turns of phrase that would be unfamiliar to non-native English speakers. The question was phrased "what do *you* think computers are used for?" instead of "what are computers used for?" to encourage students to reflect on what they thought and what their personal experience with computers had been, rather than creating a situation where the students might try to guess what the "teacher" was asking for or what the "right answer" might be and to relieve the anxiety this type of question might provoke in students who had not used computers before or who might not even know what computers were. The question was also designed to work equally well at eliciting comparable answers before the students had used computers and afterward, without having to change the question.

Student Perceptions about School

To find out more about student's perceptions about school, the survey included a Likert-type scale question about how "fun" they thought school was with five options. The question used the word "fun" because it was a reading-level appropriate word the students would understand and associate with positive emotions, and a term that would translate across cultural contexts.

Student Perceptions of Self-Efficacy

The survey asked three related questions about self-efficacy that also used Likert-type scales. Each question was structured the same way, with only the academic subject name changing. The math question read:

Which one are you?
a. Very good at math
b. Good at math
d. Okay at math
c. Not very good at math

Given OLPC's emphasis on science and math, changes in responses to the science and math questions were of primary interest, relative to English. The trio of questions was based on the hypothesis that exposure to the computers would make the students more confident in their ability to perform math, science and English.

Participants

The surveys were administered to students in standard (grade) 4 and standard 5 in 2009, creating a baseline. The surveys were administered again, one year later, in 2010, to the same students, then in standards 5 and 6. Ages for this population of students on the day of the evaluations ranged from 9 to 14 in 2009 and 10 to 15 in 2010, with an average of 11.36 in 2009 and 12.2 in 2010. In 2009, there were 32 girls and 25 boys. In 2010 the break down was 29 girls and 20 boys. Shady Palms Junior School consistently performs well on standardized tests. School attendance is very high. In 2009, the SCC reported a 94.3 percent attendance rate for the school as a whole and an 87.67 percent rate of students achieving greater than 60 percent on their final exams. Six teachers at the school also received teacher surveys and were interviewed.

All students live in the Seaside Village area. Although this research did not collect substantial socio-economic data on the students and their families, the socio-economic distribution of students roughly mirrors the area. Some students live in cinderblock houses that may or may not have electricity. Others live in mud houses with no electricity or running water at all. The students come from families that ascribe to Islamic, Christian or traditional (Animistic) beliefs. The students do not have computers at home, although some families may have television, and most families have mobile phones.

Data Collection Procedures

The Kenya Program Director, SCC graduate student volunteers and the author collected all data for this evaluation. The teachers also assisted with administering student surveys. For both the 2009 data collection and the 2010 data collection, the volunteers were trained in data collection methods remotely (by phone and email) and provided written instructions. University of Washington Institutional Review Board (IRB) requirements were successfully met for all data collected. Student responses were labeled with a code that allowed responses from 2009 and 2010 to be linked to each other, but that did not allow data to be linked back to the students' identities.

The pre-assessment took place in June 2009 before the teachers were trained and before the laptops were given to the students and included teacher surveys, student surveys and classroom observations. The SCC Kenya Program Director distributed the surveys to the teachers. An SCC volunteer and the teachers of the school distributed the surveys to the students. Two SCC volunteers and the author collected the remaining pre-assessment data.

The post-assessment, which took place in May 2010, nearly one year after the pre-assessment, followed the same steps as the pre-assessment. All data were collected by the SCC Kenya Program Director and an SCC graduate student volunteer.

The author received all assessment materials by May 2011.

Data Analysis Methods

Upon receiving and reviewing all of the data, student responses were coded and entered first into Excel, then into SPSS 19. For open-ended questions such as "What do you think computers are used for," each discrete student response received a number. After student responses were catalogued, the pooled responses were reviewed for obvious trends. None emerged, so the responses were associated with keywords, from which categories were created. The analysis let keywords and categories emerge from the data, rather than forcing the data to fit an existing schema. Using multiple passes, categories were refined until each response had been categorized, category groupings seemed coherent and categories seemed balanced in level of specificity.

Categorization was fairly straightforward when students only responded with one answer (such as "They are used for writing letters"). When students responded with multiple items, however, (such as "It is used to play games. It is used to write some names.") categorization posed a problem. Too much detail was lost if only the first item the students listed was used and the rest discarded, so the second, third and fourth responses were included, but labeled clearly. It also proved to be more useful to "stay close to the data" and use percentages to describe the distribution of responses before and after the intervention, rather than creating an index.

After categories had been established, the data were divided into pre- and post-assessments and grade levels. Finally, within SPSS, each student's pre-assessment and post-assessment responses were compared, student by student.

Since the categorization method of examining the data revealed only small trends, word cloud and word counts were added to the data analysis to look for patterns. Student responses were entered into the word cloud generator TagCrowd (tagcrowd.com, created by Daniel Steinbock) in two batches — pre- and post-assessment — and the resulting clouds, which included word counts, were compared.

Many of the answers included restatement of part of the question, so the words "I think computers are used for" were excluded to focus on the content of the students' responses. Some spelling was also standardized to make comparisons easier. (For example "wark" to "work", "now" to "know" or "hurrendly" to "hurriedly").

For the Likert-type question about whether school was fun and the self-efficacy questions, all student responses were entered into SPSS and pair-wise t-tests were used to compare answers from before to after the intervention.

Results

Teacher Survey and Interview Responses

Teacher Survey Responses

Do you use computers in your classroom now? If so, how do you use them now?

- I use computers in my classroom at least 3 times a week, as a language teacher, science and maths. I assign my student[s] essay writing in the computers, and I also use it to do calculations in maths and viewing different images in science.

If you use computers in your class now, please describe a typical lesson you have taught using the computer.

- Kiswahili (essay writing), Maths (calculator), Science (plants and weather and the sky).
- Yes. Measuring longer distance by using distance activity in mathematics. Note activity in essay writing for Kiswahili in connection to Paint activity.

If you use computers in your class now, do you think your teaching has changed as a result of having computers to use in your class? If so, how? Why?

- Yes, it has made learning more meaningful. Because students enjoy learning by doing (i.e. more practical learning/child-student learning approach.)

Do you think computers change how students learn in school? If so, how?

- Yes. The child/student is learning more things by himself and get[s] exposed to modern technology.
- Yes; increased individual work by computers make[s] learning more learner centered.

What is most important to you about having computers in the classroom?

- It caters for follow-up activities and project-based learning [for] learners.

Do you have any concerns about having computers in your classroom? If so, what are those concerns?

- Time allocated for the computer lesson is not enough.

Describe a lesson you have taught using the computers. What do you think went well? What was difficult?

- Have not used in other subjects. [Beyond computer class.]
- When we studied the respiratory system we drew it using Turtle Art.
- Kiswahili lesson, writing essay. Story building and development drawing was good but a lot of times wasted on typing.

What would help you prepare to teach with computers?

- Pamphlets with handouts/books with all activities found in the computers, broken down into smaller teachable unites [units]. Lesson plan for the teacher, notebooks for the learners.
- Projector and regular laptop/computer.
- More training because technology is very wide. More computers and programs. Internet enabled connection.

Additional comments:

- Wishing school connected to internet

Figure 4: Sample of teacher survey responses

Teacher Interview Responses

What do you think of the computer project so far? Do you think there are advantages to having computers available for use in the classroom? What about disadvantages?

- Makes learning interesting since they learn by doing . . . it consumes a lot of time (shutting down, turning on, typing . . . learners get excited and lose their concentration . . . it makes learners dependent on the computers more than their brains.
- As I teach, I think 'how can I integrate the XO into this.'
- We have only 35 minutes to teach and involve the computer — need more time. Time is not enough

Have you found the teacher training for the computer project helpful so far? What has been most helpful? What has been least helpful?

- A success. Everything, all information was helpful
- XO projects have not been easy to use. Need more training on Activities
- Training was helpful. Need more activities, more programs — use same over and over.
- Yes, the training was helpful.

What kinds of curriculum materials would most help you teach with the computers?

- Pamphlets with handouts. Books with all the activities found in the computers, broken down into smaller teachable units.

- Print manuals [that] elaborate on XO activity.
- A manual with XO activities related to lesson plans
  Manual related to current topics.
- What would help you prepare to teach with computers?
- More training because technology is very wide. More computers and programes. Internet enabled/connections.
- Computer manuals on the available activities.

What activities have you been most excited to teach?

- Moon, Story Builder, Pippy, Turtle Art, Speak, Record and Browse.
- The kids really enjoy the video/film.
- Typing Turtle
- Write, Memorize, Paint and Tam-Tam
- Calculator activity . . . Chat

What do you see as the biggest barriers to using computers in the classroom?

- There's not enough time
- Time is not enough
- There's not enough time. It takes a long time to get them, set up, address low/dead batteries
- Electricity failure to recharge the XOs

What is your biggest hope for the project?

- To get real laptops as the age of the learner increases and more XO to other students in school.

Additional Comments:

- A laptop would be more realistic. Access to the internet, maybe through router or Safaricom, would be helpful.
- I'd like for the teachers to have a more advanced laptop (one to share). It would also be helpful to have wifi.
- Need internet access — can get teaching materials from internet

Figure 5: Sample of teacher survey responses

The teachers were asked about their use of the computers in their classes during teacher interviews and surveys in May 2010, nearly one year after the initial deployment. The responses summarized in figures 4 and 5 provide some evidence of the rate and nature of uptake by the teachers and how they employed the computers in their classroom teaching one year into the project. As their answers illustrate, teachers used a variety of the available software applications in their classrooms, sometimes in creative ways (such as using Turtle Art to draw the respiratory system.)

There was also evidence from the teacher surveys that the teachers were thinking about constructionist/constructivist learning concepts and planning their own curriculum. For example, they mentioned "learning by doing," project-based learning and integrating the XO into their teaching. However, all teachers mentioned time constraints, and, although they found the teacher training helpful (for example, considering it "a success"), the teachers requested more training, computer manuals and lesson plans.

The teachers also expressed concerns about electricity failures, "low/dead batteries" and set up time. They requested an Internet connection — both for the students and so teachers could research lesson plans and curriculum materials. Several of the teachers also mentioned getting "real laptops" for the students or for the teachers.

Student Survey

Perceptions about Computers

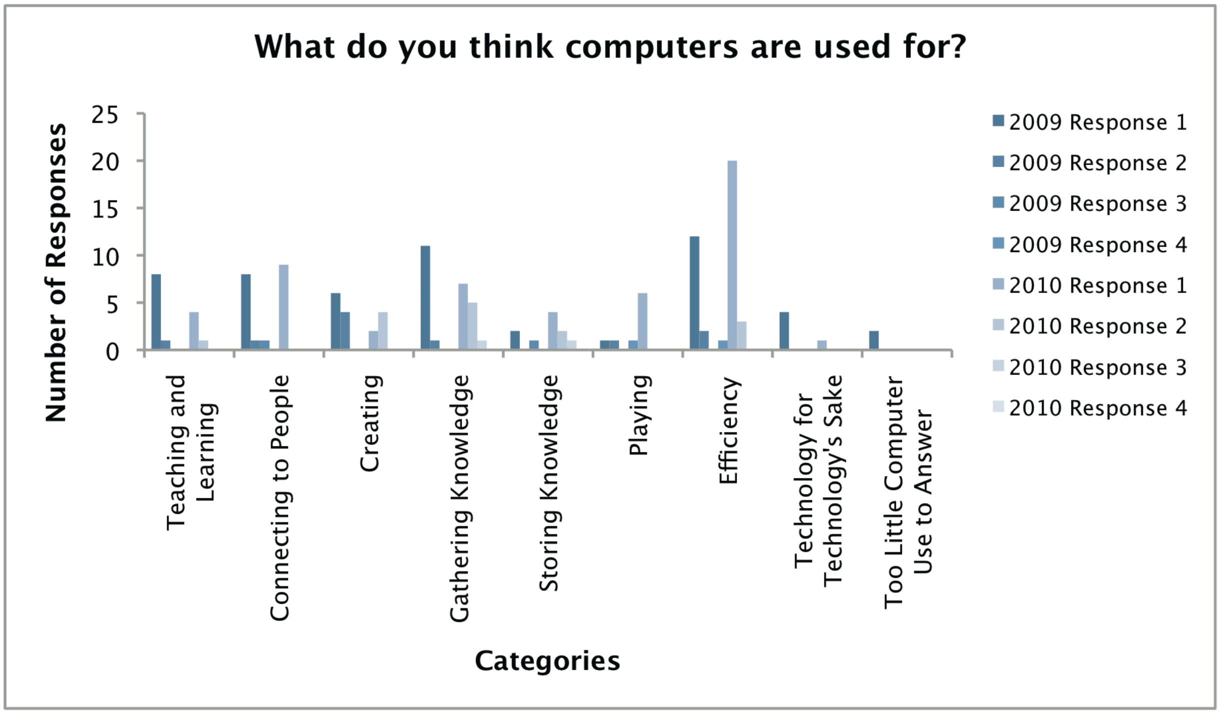

Figure 6: Student perceptions about what computers are used for, analyzed with categorizations

Overall, categorizing the answers revealed little change from 2009 to 2010. The "Efficiency" category increased the most (by 8 responses, from 12 to 20, up by 66.6 percent, if only the students' first responses are considered, and from 15 to 23, or 53.3 percent, if all responses are take into account), but this increase is tempered by the increase in the answer "computers are used for making work easier," which may not have come from the intervention at all. If students second and third answers are included, "Gathering Knowledge" increased by 1 from 2009 to 2010, up 8.3 percent, supporting the hypothesis about information gathering. "Teaching and Learning" went down by 4 (44.4 percent), decreasing the students' association of the computers with specific academic subjects and concepts. "Playing" doubled, increasing by 3, supporting an engagement hypothesis. Surprisingly, “Creating” went down by 4 (40 percent). “Storing Knowledge” increased by 4, from 3 to 7 (133.3 percent), and “Connecting to People” went down by 1, from 10 to 9 (10 percent). All of these results suggest the students had greater awareness of computers before the project began than anticipated and changes were not as dramatic as expected.

The consistency of “Storing Knowledge” and “Connecting to People” suggest that these were important functions of computers for the students before and after the intervention (although this conclusion is extrapolating somewhat because the question asked “What do you think computers are used for?” not “What do you value about computers?”) “Connecting with People” is aligned with the goals of OLPC and the intervention. The XO computers and XS server also make it easy for students to store documents. The students live in a relatively rural area where connecting to people far away is not easy (although easier with the introduction of cell phones) and preserving documents and information can be challenging.

Figure 7: Student perceptions about what computers are used for, analyzed with a word cloud

Another method used to look for trends was a word cloud comparison (Cidell, 2010). All responses were included but spelling was corrected for readability and question stem "I think computers are used for" and words marked unreadable in the transcription were omitted. Differences were subtle, but some trends were visible this way that supported the conclusions from the categorizations.

The most striking change was the increase in instances of the words "easier" (3 to 13, an increase of 333 percent), "making" (5 to 11, an increase of 120 percent) and "work" (4 to 16, an increase of 300 percent). The trend in these terms — especially "making" given its relevance to constructionism — sounds promising; however they map to a common response of "computers are used for making work easier." This answer was so similar for so many students, it implies a memorized answer, perhaps one that may have appeared in the government curriculum. This answer increased in frequency in the fifth grade, suggesting it may appear somewhere in the fifth grade social studies curriculum, or have been stated at some point by one of the fifth grade teachers. It is in fact quite the opposite of an indicator of construction happening in the classroom.

The term "things" changed from 12 to 7, a difference of 5 (a decrease of 41.66 percent), suggesting a move on the students' part to more specificity, supporting the conclusions from the categorizations. The concepts of "information" (3) and "technology" (1) also appear for the first time in the 2010 answers. Likewise, the term "letters" appears less frequently (8 to 2, a decrease of 75 percent), but the appearance of the term "chat" (1) and "messenger" (2) and an increase in "messages" (doubling from 1 to 2) suggest a shift to a broader understanding of communication using the computers. The words "world" (3) and "countries" (1) also appear in 2010, but not 2009, suggesting a greater awareness of the world and perhaps a sense that the computer could be used to connect to and communicate with this broader world. The appearance of “information” (3), “finding” (1), “getting” (2) “browsing” (1) and “searching” (1) support the hypothesis that students would see themselves as knowledge gathers, although the frequency of terms such as “learn” and “learning,” remain similar from 2009 to 2010.

Introduction of words such as “draw” (1), “chat” (1), “document” (1) and “documents” (1) and “browsing” (1) in the 2010 set might suggest a more sophisticated and broader knowledge of how computers can be used, but the 2009 answers include terms such as “email” (1), “internet” (1), “map” (3), “music” (1), “pictures” (1) and “picturing” (1), “camera” (1) and “science” (1). This suggests that the students had broader knowledge of computers before the project started than anticipated and that their understanding of what computers could be used for was not more diverse after the intervention. These results could also have been affected by how the volunteers and teachers informed the class about the project before it had started. The supply and nature of the information was hard to control without being on site the whole time. Moreover, there is no way to know how the teachers may or may not have been using the computers throughout the intervention. (For example, perhaps they used some applications more than others. One teacher, for instance, did not like the chaos and noise created by the class using the music applications all at the same time. As a result, it is possible the music activities were not used as much as say, browsing.)

Student Perceptions about School

Perceptions of Whether Students Thought School Was Fun 2009-2010

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Fun 2009	3.86	51	1.200	.168
	Fun 2010	3.29	51	1.301	.182

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	Fun 2009 & Fun 2010	51	.206	.148

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	Fun 2009 - Fun 2010	.569	1.578	.221	.125	1.012	2.573	50	.013

Figure 8: Paired samples t-test comparing student perceptions about whether school was fun from 2009 to 2010

In addition to the question "What do you think computers are used for?" the student survey also used a Likert-type scale to ask whether the students thought school was fun. Since the surveys were administered to the students as a pre- and post-test, a pair-wise t-test was used to analyze the results of this question, which revealed a statistically significant drop in students' perceptions of school as "fun" from 2009 to 2010, ($t(50) = 2.573$, $p < .05$).

Student Perceptions about Self-Efficacy

Perceptions of Science Ability 2009-2010

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Science 2009	3.22	51	.945	.132
	Science 2010	3.18	51	.590	.083

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	Science 2009 & Science 2010	51	.038	.791

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	Science 2009 - Science 2010	.039	1.095	.153	-.269	.347	.256	50	.799

Figure 9: Paired samples t-test comparing student perception of ability in science from 2009 to 2010

Perceptions of Math Ability 2009-2010

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Math 2009	3.30	27	1.031	.198
	Math 2010	3.15	27	.718	.138

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	Math 2009 & Math 2010	27	-.010	.962

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	Math 2009 - Math 2010	.148	1.262	.243	-.351	.647	.610	26	.547

Figure 10: Paired samples t-test comparing student perception of ability in math from 2009 to 2010

Perceptions of English Ability 2009-2010

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	English 2009	3.28	50	.784	.111
	English 2010	3.20	50	.639	.090

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	English 2009 & English 2010	50	-.073	.613

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	English 2009 - English 2010	.080	1.047	.148	-.217	.377	.540	49	.591

Figure 11: Paired samples t-test comparing student perception of ability in English from 2009 to 2010

The survey also asked a group of three questions about self-efficacy similar to the previous question about students' perceptions of school. Again using a Likert-type scale, the questions asked if students perceived themselves to be good at math, science or English. Pair-wise t-tests revealed that these indicators had no significant change from 2009 to 2010. For perception of science, the responses were ($t(50) = .265$, $p > .05$), for math ($t(26) = .610$, $p > .05$) and for English ($t(49) = .540$, $p > .05$). (Note that the sample size for math decreased because this question was missing from one set of student responses when received.)

Study Limitations

Limitations of the study include small sample size, lack of a control group, and unforeseen obstacles to program implementation and influences on the evaluation. Nearly all of the data were collected by SCC staff and volunteers. Some training as well as written instructions were provided to staff and volunteers; however it was difficult to ensure data were collected correctly from a remote distance. Likewise, it was difficult to ensure conditions were the same for each group and each data collection period. For example, some students may have had more or less time to answer questions on the survey. It appears that some students received their own word-processed, paper copies of the survey, while others appear to have copied the questions and answers off of the chalkboard. It is possible the difference in presentation (word-processed vs. non-word-processed) may have influenced student responses to the question "what do you think computers are used for?" inspiring such answers as "computers are used for making exams".

The study is also based on the evaluation of a program implementation at one small school with only one class per grade, so it involves a relatively small sample size and does not include a control group. In addition to study limitations, program implementation was not complete; for example, the team was not able to install the XS server due to technical difficulties until after the data collection period, impacting the effectiveness of the program. Students were not given as much free time with the computers as had been originally intended, possibly limiting the effect of the computers on student learning. The team had hoped to cover more material and devote more time to more complex student projects, but were not able to do this. Similarly, the SCC implementation diverged somewhat from OLPC's vision. For example, while we did maintain a 1-to-1 ratio of computers to students, we were not able to send the computers home with students. Although we provided training in constructivist/constructionist and project-based learning, we allowed the teachers to integrate the computers into their teaching and the national curriculum for which they were responsible as they saw fit. Consequently, the teachers assimilated these concepts into their previous teaching methods. Perhaps we would have seen greater differences in student responses had the intervention been more robust and the teacher training been longer and more intensive. At the same time, even without these changes, we might have seen greater differences had data been collected two or even three years after the advent of the program to mitigate possible first-year effects, resulting from the first few months of teachers adapting to a new intervention.

It is also hard to say if these results can be generalized to other schools in Kenya. In some senses, the Shady Palms Junior School provided the perfect venue for an XO pilot project and evaluation — as a small school, it allowed for relative saturation of 1-to-1 computing (in our project all students in grades 4 and 5 received computers in 2009; 4, 5 and 6 in 2010). Determined to break from a tradition of "computer labs," OLPC holds school saturation as a fundamental principle of the project and encouraged the OLPCorps teams to saturate their schools, or try to, even when the schools were much bigger than the 100 computers supplied. (OLPC, 2009; 2012a). Although we couldn't saturate the entire school, we could saturate several grades and plan for a sustainable project, with the intention of adding 30 computers each year. With the provision of school lunches, small class sizes, qualified teachers, adequate facilities and sufficient materials, the setting for the study minimized some of the enormously confounding factors at typical public primary schools in Kenya, making the Shady Palms Junior School quite different from a typical Kenyan primary school.

Analysis methods for the question "what do you think computers are used for?" posed another possible limitation as categories were created from a Western/American perspective with Western ideas about how computers are used, rather than from a Kenyan perspective, which might be more appropriate.

As mentioned in the "Implications" section of this paper, there are few studies of OLPC implementations, and, in particular, OLPCorps implementations in Africa. Even with limitations on this study, it contributes needed insight into learning with the XO.

Chapter 3: Looking Back and Thinking Ahead

This chapter considers the “what next?” or “what if?” questions that every researcher asks when the original case study has ended. Considered here, in light of our findings, are not only recent research that could have helped our insight into contextual issues OLPC faced in Seaside, but also implications of this case study for future researchers.

Summary of Findings

Teacher Survey & Interviews

As evidenced by their survey responses, the teachers used a range of software applications both through a dedicated computer class and in their subject areas and expressed some understanding of constructionist principles. They struggled, however, with keeping the computers charged and finding enough time to use computers in class. They also desired more manuals and other forms of support.

Although the teachers did integrate the computers into their classes, the challenges they expressed through their survey and interview responses are consistent with other studies of introducing laptops into classrooms. As Stephen Kerr recounts, the adoption of new technologies into teaching are not so much about the hurdle posed by learning the new technology itself, although he suggests this should be considered on the order of “years rather than hours or days,” but rather one of how teachers define their work and a radical reshaping of the teacher’s role in the classroom. Kerr writes:

> Confronting a machine that some suggested could radically restructure classroom organization was also a challenge for many teachers. If one was in fact to move from working as a direct instructor to being more of a mentor and guide, then how was one to learn how to do that, and how was one to assure that one's students were in fact progressing as they should and not using their own (many times superior) ability with technology to create merely a Potemkin village of progress? (1996, para. 36)

Leander's 2007 work analyzing the dynamics of a technology-rich private school echo the same interpretation of the influx of laptops into classrooms as a "spatial and temporal" challenge for teachers rather than a "tools and tool training" challenge (p. 26). Teachers in Leander's case study lament the interference of laptop screens with face-to-face interactions (teacher-student and student-student). He writes, "the laptops were seen as damaging by putting up a physical barrier between interlocutors in the classroom" (p. 36). These "physical barriers" lead to a fracturing of attention and classroom-as-community where learners participate in a collective and collaborative learning activity. The screens disrupt the social space and introduce inherent tensions between the "dualing discourses" introduced by laptops and Internet connectivity in the classroom (p. 29) that must be worked out for successful integration of the machines into the existing learning environment.

While the teachers at the Shady Palm Junior School adopted the new teaching methods and integrated the laptops to an extent, as witnessed by their comments, they were only able to do so insofar as their limited training on the XOs and their professional capacity enabled. As

Toyama asserts, “People have intent and capacity, while technology is merely a tool that multiplies human capacity in the direction of human intent . . . this means, specifically, that the technology cannot substitute for human intent or capacity where it is lacking” (Toyama, 2011, p. 77). Much as it would be convenient to engender school, institution, or system-wide change with the dissemination of laptops and short-term training, “Technology-as-amplifier leads to the conclusion that successful development programs that rely on technology cannot be scaled simply by scaling the technology. Rather, direct investments in building human capacity must be made. Yet, those are exactly the expensive investments that development organizations hope to avoid through technology” (p. 80).

The teachers’ repeated requests for more training and more support materials, as well as their expression of time pressures, confirm this point. The effect of space-time disruption in the classroom was likely exacerbated by the lack of connection between new modes of classroom interaction and the teachers’ existing teaching styles and curriculum, as well as the lack of continuity between their newly technology-rich school and that technology’s individual-oriented pedagogy with the surrounding relatively technology-poor community and its cultural values. This may be one reason why OLPC is having relatively greater success in Uruguay where the school system had already adopted a constructionist philosophy before the XOs were introduced and a relatively higher socio-economic status has allowed for greater technology saturation in the community. (Moss, 2010; Burger, Ferro, Baraibar, Perez, Salamano & Pages, 2011). As Kerr argues regarding computers in the classroom: “As was the case with other technological changes such as phonograph records and audio tapes, new technology made its way into classrooms most easily when it had first penetrated the home market and had thus become a part of most people's everyday existence” (1996, para. 26). Even in the prosperous United States, where laptops are very much a part of everyday life, laptops in the classroom pose quandaries teachers must unravel and solve. In resource-poor nations where teachers are less supported and less familiar with technology, this is even more the case. As Solomon and Perkins write of the "fingertip effect" of technology (2005), "Learners need time and guidance to achieve the effects that many contemporary cognitive technologies afford. . . . it takes time for innovators to see the possibilities, time for early trials, time for a kind of Darwinian sifting of those new ways of working that truly offer a lot, and time for the new ways of working to pass into widespread use" (p. 81).

Student Survey

At the outset, it is important to note that by the end of the data collection period, we learned that despite our efforts, change was minimal at the Shady Palms Junior School; in fact, the students' enthusiasm for school decreased between 2009 and 2010.

Student Perceptions about Computers

At the time of the data collection, the implementation in Seaside did not meet one of OLPC's primary tenets of allowing the students to take the computers home, and we did not have a working XS server or access to the Internet. Due to the school schedule and the teachers' reticence to give the students large amounts of unstructured time, students' use of the computers at school was somewhat constrained. Despite these setbacks, what were students able to take away from the experience about what a computer was and how it could be used for creative and/or knowledge gathering activities? A primary objective for the SCC of introducing technology to the Shady Palms Junior School was to teach the students to type, use the mouse and navigate the operating system, closing "the digital divide" in the narrowest sense. While these skills will undoubtedly help the students in later life as computers permeate life in Kenya and mastery of basic computer skills becomes a barrier to entry into higher education and the job market, teaching basic computer skills is not the primary objective for OLPC, nor is it necessarily the most interesting one for education research. The question "What do you think computers are used for?" instead gets at a slightly different objective, that of seeing computers not as buttons to be manipulated or techniques to be mastered, but in Papert's conception of OLPC's predecessor, the Children's Machine, "as objects to think with," and in a constructionist sense, as tools to build with (Papert, 1993; Papert, 1990; Falbel, n.d.). How could the students' responses to this question indicate whether the deployment successfully empowered students to see technology as something to create and learn with, not just as a means to digitize a handwritten document or as a source of digital illustrations for an otherwise conventional lecture? In what ways would the students' answers suggest a unique aspect of what OLPC has to offer?

While revealing some nuances in the students' understanding of computers before and after the intervention, the relative lack of change in students' perceptions of computers between 2009 and 2010 shows that the students, most likely, had much more background knowledge about computers before the start of the program than anticipated. Although the researcher spent several months in Seaside in 2004 and observed that students in fourth and fifth grades did not have any exposure to or understanding of computers, the evaluations created in 2009 assumed the students would still have no knowledge of computers, failing to take into account how much

Kenya and the village changed in the intervening five years, as well as the effect of the students' exposure to international volunteers, likely with laptops in tow, and the students' exposure to Kenyan and international media.

This finding that students most likely had a higher level of computer knowledge than anticipated before the program commenced, echoes research recently conducted by Joyoeet Pal in India. In his article, "The Machine to Aspire to: The Computer in Rural South India" (2012) Pal lays out the ways Indian media influenced parents' and students' ideas about computers even when they had not used or seen a computer in person, as well as how those ideas persisted even when computers were used in schools. Not only is the case in Pal's article analogous to the situation in Kenya, but a similar phenomenon on the Kenyan coast is quite plausible due to the popularity of imported Indian movies and other Indian media there.

Likewise, the students' responses could have been influenced by content introduced into the state curriculum regarding technology concepts. As described above, the prevalence of the answer "computers are used for making work easier," particularly among the fifth graders, suggests that it may appear somewhere in the fifth-grade curriculum. This lesson would almost certainly be very limited declarative knowledge with little depth, but nevertheless appears to have had an effect on the students' lasting impressions about the purpose of computers, even after their first-hand exposure and an emphasis on project-based learning intended to be anything but merely an exercise in efficiency.

This possible cause for the students' responses and the media exposure mentioned above, draw attention to the persistence of students' prior knowledge and the need for explicitly addressing students' prior knowledge about computers as a part of an OLPC or similar program, rather than assuming students are "blank slates" when it comes to technology or that the intended meaning will be learned effectively in an implicit manner. From a constructivist or constructionist perspective, students build knowledge with existing knowledge and first-hand experience. Left to their own devices, however, this can still lead students to develop fish-is-fish misunderstandings, where, like the fish from the story, students can be limited in their interpretation of new information by the boundaries of their experience (Bransford, Brown & Cocking, 2000, pp. 10–11). Even if one is to follow OLPC's curriculum-free constructionist teaching method (facilitation), students' prior learning must be addressed. As described in *How People Learn,* "There is a good deal of evidence that learning is enhanced when teachers pay attention to the knowledge and beliefs that learners bring to a learning task, use this knowledge as a starting point for new instruction, and monitor students, changing conceptions as instruction proceeds" and that even in a constructivist classroom where students "have first grappled with issues on their own . . . teachers still need to pay attention to students' interpretations and provide guidance when necessary" (Bransford, et. al., 2000, p. 11). Of course this presupposes that those guiding the students — whether teachers, parents or peers — are not operating on a foundation of inaccurate information.

In addition to these flawed assumptions about the students' prior exposure to computers and technology's appearance in textbooks, it was also difficult to control how the project was discussed before the laptops arrived. We asked the community its permission to bring in the computers, which necessarily entailed sharing information with the teachers and parents about the computers and their functionality; it was impossible to control what information was then passed on to the students. We administered the pre-assessments at the earliest possible date before the computers arrived, but the tight timeline for the project and the ethical obligation we had to inform the parents prevented us from testing the students before any information about the

OLPC project had been communicated.

OLPC's mission states that with introduction of the computers, students "learn, share, create, and collaborate. They become connected to each other, to the world and to a brighter future" (OLPC, n.d., e). Certainly the students' ideas about computers illustrated in their responses to this question show that they associate computers with connecting to the world and other people, but that was the case both before and after the intervention (the category "Connecting to People" actually decreased slightly). The student answers *did not* indicate that the students associated computers with "creating" after the introduction of the XOs. In fact, the "create" category decreased by 40 percent (while "efficiency" increased by more than 50 percent). What does this say about OLPC's statement? Given these student responses, our pilot project raises questions about whether OLPC's statement is supportable, whether the XOs and constructionist-based learning alone do lead students to "learn, share, create and collaborate" and "connect to each other, to the world" more than they would otherwise. Despite the fact that students had a higher level of prior knowledge about computers before the program, one might expect their answers after one year of the program to show more evidence of their learning, sharing, creating, collaborating and connecting — for example, through a greater number of mentions of specific Activities (software applications) they were using on the XOs or more mentions of computers as tools for learning and creating. The absence of these responses suggest more explicit teaching may be necessary for students to revise their prior conceptions about computers and to move into a new, more empowered understanding of how the XOs can be used. On the flip side, perhaps as OLPC might argue, the students may have needed more time to work with the computers, such as in the home environment, which we were not able to achieve during the first year of the project.

Either way, these findings underscore the need for further research about what students *do* and *do not* learn from OLPC's program, at school or at home.

Student Perceptions of Self-Efficacy

OLPC's mission refers to self-empowered learning, implying an increased perception of ability as a result of their program. Hence, increased exposure to the XO computers should enhance the students' perceptions of their own abilities, allow students to see themselves as participants and agents in a technology-rich world and provide potentially greater interest and opportunities for success with math, science and English through use of the computers and the constructionist learning concepts. No significant changes were found for the questions about student perceptions of self-efficacy for this study, however. Although the analysis of students' perceptions about computers suggests a small trend in the direction of students identifying computers with knowledge-gathering activities and activities associated with agency, their answers to these three questions about self-efficacy indicate that exposure to the computers did not have a positive effect on their perceptions of abilities.

If perception of ability in the areas of math, science and English showed no significant change as a result of the project, were the laptops really empowering? The most fundamental issues are the assumptions underlying the OLPC program. The program assumed that the XO project would have an effect on school culture and student learning in general, not just while students were using the computers. This belief was not born out in our case, mitigating what can be inferred about laptop learning from the trio of questions we administered. OLPC also assumes that students are not already self-empowered learners. In our data on self-efficacy, the means revealed a high level of student empowerment before the project began. The three questions were structured as follows and coded 1–4, with 4 being "Very good at [math, science, English]:

12. Which one are you?

a. Very good at math
b. Good at math
d. Okay at math
c. Not very good at math

Mean values of 3.22, 3.30 and 3.28 in the baseline data suggest students had an overall positive view of their abilities before the XO project began.

These findings on this measure are consistent with the Inter-American Development Bank's findings for OLPC Peru, based on interviews with students, compared to a control group. They write, "Next, we check effects on a scale that measures self-perceived school competence and find some evidence of small negative effects on this dimension. Though this finding goes against expectations that computer access may increase self-esteem, the explanation might be that interaction with the laptops makes students more conscious of their own limitations" (Cristia, et al., 2012, p. 16).

Student Perceptions about School

The question about whether students thought school was fun or not was intended to determine if the students' engagement in school increased, as OLPC claimed. Student perception of "fun" decreased, but whether this indicates that student engagement decreased or that the computers were responsible for this change in perception about school proved to be much more complex than the author originally thought. This indicator proved to be little better than OLPC's own primary evidence — their photos of smiling children. OLPC highlights “engagement” as an outcome of its program through its mission statement (OLPC, n.d., e; OLPC, 2012a), but their materials fail to define the term or explain the literature backing up their definition. While engagement can be associated with a student’s attitude toward school that could be considered “fun,” or, to use OLPC’s term “joyful,” it doesn’t necessarily have anything to do with these terms. Nevertheless, the data collected does shed light on students’ attitudes toward school before and after the introduction of the XOs, regardless of whether this is tied to engagement as originally thought. It is difficult to draw concrete conclusions about what this measure indicates, but the fact that the students’ perception that school is fun declined over time suggests a possible novelty effect, as well as several problematic issues.

The students’ decreased feelings that school is fun could mean that they perceived school as a more serious and challenging endeavor and were in fact more engaged after the introduction of the computers (Csikszentmihalyi, 1990, p. 3). Or it could possibly mean the opposite. Perhaps the unstructured lessons and technical problems posed by the computers introduced new frustrations or replaced enjoyable activities. Perhaps, as in Pal’s article (2012), the computers “raised the bar for performance,” increasing anxiety (para. 3) or, as for OLPC Peru’s self-perceived school confidence indicator “the explanation might be that interaction with the laptops makes the students more conscious of their own limitations” (Cristia, et al., 2012, p. 16). Perhaps the classes were fun while the teachers had the help of volunteers, but ceased to be as enjoyable when the Americans left and the teachers were lacking this extra support and reverted to their usual teaching methods, which might not have been well-suited to working with the XOs and constructionist learning concepts. On the other hand, the students could have been feeling the effects of the teachers struggling to adapt to a new program in the first year of implementation, an effect that could very well change over succeeding months and years as the teachers become fluent with the technology and new teaching methods — an interpretation that would be supported by the improvements in teacher adaptation found in Plan Ceibal's evaluation of year two of their introduction of computers (Burger, et al., 2011). Without further information it is impossible to tell.

The shift in this question also suggests a possible novelty effect, with the students being enthusiastic when the computers arrived, but less so as the XOs became familiar and integrated into daily life at school and ceased to hold the exciting appeal they had at the beginning. The students may even have been disappointed if the computers did not live up to their expectations. Likewise, when the pre-assessments were administered, although the students had not received their computers yet, they may very well have been looking forward to the advent of the XO project and the arrival of the volunteers. During the post-assessment period, no such dramatic new project was on the horizon.

Just as for the question about perceptions of computers discussed above, following OLPC's lead, we had assumed the introduction of the XOs and the associated teacher training would have some effect on the school culture as a whole, infusing the school with constructionist teaching and learning concepts. The hope had been that the teachers would respond by increasing the number of meaningful projects and amount of student-directed learning occurring in their classes and by being more receptive to student question-asking and divergent student answers. In turn, the hope was that students would respond by feeling more comfortable asking questions and trying out new ideas. As student responses to this question indicate, however, students were not more enthusiastic about school after the introduction of the XOs. This question, among others, was intended to determine how students' orientation toward school *at large* had changed.

If one assumes that the question does in fact measure the effect of the computers on school culture as a whole, then the decrease suggests that the hypothesis about the changes that might take place was incorrect, at least over the duration of one year's time.

Although it is tempting to attribute the drop in students' enjoyment of school to differences between teachers in the fourth, fifth and sixth grades, the same teachers teach all three grades (rotating through subjects) so this is not likely a contributing factor. The surveys were also administered at the same time of year in both instances.

The Inter-American Development Bank's study of OLPC Peru also found that the program "did not seem to have affected the quality of instruction in class" and did not find statistically significant effects on school attendance, homework time, or motivation. Their study used "an intrinsic motivation index constructed using 20 related questions to students" based on the Intrinsic Motivation Index inventory which they attribute to Ryan, 1982 (Cristia, et al., 2012, p. 16, p. 11).

As mentioned, the intention with this question about whether students perceived school as fun was to test OLPC's statement that the XOs increase student engagement. These findings, while not conclusive, have illuminated that a fundamental problem in this situation, and one that contributed to confusion in measuring this objective, is OLPC's lack of clarity about what they mean by "engagement."

While one could argue that OLPC chose the hard-to-pin-down word "engagement" deliberately, the organization's lack of clarity on what is meant by this term could be in part because of the "messy" state of engagement research. As Harris (2011) writes, "While improving student engagement is seen as a potential way to remediate social inequality and better educational outcomes for all students, work to accomplish this goal is currently hampered by the fact that at present student engagement is a 'messy' construct, conceptualised in diverse ways." (p. 377). Hidi and Renninger convey a similar sentiment, "Learner engagement is an aspect of educational practice that has been described as both critical and complicated because there is a need for better detail about how 'students behave, feel, and think'" (2006, p. 121). Nolen, Ward and Horn, too, describe the varying definitions and approaches to motivation and engagement in their chapter "Motivation, Engagement and Identity: Opening a Conversation," however, they do define engagement as follows: "The term *engagement* has been used to describe the ways that individuals relate to ongoing interactions with people and objects, combining both cognitive and affective components. . . . Cognitive and motivational psychologists have conceived of engagement largely as a characteristic of individuals (e.g., as school engagement) or as an indicator or outcome of motivation" (2011, pp. 110–111).

OLPC's emphasis on the affective component of engagement is evidenced through OLPC's association of engagement with terms such as "joyful" and OLPC's liberal use of photos of smiling children. Similarly, the question to students about whether school is "fun" gets at this affective aspect of engagement. Surely, though, OLPC's definition goes beyond emotional engagement or engagement in a single task. Statements such as "When children have access to this type of tool they get engaged in their own education" imply both motivation and engagement over time, or interest development. Only OLPC can explain what they really mean by engagement, but it is possible that their definition is closer to interest, which Hidi and Renninger define this way: "Interest is a psychological state that, in later phases of development, is also a predisposition to reengage content that applies to in-school and out-of-school learning and to young and old alike" (2006, p. 111) and "Interest as a motivational variable refers to the psychological state of engaging or the predisposition to reengage with particular classes of objects, events, or ideas over time" (2006, p. 112).

To follow Hidi and Renninger's conception of interest and its development, which encompasses triggered situational interest, maintained situational interest, emerging individual interest and well-developed individual interest, the introduction of XO computers would map to triggered situational interest: "focused attention and the affective reaction that is triggered in the moment by environmental stimuli, which may or may not last over time" (2006, p. 113). As Hidi and Renninger describe, triggered situational interest has been associated with computer use and positive affect in previous research (2006, p. 114). The real question would be then, whether XO use leads to the other three phases of interest development, culminating in a well-developed individual interest consistent with OLPC's description of a dedicated, self-directed learner. If students' positive affect declines over time, as in these findings, perhaps situational interest is effectively triggered by the computers, but is not sustained through the next several phases, possibly due to lack of effective external support. Although Hidi and Renninger endorse practices such as project-based learning and choice, which OLPC also employs, the authors state: "without support from others, any phase of interest development can become dormant, regress to a previous phase, or disappear altogether" (2006, p. 112), and, while some students may benefit from "cooperative project-based work," other students "may require the verbal scaffolding of teachers or support from the way in which a task is organized," (2006, p. 122). Measuring enjoyment or fun may indicate triggered situational interest, but evaluating whether students achieve a well-developed personal interest, or even a motivated situational interest, will require a more precise definition of objectives and a wider range of research. Hidi and Renninger write (emphasis added), "the four-phase model describes early phases of interest development as primarily consisting of focused attention and positive feelings. As such, it provides a rationale for identifying early phases of interest development in terms of affect or liking. In contrast, because the later phases consist of positive feelings *as well as both stored value and knowledge,* it is suggested that interest in these phases should be assessed by indicators of stored knowledge and repeated engagement, in addition to positive feelings" (2006, p. 114).

Beyond interest development and the nature of engagement over time, Harris calls for more clarity and increased emphasis on the cognitive aspects of engagement, not just the behavioral, academic or psychological ones, citing this cognitive engagement as the most strongly associated with "improvements in student learning" in prior research. The author calls for a differentiation between "engagement in schooling (defined as students displaying behavioural, academic, and psychological aspects of engagement, e.g., participation, enjoyment, attachment with school) and engagement in learning (defined as students who are cognitively engaged, e.g., acting as self-regulated learners, intrinsically motivated, committed to mastery learning using deep learning strategies)" (2011, p. 377). OLPC appears to aim for a self-regulated, intrinsically motivated learner, such as those Harris describes, however with stated goals that use terms such as "joyful," and the pictures of smiling children mentioned earlier, along with the relative lack of data on learning outcomes, OLPC is currently at risk of an over emphasis on psychological engagement, as Harris cites. The author argues that, "While raising student engagement holds much promise internationally for improving equity in society through education, it also risks becoming the next 'silver bullet'. Mandating improved student engagement in countries around the world may lead to behavioural and psychological aspects being over-emphasized as these are easiest to track and measure" (Harris, 2011, p. 385). Research on engagement in the future must relate to a concrete definition of what it means to be engaged and would benefit from indicators of engagement that go beyond the affective and the situational; that encompass indicators of this cognitive aspect of engagement, as well as monitor student's longer-term interest development over time. Harris' conclusion is also applicable here, "While increasing positive student affective experiences in school is a worthy goal and can lead to social benefits, increasing student academic learning must remain the core business of education" (2011, p. 385). At the same time, any definition of engagement needs to be sensitive to a Western bias. Nolen, Ward and Horn succinctly summarize the work of Plaut and Markus in their chapter:

> Plaut and Markus (2005) point out the prevalence of the dominant American-European model of motivation as internal and individualistic, rather than relational. This cultural model leads to emphasis, in both psychological theory and educational practice, on individual characteristics and on the motivating properties of choice, autonomy, and success. They caution that notions of success differ culturally, along with the value accorded autonomy and personal choice in educational settings. (Nolen, et al., 2011, p. 112)

Is Student Engagement the Problem to Solve?

As illustrated, an underlying problem with studying engagement in OLPC deployments is a missing definition of engagement based on the literature, but this is beside the point that perhaps student engagement, however defined and measured, should not be the priority. OLPC's (and the researcher's) prioritization of engagement as the goal of OLPC deployments is itself a

Western bias that fails to take into account socio-cultural factors and local priorities at play at international sites. Perhaps an even deeper problem than a definition for engagement is OLPC's rigid constructionist/constructivist framework that does not take into account socio-cultural factors. Bringing a socio-cultural perspective to OLPC's work would allow OLPC and its colleagues to consider local factors and local priorities when attempting to "eliminate poverty" (Cellan-Jones, 2007). The experience in Seaside has shown how critical the specific dynamics at play in a particular location and within a particular community of learners are for the success of OLPC or projects like it. Different communities have different challenges to student learning. Student engagement may not be the most pressing concern or a concern at all.

In Kenya, for example, a host of factors keep students from attending school or learning effectively once there. In addition to the strains on the educational system outlined earlier, students fail to attend school and/or underachieve due to household responsibilities, child labor (Moyi, 2011, p. 9; Ohba, 2011, p. 406; Munene & Ruto, 2010, p. 130), gender bias (Lloyd, Mensch and Clark, 2000, p. 14), pregnancy, homelessness, AIDS orphan status (Kinuthia, 2009; Mishra, Arnold, Otieno, Cross, & Hong, 2007; Kendall & O'Gara, 2007, p. 5), ancillary school fees (Ohba, 2011, p. 407), corporal punishment (Lloyd, Mensch and Clark, 2000, p. 14), drug use (Ndetei, Khasakhala, Mutiso, Ongecha-Owuor & Kokonya, 2009), and hunger (Walingo & Musamali, 2008, p. 2).

Although primary school is free in Kenya, add-on costs can prevent students from attending school. These costs include uniforms, school lunch fees and extra paid tuition (tutoring) (Somerset, 2009, p. 245; Ohba, 2011, p. 406). Ohba also concludes that "access is not only dependent on school fees per se, but also on the household's other direct and opportunity costs, which can be substantial" (2011, p. 408). These opportunity costs include families that are dependent on their children to provide labor or income. In his article “Child labour and school attendance in Kenya,” Moyi cites UN child labor statistics in Sub-Saharan Africa:

> United Nations Children's Emergency Fund (UNICEF) estimates approximately 37% of children 5 to 14 years are actively involved in the labor market (UNICEF, 2007). The proportion of children working has continued to rise in the region. Child labor participation rates are highest in East Africa, followed by Central Africa and West Africa (Admassie, 2002; Bass, 2004). Child labor is characterized by low wages, long hours, and in many cases, physical and sexual abuse.
>
> The Government of Kenya acknowledges that, despite eliminating school fees, about 1 million children are still out of school and pressure for children to supplement household income remains high (Republic of Kenya, 2008). (Moyi, 2011, p. 9)

Similarly Ohba found that of the children and parents interviewed for the study, “roughly one in three children had been engaged in some form of income-generating activity in the month before the interviews. The proportion of the overall household income that their earnings contributed was on average 33%, ranging from 8% to 90%” (2011, p. 406). Not only does child labour prevent students from attending school, but when they do attend school it can impact their ability to concentrate and ultimately their achievement (Moyi, 2011, p. 3).

As discussed earlier, school facilities are often inadequate in Kenya and schools over crowded. Uwezo, the publisher of a 2010 report based on 2009 data, writes, “1 in every 100 schools has no toilet, nearly half have no water. 1 in every 10 students sit[s] on the floor” (2010b, p. 36). For the Coast Province, students sit on the floor at four out of ten schools (Uwezo, 2010a, p. 60). The Coast Province report also found 2.4 students per textbook (Uwezo, 2010a, p. 60).

Hunger can impact students’ attendance and ability to learn once in school. In their article on school lunch programs in Kenya, Walingo and Musamali state:

> School lunch programs have been reported to stabilize attendance and increase enrollment in Kenya and India. School feeding programs reportedly contribute to cognitive attentiveness, improved school attendance, reduced absenteeism, and better household food security. Providing breakfast to primary school students significantly increased attendance and arithmetic scores, and mostly benefited children who were stunted, wasted, or previously malnourished. Breakfast programs are beneficial to nutrient intake, school attendance, and academic performance. (Walingo & Musamali, 2008, p. 2)

Their work continues the research they summarize, examining schools with fee-based school lunch programs. Fifty-eight percent of non-participant students reported absenteeism due to hunger (compared to 2.8% of participant students.) The authors report, “Pupil participation in the SLP is influenced by the ability of families to meet the participation criteria, which require families to pay a fee for the school lunch and contribute maize and beans” (Walingo & Musamali, 2008, p. 6).

Students who are orphaned from AIDS (as well as other causes) face hunger and other hurdles to school attendance and learning. According to Mishra, et al. “Children of HIV–positive parents are less likely to be attending school, more likely to be underweight and wasted” (2007, p. 390). According to the same 2007 study “In sub–Saharan Africa, every eighth child is an orphan” (p. 384). More recent data from the UNAIDS 2010 Global Report estimates 1.2 million orphans in Kenya ages 0–17.

Gender bias at school and even the physical safety of girls affect the educational experience of girls in particular and their attendance rates. Lloyd, Mensch and Clark found in their study of Kenyan school quality that:

> An average of approximately 20 percent of teachers express an explicit preference for teaching boys (versus no preference or a preference for teaching girls), and 32 percent on average do not think math is an “important” subject for girls to study. Teachers often used adjectives such as “weak,” “lazy,” and “blind” to characterize the girls in their classrooms . . . only a slight majority felt that the action against a teacher who has had sex with a student should be “severe” (Lloyd, Mensch & Clark, 2000, p. 126)

The authors conclude “that school environments are discouraging to girls where boys are favored in class and provided with a more supportive environment in terms of advice, where teachers take the importance of more difficult subjects like math less seriously for girls, where boys are left free to harass girls, and where girls’ experience of less equal treatment is not fully recognized by boys” (Lloyd, Mensch & Clark, 2000, p. 142).

Implications

These examples provide some evidence of the enormous conflicts and contradictions between OLPC and the context in which it was considered. One of the most obvious of these points of tension is introducing expensive XO laptops where child hunger is a persistent problem. How much learning can be achieved on an XO laptop if students are too hungry to concentrate? Even if XO learning could some day improve student socio-economic status and feed them, there are many hungry years between learning to operate a computer in fourth grade and someday being employed in an as yet nascent knowledge economy. It is not that computers should be denied to any of these populations of students, but these students live within a system, and without changes to the economy and specifically to schooling as it relates to employment, prospects for reducing poverty, not to mention using computers to leapfrog socio-economic standing, remain dim.

This OLPC project is not the first well-meaning effort in impoverished countries to introduce new habits, material items, and especially means of communication in rural areas in the hope of improving quality of life. As literacy experts Brian Street and Alan Rogers, as well as others, have argued for thirty years, the projects that assert Western values over local norms have little chance of sustainability (Rogers, and Street, 2012; Gebre, Rogers, Street, & Openjuru, 2009). While even those projects with close proximity to the target community often struggle to address the true causes of poverty, any non-profit or NGO that attempts to do so from afar must approach such an effort from a perspective grounded in experience with the specific place in which they intend to work, preferably through one or more leaders with extensive experience in the targeted locations. Such experience would demonstrate that in poor nations there are many reasons students may or may not attend school and/or learn, calling into question the usefulness of, for example, engagement and affect as top-level objectives or outcome indicators for OLPC deployments or other educational interventions in these nations. Throughout this thesis, examples abound of the blind spots of OLPC's constructionist stance that does not incorporate a socio-cultural perspective and does not enable OLPC to take these local conditions into account. On the contrary, with the exception of localized keyboards for large orders, OLPC has created a-one-size-fits-all approach that may not fit all. Coming from this position, OLPC is entrenched in an overly simplistic either/or dichotomy where a both/and solution may be more applicable. Perhaps each XO deployment could respond to the most pressing needs of the community as well as introduce XO computers?

A socio-cultural perspective would aid consideration of the unique conditions of *each community*, in which community residents could be partnered-with on more equal footing to determine and lead the best intervention for their specific location and conditions. Why not a breakfast program *and* a laptop deployment? In the case of the Shady Palms Junior School, we were fortunate to be working in an environment where students did have a school meal program, adequate facilities and high-quality teachers. Although our XO deployment still had challenges to effectiveness, the Shady Palms Junior School has been able to address some of the most egregious obstacles to education in the area, at the request of the community, and *then* introduce computers to enhance the students' educational experience. OLPC does not want XO learning to be an add-on, but their failure to acknowledge the significance of persistent barriers to learning such as child labor, malnutrition and gender bias will do more to undermine the revolutionary potential of their interventions than accommodating and addressing these challenges ever would. If the true goal, as OLPC claims, is to eliminate poverty and provide equitable education (Cellan-Jones, 2007; Negroponte, 2010, para. 2; OLPC, 2008; Cavallo, n.d., a; b), then each nation, province and village, must be examined on a case-by-case basis. Multiple theoretical frameworks must be drawn upon and synthesized to arrive at the best solutions for that specific location. What is the most pressing issue undermining equitable education and contributing to the cycle of poverty in that area? How can it best be addressed with the resources available? In some cases, computers that enable autodidactic learning may be a solution. In others, they may not.

OLPC espouses the objective of equity, making the point that "the goal of One Laptop Per Child is nothing less than eliminating poverty," (Cellan-Jones, 2007, 2:16), but this premise does not take into account current socio-economic factors and future projections. Meanwhile, nations such as Kenya are expected to spend millions of dollars on the program on faith, while proven methods for improving student learning, or moreover, poverty, have not been exhausted.

The Kenyan government, as a part of the East African Community, an intergovernmental partnership representing Kenya, Tanzania, Rwanda, Uganda and Burundi, has entered into a partnership to deploy 30 million laptops in the region by 2015. The group issued a memorandum of understanding with OLPC to that effect on April 28, 2010 (Fildes, 2010; East African Community, 2010).

Plans have recently been announced to air drop the next generation XO-3 tablet computers in remote villages to see if children can learn to read using the computers in a project inspired by Sugata Mitra's "Hole in the Wall" (Hachman, 2011). India has also announced delivery of the apparent copycat children's tablet computer Aakash ("sky"), as well as government subsidies that will reduce the cost from $45 to $35. Intended for the "rural poor," the government wants to help 220 million children get online with the device (Daigle, 2011).

The author can only hope that these future directions will take advantage of studies of past efforts. Until recently, research on OLPC deployments has been limited. In 2008 Everts, Herren and Hollow released a report on a four-month trial of XO computers plus Eduvision software that took place in 2007 in Ethiopia. Nugroho and Lonsdale published an Australian Council for Education Research literature review of deployments in twelve countries noting considerable inconsistency in project evaluations and methods and that "A more informal approach, often using the OLPC wiki, is preferred by deployments run by local foundations or organizations, often along with representatives from the OLPC team" (2009, p. 8). They conclude:

> The results of existing evaluations tend to be positive, highlighting the educational impacts on students, effects on teacher-student relations, and impacts on the wider community. Recommendations arising from these evaluations often relate to training needs and technical matters, such as charging and network support. (Nugroho and Lonsdale, 2009, p. 8)

The research landscape on OLPC projects, however, may be changing. The Inter-American Development Bank published a report in 2012 on the results of a study on the large-scale OLPC deployment in Peru that uses a randomized, experimental design, as well as qualitative interviews. The study found mixed results; some indicators of cognitive development increased, but "no evidence is found of effects on enrollment and test scores in Math and

Language," among other findings (Cristia, Ibarrarán, Cueto, Santiago & Severín, 2012, p. 1). Plan Ceibal, Uruguay's country-wide deployment, has also released findings on the second year of the program (from data collected in July 2010). These are primarily qualitative and descriptive in nature (Burger, Ferro, Baraibar, Perez, Salamano & Pages, 2011). A handful of graduate students are also at work on theses and dissertation projects concerning OLPC, but as of this writing, results from these projects have not been released. Although these reports are more robust and, encouragingly, rely on quantitative and qualitative data, they do not pertain directly to OLPCorps deployments in Africa for a variety of reasons. In Uruguay's case in particular, its relatively small size, socio-economic status, existing constructivist-based curriculum and commitment to provide the Internet to students creates conditions quite different from those that exist in a nation such as Kenya (Moss, 2010). OLPC has also released an "Assessment Overview of OLPC Projects" providing a broad survey of projects and evaluations thus far and echoing many of the earlier findings of the Nugroho and Lonsdale report (Hirji, Barry, Fadel and Gavin, 2010).

Implications for Future Research

Fruitful areas of research should benefit from a full picture of the nature and extent of XO deployments to the degree they are available. Future studies could build on existing research and the findings presented in this paper by interviewing students, observing students at home and at school, gathering portfolio materials and socio-economic data, testing student skill level, using the laptops to collect information on time-on-task and patterns of use over time, and, of course, having control and experimental conditions. In addition, researchers would do well to spend more time in the community before beginning an evaluation to gain background knowledge, including learning more about the current educational program, curriculum, teaching materials and most significant obstacles to student learning, as well as parents' knowledge of and attitudes toward education and technology. Researchers could ask more detailed questions about students' exposure to computers and technology concepts to establish a more substantial baseline. The present study began from an assumption that students would learn the basics of how to operate the computer and navigate the software applications, and asked a question that aimed to gain insight into students' abstract understanding of how computers could be used. Given the relative lack of change, future studies might want to take a step back and measure what the students were actually doing on the computers and what concrete skills they were learning. (As discussed below, the ability to conduct assessments on the laptops themselves would greatly enhance this effort.) Upon establishing that the XOs and constructionist methods actually did lead to a basic level of computer skill, researchers might want to ask more in-depth questions, by interview, about how students use the computers, how they would like to use them, what their values about technology are and how they feel their perceptions about computers have changed. Collecting portfolio materials and observing the children at work, both at school and at home and observing the classroom dynamics would round out this effort, although any case studies or portfolio materials would need to be contextualized both in terms of students' socio-economic status and in terms of how typical their case is in the school. OLPC has collected some examples of student work which suggest students do create with the XOs, but these examples are often not given enough context to fully understand what the examples mean nor understand how many students in a given group are able to produce similar materials and why (OLPC, 2012b; OLPC, n.d., d). Any future research would need to go beyond the abstract questions looked at here and also beyond OLPC's abstracted examples.

Data collection would be greatly enhanced if the XO laptops and their software were designed with operating-system level data analytics. The 2012 study of XO computers in Peru made use of the Sugar OS's "Log" program that keeps basic information about the most recent software applications students have been using (Cristia, et al. 2012, p. 11). Much more of this type of research is needed. If, for example, XO laptops could log student time-on-task and which applications were used the most for an extended timeframe, so much could be learned about how the laptops are used and if the students are engaged with the devices and their software over time. Monitored over extended periods, this type of data could shed light on students' transition from triggered situational interest through well-developed personal interest, among other measures. Students could also stand to gain, especially if they are learning on their own, if the OS could display this and other data to the students so they could track their own learning, introducing a metacognitive element into laptop learning. This data could be stored on the XS server and uploaded to the Internet periodically (or downloaded manually if an Internet connection were not available). Qualitative data capture could be integrated into the OS in this way as well with techniques such as Csikszentmihalyi's Experience Sampling Method (1990, p. 4) or a system to randomly sample student work. Data collection could pose privacy concerns, but data could be anonymous and would not necessarily have to track content, websites visited, etc., to be highly useful for education research.

Beyond data collection, the XO computers and OLPC program would benefit from a more robust collection of lesson plans, resources for teachers, and open-access content. Although OLPC claims the XO makes more than a million books available for children (Roush, 2009), for this project the team spent many hours tracking down resources for the students in Kenya in

2009 through OLPC portals and elsewhere on the Web, and there was a distinct dearth of content or lesson plans available. While there may be some open-source books, most textbooks were college-level and not useful for the fourth and fifth graders the team was working with, and novels were primarily old classics or more obscure titles in the public domain, (which begs the question that if nothing by the newest computer hardware should be distributed to children, why old books are assumed to suffice.) We found hardly any books for children and almost none in languages other than English and Spanish. OLPC Peru and Plan Ceibal Uruguay claim 200 and 100 books available for students on the XO, but presumably most, if not all, of these are in Spanish (Cristia, et al, 2012, p. 7; Burger, et al., 2011, p. 8).

Likewise, our experience showed that bringing in computers and providing a few weeks of teacher training and project-based learning are not enough transform teachers' teaching styles, to give them the confidence they need to succeed with XO laptop learning, or to have a large impact on school culture as a whole. Even the creative and well-supported teachers at the SCC were dependent on their teaching materials and requested more support materials, lesson planning ideas and training for success with the XO laptops. Some teachers may never feel as though they have enough support and preparation to teach with computers, but on the other hand, teachers will be better able to make the transition to a new way of teaching/facilitating/supporting students if they are given lesson plan ideas, more training and guidance for navigating a new style of teaching and new tools, along with consideration for their obligations to teach the state-mandated curricula and the time constraints they are under to meet the demands of an already packed school schedule. Cristia, et al.'s OLPC Peru study came to similar conclusions, noting that "the program did not seem to have affected the quality of instruction in class" and calling out "the absence of a clear pedagogical model that links software to be used with particular curriculum objectives" as responsible for the lack of change in student math and language scores (2012, p. 3; p. 16).

Papert places constructionism *in opposition* to instructionism and describes the "Piagetian learning" that inspired constructionism as "the natural, spontaneous learning of people in interaction with their environment, and contrasted it with the curriculum-driven learning characteristic of traditional schools" (Papert & Harel, 1991, p. 9; 1993, p. 31, p. 156). This viewpoint that sets constructionism apart from teaching, teachers and curriculum, while influential at the time Papert developed it, is based on an old model of what curriculum can and should be and superseded by modern learning science. As Bransford, et al. discuss in *How People Learn* of the constructivism that underpins constructionism:

> A common misconception regarding "constructivist" theories of knowing (that existing knowledge is used to build new knowledge) is that teachers should never tell students anything directly, but instead, should always allow them to construct knowledge for themselves. This perspective confuses a theory of pedagogy (teaching) with a theory of knowing . . . teachers still need to pay attention to students' interpretations and provide guidance when necessary. (Bransford, et al., 2000, p. 11)

Similarly, OLPC is deeply invested in their conception of meta-cognition. Negroponte wrote in 2010 for the *Boston Review*:

> Think of computers differently. Think of them as a medium for learning, as opposed to a medium for teaching. I literally mean that the computer is

> learning and you (or a child) are teaching it. The best way to learn something is to teach it. Writing a computer program is the most direct way to teach a computer. Since a computer program never works the first time, the user—in this case, a child—has to debug it, to try again, to look at the program's behavior, iterate, and finally succeed. That process is the closest a child will ever come to understanding how to learn, to *learn learning*. (Negroponte, 2010, para. 6)

This idea, too, comes from Papert. In *Mindstorms* (1993), Papert argues that children will learn about their own learning by programming computers: "in teaching the computer how to think, children embark on an exploration about how they themselves think" (p. 19). In their case for education with the XO, OLPC writes, "The best preparation for children is to develop the passion for learning and the ability to learn how to learn" (OLPC, n.d., b, para. 1). But in *How People Learn* (2000), Bransford, et al. state, "Because metacognition often takes the form of an internal dialogue, many students may be unaware of its importance unless the processes are explicitly emphasized by teachers" (2000, p. 21). Can students learn how to learn simply by teaching a computer? Maybe some can, but the problem goes one step further. Bransford, et al. claim in "Learning Theories and Education" (2005) that, "metacognitive strategies need to be taught in the context of the individual subject areas" (Bransford, Vye, Stevens, Kuhl, Schwartz, Bell, et al., p. 230). The authors of *How People Learn* continue, "These strategies are not generic across subjects, and attempts to teach them as generic can lead to failure to transfer" (Bransford, et al., 2000, p. 19). Perhaps children will learn about how they learn to program computers, but will they learn about how they learn other things? Will they learn the kind of metacognitive skills needed to become the self-sufficient, life-long learners OLPC envisions? Computers provided a powerful metaphor for the mind at the time of the cognitive revolution that enabled the development of modern learning science, but this metaphor no longer captures the complexity of how the human mind thinks and learns across contexts.

Ultimately, the XO and OLPC learning projects could be greatly strengthened with continued research and development that takes into consideration other viewpoints beyond constructionism. Just as the OLPC website states that, “simply doing more of the same is no longer enough, if it ever was,” (OLPC, 2009, June; n.d., b, para. 2), if OLPC’s altruistic goals of “making a better world” and solving “gaps in equity in education and subsequent opportunity” (OLPC, n.d., b, para. 2) are true, working from a strictly constructionist viewpoint lodged in the past is also not enough.

Bransford, et al. (2005) claim about working across disciplines “We believe that the timing is right for targeted efforts toward synergy to become an explicit goal of educational researchers” (p. 210). The authors continue, “attempts to look at similar phenomena from multiple perspectives (what some have called *anchored collaboration*, CTGV, 1997) can help surface (often tacit) assumptions that can then be compared” (p. 229). It is those tacit assumptions that undermined the research reported on in this paper and that are undermining OLPC’s work. The time is right for OLPC and those who build upon it to work from a place of theoretical and disciplinary synthesis to do a better job of helping children learn.

This synthesis, rather than rejecting curriculum and human teachers, needs to have room for a modern version of what curriculum and instruction can be, as well as a more nuanced understanding of meta-cognition that reflects up-to-date learning science. In a similar vein, bringing a socio-cultural perspective to OLPC’s work would allow for greater consideration of local priorities and local problems. Just as a purely constructionist learning model is outmoded, so too is a model of international development that imposes values and project priorities from the outside or that looks to technology alone as the key to revolutionizing education or solving the cycle of poverty.

Incorporating a variety of perspectives does not have to lead to the “conformance” or reform of the reform that Cavallo (2000) describes in his “Emergent Design” article and that OLPC appears to fear. Instead it can be a 2013 vision — not a 1980 vision or a 1995 vision — that transcends either-or dichotomies. Constructionist values, such as creating personally meaningful education, do not have to be thrown out but can be enhanced by other perspectives, and given a structure to make them more likely to succeed and create educational change, not less. Synthesis can provide better answers to create educational solutions that truly serve students in school and at home, that encompass what we know to be true about equity in education, that work from where we are now with technology as a tool for ubiquitous learning, and that leave room for the personally meaningful, creative, tangible and knowledge-building activities that constructionism and the XO capture so well.

Further Implications

Conclusions that can be drawn from any single case study have numerous limits. The choice of any particular site for a case study is likely to be idiosyncratic or *ad hoc.* For every instance in which behavioral change is the goal, factors or variables beyond the control of the external change agents come into play to alter “best-laid plans.” The case study of Seaside related here is no exception. The choice of location of the NGO that hosted the researcher in

Kenya was made years before the expansion of the One Laptop Per Child program. Unforeseen events throughout the term of data collection ranged from scheduling of a national census to parental concerns about children taking the computers home, including threats to the children's safety. However, cumulative cases from which researchers can deduce contextual circumstances and co-occurring aspects of behavioral change enable social scientists and educators to work toward a body of data in which they can place faith. Contributions from this case rest not primarily on the specific findings drawn from the teacher and student surveys, teacher interviews or researcher observations. Instead, this case offers a set of reality checks and cautionary notes about outsiders' expectations of behavioral change likely to come about through the introduction of material items to schools located in rural villages of developing nations. Through this example from Kenya, OLPC can be placed into its historical context, as a technology and pedagogy that emerged as only one recent iteration of a long-term trend to invest a piece of hardware and its accompanying philosophy with the power to change entrenched problems with education and poverty in one fell swoop. Such interventions also have a pattern of inspiring the allegiance of fans and criticism of foes, without looking at these larger trends.

Diversity in Practices and Values Surrounding Material Goods and Literacy

Within the literature of anthropology and education, many books and articles illustrate the hazards of bringing into schools values grounded in societies with widely different patterns of child socialization and uses of time and space. The most consistent conclusion from these studies relates to the widely varying valuations of children across societies locked in poverty, subsistence agriculture, and irregular access to vital resources such as water, fuel, electricity, health workers, and a reliable State governmental system of protection.[5]

Moreover, when material items — particularly those linked to sensitive areas such as communication, labor, and childrearing — are introduced into rural communities in developing nations along with a specific theory regarding use and behavioral change, extra precautions are needed. These areas of behavioral change impinge on more fundamental values such as respect, time and space usage, familial hierarchies, and gender-segregated expectations.[6] Religious beliefs uphold several of these value systems, particularly those related to differentiations in codes of behavior for men and women and individuals of different ages. Thus an innocent introduction of a computer, mobile phone, or other communication device to children or to women can disrupt long-held norms of status and access to material goods within families as well as villages, leading to unintended consequences (Rahman, 1999). In impoverished settings where material items hold symbolic as well as functional value, ideological grounds linked to specific behaviors carry more weight than norms of institutions such as schools, and thus need to be introduced with careful consideration of local values and protocols.

Western societies value "fun" in learning. They do so in part because time and spaces, as well as material goods for leisure and enjoyment, are abundant for most families (Heath, 2012). Marketed widely in association with the "need" for entertainment and social capital, material items as well as commercial entertainment opportunities have become expected within child socialization. Contradictions between the educational potential and entertainment possibilities of

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[5] Numerous volumes related to language socialization, literacy studies, and the anthropology of childhood, as well as collections of essays dedicated to the anthropology of education, recount the wide range of values that parents associate with their children. See Barton & Hamilton, 1998; Duranti, Ochs, & Schieffelin, 2011; Lancy, 2008; and issues of *Anthropology and Education Quarterly.*

[6] This point holds for communities within modern economies as well. See, for example, Barton & Hamilton, 1998, for a study of local literacy practices and their intertwining with ideological values in one community in England.

electronic equipment have received relatively little attention in the public media. Self-monitoring and individually-perceived needs are seen as ample disciplinary restraints on an excess emphasis on entertainment.

None of these core features of mainstream family and school life in modern economies can reliably be expected to prevail in rural impoverished nations. In these locales, individuals now know about the ICT world and the rapidly expanding communication and entertainment possibilities of electronic equipment of all types. Introduction of these items into an otherwise generally stable social network of intensive labor practices, however, carries little or no predictability in relation to theories of learning or of change that may surround material goods.[7] Constructionism, a theory that may have viable applications within modern economies filled with mainstream families, holds little likelihood of uptake in value systems of rural villages in developing nations.

Theories Today

In 2009–2010, at the time of the introduction of the XO computers in Seaside, developers and program planners at One Laptop Per Child and MIT still held strongly to Papert's early ideas surrounding constructionism. As noted previously, this theory brought with it specific ideas about individualism and the relationship of learning to this fundamental value of modern economies. Although collaboration was a stated goal of OLPC, inherent in this individualist philosophy is an expectation of the competition also characteristic of modern Western culture.

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[7] See, for example, Katz, 2004, for an account of the extraordinary upheaval for child socialization that followed introduction of mechanized equipment in farm labor in a rural African village.

Other theories of both learning and literacy, such as those of Shirley Brice Heath (1983), Jean Lave (1988), Sylvia Scribner and Michael Cole (1981), Brian Street (1984), and Lev Vygotsky (1986) could have applied as well. These theories, however, derived from extensive fieldwork within everyday practices in both developing nations and in communities outside the mainstream in modern economies. What these theories have in common is the situatedness of all practices related to structured symbol systems. As Lave put it: “A theory of practice does take learning, thinking and knowledge to be historically/culturally specific, socially constituted, and politically tempered, and argues that they structure the social world writ large as well as being structured by it” (1988, p.123).

Moreover, beyond these theories that locate both literacy and learning within situations that give rise to cognition in practice, the end of the 20th century and the opening decade of the 21st added theories surrounding the multimodal nature of literacy. Drawing heavily on semiotics, developers of these theories that examined multiple modes and means of conveying structured symbol systems pointed to the expanded cognitive demands of texts in the contemporary world. Communications from print and screens of all types come packaged with images and often sound. Immersion within several modes simultaneously is possible and increasingly difficult to avoid in modern economies (Kress, 2010), requiring the ability to fluidly navigate between discourses of meaning (New London Group, 1996). Glyda Hull wrote in 2003, “In the current context the old debates about orality and literacy, as well as long-held distinctions separating the personal and the analytic, seem almost quaint in their dichotomous views, given the complex combinations, juxtapositions, and manipulations of spoken and written language and other semiotic systems and designs for meaning presently possible” (p. 231).

Networking, but also competition, come embedded within communication forms, engaging young and old in the world of play, entertainment and commerce (Gee, 2004; New London Group, 1996). As the New London Group, that included Gee and Kress, among others, described, “The new fast capitalist literature stresses adaptation to constant change through thinking and speaking for oneself, critique and empowerment, innovation and creativity, technical and systems thinking, and learning how to learn” (p. 67). The authors write of this scenario that is both positive and full of peril, “it may well be that market-directed theories and practices, even though they sound humane, will never authentically include a vision of meaningful success for all students” (p. 67). They go on to describe the “global commodity culture” (p. 70) that is now “interwoven” into the narratives of childhood. Viewing knowledge as “embedded in social, cultural and material contexts” (p. 82), they tie New Literacies to “chains of past texts” (p. 77), raising the issues of continuity, learning within a community of authentic practitioners, and risk-taking. Their prescription is a call for the development of a pedagogy based on situated practice, overt instruction, critical framing and transformed practice.

Subsequently, scholars such as Glyda Hull looked in-depth at multimodal learning as intimately tied to its social context, as well as identity construction, linking concepts of future selves and the desire to master relevant skills — “the connection between conceptions of self and how and why we learn, and the linkage between the desire to acquire new skills and knowledge and who we yearn to become as people” (p. 232). This argument underscores the need for continuity between learning new technologies in school or at home and models for future use and future selves in relationship with these technologies, such as in the world of work. Scholars including Hull, Street and Heath emphasized the connections between in and out of school multimodal literacy practices engaged in by young people and how building a bridge between these worlds influences learning outside of school, as well as successful integration of new technologies and multimodal literacy practices into the classroom. Their examination of poor and marginalized communities and international settings in some of these studies suggest that paying particular attention to this space "between" and connecting to a broader definition of literacy practices authentically engaged in by youth could also have relevance in developing nations such as Kenya and for projects like OLPC that push for independent learning at home.

Meanwhile, other researchers at the MIT Media Lab, their students and their colleagues have been taking Papert's ideas in different directions from OLPC. Building on work by New Literacies scholars (for example, Lankshear and Knobel, 2010), researchers such as Kylie Peppler and Yasmin Kafai have begun to synthesize New Literacies theory with constructionism, through the lens of do-it-yourself (DIY) culture (also known as "maker" culture), both in words and in practice. Their projects have involved introducing students to the Scratch programming environment and the Lilypad Arduino — Leah Buckley's programmable controller for use with sewing and craft projects (e-textiles) — most often in after-school venues, such as the Computer Clubhouse and Boys and Girls Clubs. Although primarily hardware and materials oriented, projects by these researchers have attempted to connect programming and material construction with existing craft and fashion traditions engaged in by youth, their families, or members of their communities. Like Hull, their approach focuses on "creating, repurposing, and remixing multimodal representations" (p. 90).

While still dependent on material culture, these new directions hold some promise for creating continuity with students' culture and family life. This examination of DIY and programming engaged in by youth in the United States may not be directly applicable to a developing nation, as the current DIY movement has emerged out of a particular cultural moment in the United States,[8] but at the same time, combining new computers and controllers with more common materials in a given place in ways connected to local traditions, as documented and defined by students, could provide a path to more meaningful and lasting means of technology introduction. This may be especially the case if such projects are tackled in the less fettered spaces that may exist between school and home and if projects maintain their involvement of the hands in learning.[9] The way forward brings together previous notions of teaching children the structured symbol system of programming with theories of situated practice to enrich current ideas about multimodal literacy that tend to hover on the surface of media production and typically do not include programming.

In addition to examinations of multiliteracies and situated practices, in recent years, widening recognition of the pull of screens for learners of all ages came with intensive examination by neuroscientists of what increasingly accepted practices with ICT means for brain functions and operations. The popular press picked up on every tidbit of news from neurology and neuroscience journals, transforming this information into best sellers, in some cases. Three themes relevant to this project emerged from the first few years of research from neuroscientists

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[8] Rural and poor communities have long had traditions of making needed objects rather than buying them out of necessity, but events such as Maker Faire Africa (http://makerfaireafrica.com) show that there is a growing Western-style DIY movement on the African Continent as well.

[9] The Future of Learning Group at MIT, headed by David Cavallo before he joined the OLPC team, developed the GoGo board as an open source, low cost tool for students in developing countries to engage self-defined work with found materials. This product was intended to be a cheaper alternative to the Cricket controller sold in the U.S. The GoGo board, however, is not catered to use with sewing and craft materials in the same way as the LilyPad Arduino and its less expensive variations. All of these controllers also do require the use of a computer to program them. It is worth noting, too, that computers and controllers that are inexpensive and composed of locally available parts, as well as found materials, may provide more continuity with local communities and a more sustainable program, but OLPC makes a good point that children in developing nations do not need “donated” used and often broken computers destined to be come e-waste, but instead deserve new, robust equipment designed for use by children and in harsh conditions. In the same vein, found electronic materials, such as some of those used in David Cavallo’s work with the GoGo Board in Brazil pose the concern that they may not be safe for children to handle.

on children's interactions with computers: search behaviors, attention spans and language development.

The first of these considered the relationship between brain maturation of children and tasks called for in creative uses of the computer. For example, to process information from more than one location on the Internet, children need to internalize search behaviors. Children growing up in Western societies have relatively poorly integrated search behaviors before the early years of schooling (Sperber & Hirschfield, 2004). Those who have had strong backgrounds of reading children's literature with adults tend to learn these skills well before children who lack such experience. Pulling together who, when, where, and what from different sources is related to language skills, including question asking (Snow, *et al.,* 1991). We know very little about how children growing up in societies without traditions of written children's literature learn integrative information search skills, yet creative work and self-directed learning on the Internet requires such skills.

In addition to the challenge of search and information integration behaviors, a growing body of research has looked into the association between screens and attention spans. The message thus far is not at all clear, and researchers have yet to establish a causal link, but recent brain imaging studies indicate that extended gaming or Internet use is associated with abnormalities in the grey and white matter in adolescent brains (Lin, et al. 2012; Yuan, et al., n.d., Kühn, et al 2011). Longitudinal studies have also found associations between television and video game use and attention problems (Christakis, Zimmerman, Giuseppe and McCarty, 2004; Swing, et al. 2010).

A third consideration is the role of the hand in learning and the development of language processing centers in the brain. Brain imaging studies such those by Karin Harman James (2009) and Todd Richards and Virginia Berninger (Richards, Berninger, Stock, Altemeier, Trivedi & Maravilla, 2011) highlight the role of handwriting in the development of orthographic/visual word form brain regions. According to these functional magnetic resonance imaging (fMRI) studies, writing out letters by hand appears to be important for developing letter recognition and letter-sound correspondences, as well as for automating these language processes upon which writing, reading and math depend. There is still much to be explored in this area concerning the role of computer use and keyboarding on developmental language processes, however, studies such as Longcamp, et al., (2008), show that learning letterforms via handwriting with pen and paper versus learning letterforms via keyboard use different pathways in the brain.

In addition to typing, the mouse posed a problem for the students at the Shady Palms Junior School. Students struggled to use the touchpad mouse on the XO computers because of this input device's poor design features and technical glitches and because, unfamiliar with the new process, the students didn't yet have the manual dexterity to manipulate the cursor on the screen and simultaneously move the cursor and click the mouse. The computer-mouse interaction places a mediation tool between the user and action he or she wishes to perform; in this case, introducing potential frustration as students were limited by their ability to control the mouse. Tablet computers that eschew the mouse for direct use of the fingers on the screen may remove some layers of mediation and could provide for a more paper-and-pencil-like writing experience, nevertheless more brain imaging and behavioral research is needed to determine the effects, positive or negative, of these devices on language learning.

Such issues viewed in relation to research from neuroscience are informative and point to the need for further research, but it is not brain imaging *per se* — a set of technologies likely to be looked to as a panacea for what ails education in the near future — that shows the best way ahead. Instead, as argued in this paper, an interdisciplinary approach is called for, one that at once keeps in view situated, individual perspectives on learning and poverty; systemic factors; and the evolving landscape of education research. As described here, the revolutionary change in education sought by OLPC requires much more than delivering artfully designed computers and short-term training. To avoid repeating a history in which computers collect dust in the corners of classrooms (or children's living spaces), a stronger and more equal partnership with local community members is required. Teachers play an important role in constructionist learning and certainly in the successful introduction of material goods that challenge time and space arrangements in the classroom. Teachers must therefore be enlisted, listened to and supported. Parents and children, too, need to be consulted regarding what they need for successful learning, whether this is in the form of nutrition, mentorship, freedom from household obligations or more engaging learning activities. The unique characteristics and challenges in a given community must be considered, local knowledge and priorities heeded and community members looked to for leadership. Poverty reduction, high-quality education for all and enjoyable learning experiences that foster lifelong learning are goals that take time, continuity, collaboration and multifaceted investments not only in technology and new ideas, but in people. Progress and effective use of resources depend as well on continued research and communication on how and why projects such as OLPC succeed or fail, and how the terms of success are defined.

Figure 12: XO learning in the schoolyard at the Shady Palms Junior School

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References

Ackermann, E. (2001). Piaget's constructivism, Papert's constructionism: What's the difference? [Originally published as Constructivisme et Constructionisme: Quelle Différence.] *Constructivisms: Usages et Perspectives en Education,* 1(2). Geneva: SRED/Cahier 8. pp. 85–94. Retrieved May 22, 2010, from http://learning.media.mit.edu/content/publications/EA.Piaget%20_%20Papert.pdf.

Barton, D. & Hamilton, M. (1998). *Local literacies: Reading and writing in one community.* London: Routledge.

Becker, S., Crandall, M.D., Fisher, K.E., Blakewood, R., Kinney, B., & Russell-Sauvé, C. (2011). *Opportunity for all: How library policies and practices impact public Internet access.* (IMLS-2011-RES-01). Washington, D.C.: Institute of Museum and Library Services. Retrieved January 11, 2013 from http://tascha.uw.edu/publications/opportunity-for-all-how-library-policies-and-practices-impact-public-internet-access.

Bittencourt, Juliano. (2009, June). A learning synopsis for OLPCorps teams. OLPCorps Africa Training Conference. Kigali, Rwanda.

Bransford, J. D., Brown, A. L., & Cocking, R. R. (2000). *How people learn: Brain, mind, experience, and school,* (pp. 10–11). Washington, D.C.: National Academy Press.

Bransford, J. D. & Schwartz, D.L. (in press). It takes expertise to make expertise: Some thoughts about why and how and reflections on the themes in chapters 15–18. In K. A. Ericsson (Ed.), *Handbook of Expertise* (pp. 432–448). Cambridge, United Kingdom: Cambridge University Press.

Bransford, J., Vye, N., Stevens, R., Kuhl, P., Schwartz, D., Bell, P., et al. (2005). Learning theories and education: Toward a decade of synergy. In P. Alexander & P. Winne (Eds.), *Handbook of Educational Psychology* (2nd ed.) (pp. 209–244). Mahwah, NJ: Erlbaum.

Burger, M., Ferro, H. Baraibar, Perez, L. Salamano, I. & Pages, P. (2011). *Ceibal Assessment 2010 Document Summary.* Trans. Uruguay National Public Education Administration, Educational Sectoral Planning Directorate, Assessment Area Ceibal. Retrieved May 23, 2011 from the OLPC Wiki: http://wiki.laptop.org/go/OLPC_research.

Cavallo, David. (n.d., a). *Laptops and high-quality education for every child—part 1: The role of education in society and connected laptops in education.* Retrieved May 20, 2010, from http://wiki.laptop.org/go/Educators. Creative Commons License (http://creativecommons.org/licenses/by/3.0/).

Cavallo, David. (n.d., b). *Laptops and high-quality education for every child—part 2: How to achieve high-quality education at a national scale?* Retrieved May 20, 2010, from http://wiki.laptop.org/go/Educators. Creative Commons License (http://creativecommons.org/licenses/by/3.0/).

Cavallo, David. (2000). Emergent design and learning environments: Building on indigenous knowledge. *IBM Systems Journal*, 39 (3–4), 786–781.

Cellan-Jones, R. (2007). *Laptops for Africa.* [YouTube video]. Retrieved May 22, 2011, from the BBC website: http://video.google.com/videoplay?docid=-7242425422174872586#.

Central Intelligence Agency (CIA). (2012). *World Fact Book*. Retrieved May 27, 2012 from https://www.cia.gov/library/publications/the-world-factbook/geos/ke.html.

Christakis, D. A., Zimmerman, F. J., Di Giuseppe, D. L., McCarty, C. A. (2004). Early television exposure and subsequent attentional problems in children. *Child: Care, Health & Development,* 30(5), 559–560.

Cidell, Julie. (2010). Content clouds as exploratory qualitative data analysis. *Area,* 42(4), 514–523.

Commons, Paul. (2009, May). Corps seminar notes. OLPCorps Africa Training Conference. Kigali, Rwanda.

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

Csikszentmihalyi, M. (1990). *Flow: The Psychology of Optimal Experience.* New York: Harper & Row, Publishers, (p. 4).

Daigle, K. (2011). India Announces $35 tablet computer for the rural poor. *Associated Press.* Retrieved January 7, 2012 from *The Seattle-Post Intelligencer* website: http://www.seattlepi.com/business/article/India-announces-35-tablet-computer-for-rural-poor-2203509.php

Duranti, A., Ochs, E., & Schieffelin, B. (2011). *The handbook of language socialization.* London: Blackwell.

East African Community. (2010). *EAC adopts One Laptop Per Child initiative*. Press Release. Retrieved May 21, 2011 from the East African Community website: http://www.eac.int/component/content/424.html?task=view.

Everts, B., Herren, M., & Hollow, D. (2008). *Ethiopia implementation report*, *September – December 2007*. Eduvision. Retrieved May 23, 2011 from the OLPC Wiki: http://wiki.laptop.org/go/OLPC_research.

Falbel, A. (n.d.) *What is constructionism, and what does it have to do with Piaget?* Boston: Massachusetts Institute of Technology.

Fildes, J. (2010). *One Laptop Per Child targets Middle East and E Africa.* Retrieved May 21, 2011 from the BBC News website: http://www.bbc.co.uk/news/10091177.

Foster, G. M. (1965). Peasant society and the image of limited good. *American Anthropologist,* 67(2), 293–315.

Foster, G. M. (1967). *Tzintzuntzan: Mexican Peasants in a Changing World.* Boston: Little, Brown and Company.

Gebre, H. A., Rogers, A., Street, B. & Openjuru, G. (2009). *Everyday literacies in Africa: Ethnographic studies of literacy and numeracy practices in Ethiopia.* Kampala: Fountain Publishers.

Gee, J. P. (2004). *Situated language and learning: A critique of traditional schooling.* New York, NY: Routledge.

Hachman, M. (2011, November). Negroponte: We'll throw OLPCs out of helicopters to teach kids to read. *PC Mag*. Retrieved January 7, 2012 from the PC Mag website: http://www.pcmag.com/article2/0,2817,2395763,00.asp.

Harris, L. (2011). Teaching and teacher education secondary teachers' conceptions of student engagement: Engagement in learning or in schooling? *Teaching and Teacher Education,* 27, 376–386.

Heath, S. B. (2012). *Words at work and play: Three decades in family and community life.* London: Cambridge University Press.

Hidi, S. & Renninger, K. A. (2006). The four-phase model of interest development. *Educational Psychologist*, 41(2), 111–127.

Hirji, Z., Barry, B., Fadel, R. & Gavin, S. (2010). *Assessment Overview of OLPC Projects.* OLPC Foundation Learning Group. Retrieved May 23, 2011, from the OLPC Wiki: http://wiki.laptop.org/go/OLPC_research.

Hull, G. A. (2003). Youth culture and digital media: New Literacies for new times. *Research in the Teaching of English,* 38 (2), 229–233.

Hull, G. A., & Nelson, M. E. (2005). Locating the semiotic power of multimodality. *Written Communication, 22*, 224–261.

Hyde, A., Gentle, A., Bender, W., Farning, D., Holt, A., Jordon, B., et al. (2009). *OLPC Laptop Users Guide.* GNU General Public License version 2 (http://www.gnu.org/licenses/gpl-2.0.html).

International Fund for Agricultural Development (IFAD). (2012). *Rural poverty in Kenya*.

Retrieved May 27, 2012 from http://www.ruralpovertyportal.org/web/guest/country/home/tags/kenya.

James, K. H. (2009). Sensori-motor experience leads to changes in visual processing in the developing brain. *Developmental Science,* 13(2), 1–10.

Kafai, Y. B. and Peppler, K. A. (2011). Youth, technology, and DIY: Developing participatory competencies in creative media production. *Review of Research in Education*, 35(1), 89–119.

Katz, Cindi. (2004). *Growing up global: Economic restructuring and children's everyday lives*. Minneapolis: University of Minnesota Press.

Kendall, N. & O'Gara, C. (2007). Vulnerable children, communities and schools: Lessons from three HIV/AIDS affected areas. *Compare,* 37(1), 5–21.

Kenya National Bureau of Statistics. (2010). Percentage rural households by main type of floor material for the main dwelling unit. Retrieved May 27, 2012 from http://www.knbs.or.ke/detailed_population_results.php.

Kerr, S. T. (1996). Visions of Sugarplums: The future of technology, education, and the schools. In S. T. Kerr (Ed.), *Technology and the future of schooling*: *95th yearbook of the National Society for the Study of Education, part II* (pp. 1–27). Chicago: University of Chicago Press. Retrieved January 3, 2013 from http://faculty.washington.edu/stkerr/sugrplum.htm.

Kinuthia, W. (2009). Educational development in Kenya and the role of information and communication technology. *International Journal of Education and Development using ICT*, 5(2). Retrieved January 7, 2012 from: http://ijedict.dec.uwi.edu/printarticle.php?id=740&layout=html.

Knobel, M., & Lankshear, C. (2007). Sampling "the new" in new literacies. In Knobel, M., & Lankshear, C. (Eds.), *A new literacies sampler,* (pp. 1–24). New York: Peter Lang Publishing.

Kress, G. (2010). *Multimodality: A social semiotic approach to contemporary communication.* London: Routledge.

Kühn, S., Romanowski, A., Schilling, C., Lorenz, R., Mörsen, C., Seiferth, N., Banaschewski, T., Barbot, A., Barker, G. J., Büchel, C., Conrod, P.J., Dalley, J.W., Flor, H., Garavan, H., Ittermann, B., Mann, K., Martinot, J. L., Paus, T., Rietschel, M., Smolka, M. N., Ströhle1, A., Walaszek, B., Schumann, G., Heinz, A. and Gallinat, J. (2011). The neural basis of video gaming. *Translational Psychiatry,* 1. Retrieved January 6, 2013 from http://www.nature.com/tp/journal/v1/n11/full/tp201153a.html. Creative Commons License (http://creativecommons.org/licenses/by-nc-nd/3.0).

Lancy, D. (2008). *The anthropology of childhood: Cherubs, chattel, & changelings* . New York: Cambridge University Press.

Landhuis, C. E., Poulton, R., Welch, D., Hancox, R. J. (2007). Does childhood television viewing lead to attention problems in adolescence? Results from a prospective longitudinal study. *Pediatrics*, 120 (3), 532–537.

Lave, J. (1988). *Cognition in practice.* London: Cambridge University Press, (p. 123).

Leander, K. M. (2007). "You won't be needing your laptops today": Wired bodies in the wireless classroom. In Knobel, M., & Lankshear, C. (Eds.), *A new literacies sampler* (pp. 25–48). New York: Peter Lang Publishing.

Lenhart, A. (2009). Teens and mobile phones over the past five years: Pew Internet looks back. Retrieved January 11, 2013 from http://pewinternet.org/Reports/2009/14--Teens-and-Mobile-Phones-Data-Memo.aspx.

Lin, F., Zhou, Y., Du, Y., Qin, L., Zhao, Z., Zu, J. & Lei, H. (2012). Abnormal white matter integrity in adolescents with internet addiction disorder: A tract-based spatial statistics study. *PLoS One,* 7(1). Retrieved January 6, 2013 from http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0030253.

Lloyd, C., Mensch, B. & Clark, W. (2000). The effects of primary school quality on school dropout among Kenyan girls and boys. *Comparative Education Review*, 44(2), 113–147.

Longcamp, M., Boucard, C., Gilhodes, J., Anton, J., Roth, M., Nazarian, B. & Velay, J. (2008). Learning through hand- or typewriting influences visual recognition of new graphic shapes: Behavioral and functional imaging evidence. *Journal of Cognitive Neuroscience,* 20(5), 802–815.

Ministry of Education, Republic of Kenya, (2012). Task force on the realignment of the education sector to the constitution of Kenya 2010: Towards a globally competitive quality education for sustainable development. Retrieved December 9, 2012 from http://www.vision2030.go.ke/cms/vds/Task_Force_Final_Report_Feb_20123.pdf.

Mishra, V., Arnold, F., Otieno, F., Cross, A. & Hong, R. (2007). Education and nutritional status of orphans and children of HIV-infected parents in Kenya. *AIDS Education and Prevention,* 19(5), 383–395.

Moss, B. (2010). *OLPC in Africa.* Retrieved May 23, 2011 from https://sites.google.com/site/anth775.

Moyi, P. (2011). Child labor and school attendance in Kenya. *Educational Research and Reviews,* 6(1), 26–35.

Mukudi, E. (2004). The effect of user fee policy on attendance rates among Kenyan elementary school children. *International Review of Education,* 50(5–6), 447–461.

Munene, I. & Ruto, S. (2010). The right to education for children in domestic labour: Empirical evidence from Kenya. *International Review of Education,* 56, 127–147.

Muwanguzi, S. & Musambira, G. (2009). The transformation of East Africa's economy using mobile phone money transfer services: A comparative analysis of Kenya and Uganda's experiences. *Journal of Creative Communications,* 4(2), 131–146.

Ndetei, D., Khasakhala, L., Mutiso, V., Ongecha-Owuor, F., Kokonya, D. (2009). Psychosocial and health aspects of drug use by students in public secondary schools in Nairobi, Kenya. *Substance Abuse,* 30, 61–68.

Negroponte, N. P. (1995). *Being Digital.* New York: Random House, Inc.

Negroponte, N. P. (2010, November/December). Laptops work. *Boston Review.* Retrieved May 21, 2012, from http://www.bostonreview.net/BR35.6/negroponte.php.

New London Group, The. (1996). A pedagogy of multiliteracies: Designing social futures. *Harvard Educational Review,* 66 (1), 60–92.

Nolen, S. B., Ward, C. J., & Horn, I. S. (2011). Motivation, engagement, and identity: Opening a conversation. In D. McInerney, R. Walker & G. A. D. Liem (Eds.), *Sociocultural theories of learning and motivation: Looking back, looking forward (pp.*109–135)*.* Greenwich, CT: Information Age Press.

Nugroho, D. & Lonsdale, M. (2009). Evaluation of OLPC programs globally: a literature review. *Australian Council for Educational Research.* Retrieved May 23, 2011 from the OLPC Wiki: http://wiki.laptop.org/go/OLPC_research.

Ohba, A. (2011). The abolition of secondary school fees in Kenya: Responses by the poor *International Journal of Educational Development,* 31, 402–408.

Oketch, M. & Somerset, A. (2010). Primary education and after in Kenya: Enrolment impact, quality effects, and the transition to secondary school. *CREATE Pathways to Access.* Brighton (37). Brighton, UK: University of Sussex.

One Laptop Per Child. (n.d., a). *Core Principles*. Retrieved June 9, 2012 from http://wiki.laptop.org/go/Core_Principles. Creative Commons License (http://creativecommons.org/licenses/by/3.0/).

One Laptop Per Child. (n.d., b). *Education.* Retrieved May 20, 2010, from http://www.laptop.org/en/vision/education/index.shtml. Creative Commons License (http://creativecommons.org/licenses/by/3.0/).

One Laptop Per Child. (n.d., c). *Mission.* Retrieved May 20, 2010, from www.laptop.org/en/vision/project/index.shtml. Creative Commons License (http://creativecommons.org/licenses/by/3.0/).

One Laptop Per Child. (n.d., d). *Stories.* Retrieved June 9, 2012, from http://one.laptop.org/stories. Creative Commons License (http://creativecommons.org/licenses/by/3.0/).

One Laptop Per Child. (n.d., e). *Vision.* Retrieved August 19, 2012, from http://www.laptop.org/en/vision/index.shtml. Creative Commons License (http://creativecommons.org/licenses/by/2.5/).

One Laptop Per Child. (2008). *Learning Vision.* Retrieved May 20, 2010, from http://wiki.laptop.org/go/Learning_Vision. Creative Commons License (http://creativecommons.org/licenses/by/3.0/).

One Laptop Per Child. (2009). *OLPCorps FAQ.* Retrieved June 9, 2012 from http://wiki.laptop.org/go/OLPCorps_FAQ#Can_we_give_XOs_to_several_schools_to_start_computer_labs.3F. Creative Commons License (http://creativecommons.org/licenses/by/3.0/).

One Laptop Per Child. (2009, June). *OLPCorps Learning Guide.* OLPCorps Africa Training Conference. Kigali, Rwanda.

One Laptop Per Child. (2009, October). OLPCorps Conference. Boston, MA. [There were no proceedings published for this event.]

One Laptop Per Child. (2012a). *Educators.* Retrieved May 10, 2012, from http://wiki.laptop.org/go/Educators. Creative Commons License (http://creativecommons.org/licenses/by/3.0/).

One Laptop Per Child. (2012b). *School stories and case studies.* Retrieved June 9, 2012 from http://wiki.laptop.org/go/Educators#School_stories_and_case_studies. Creative Commons License (http://creativecommons.org/licenses/by/3.0/).

Papert, S. (1990). Computer criticism vs. technocentric thinking. *M.I.T. Media Lab Epistemology and Learning Memo No. 1.* Retrieved May 22, 2011 from the Papert.org website: http://www.papert.org/articles/ComputerCriticismVsTechnocentric.html.

Papert, S. (1993). *Mindstorms: Children, computers, and powerful ideas.* New York: HarperCollins Publishers.

Papert, S. & Harel, I. (1991). Situating Constructionism. In *Constructionism*. New York: Ablex Publishing Corporation. Retrieved May 20, 2010, from http://papert.org/articles/SituatingConstructionism.html.

Pal, J. (2012). The machine to aspire to: The computer in rural South India. *First Monday,* 17(2).

Retrieved April 28, 2012 from: http://www.firstmonday.org/htbin/cgiwrap/bin/ojs/index.php/fm/article/view/3733/3152.

Pea, R. D. (1987). The aims of software criticism: Reply to Professor Papert. *Educational Researcher*, 16 (5), 4–7.

Pew Internet & American Life Project. (n.d., a). Tech usage over time. Trend data (Teens). Excel File. Retrieved January 11, 2013 from http://pewinternet.org/Trend-Data-(Teens)/Usage-Over-Time.aspx.

Pew Internet & American Life Project. (n.d., b). Teen gadget ownership. Retrieved January 11, 2013 from http://pewinternet.org/Static-Pages/Trend-Data-(Teens)/Teen-Gadget-Ownership.aspx.

Pew Internet & American Life Project. (2010). Change in internet use by age, 200-2010. Retrieved January 11, 2013 from http://pewinternet.org/Infographics/2010/Internet-acess-by-age-group-over-time-Update.aspx.

Plaut, V. & Markus, H. (2005). The "inside" story: A cultural-historical analysis of being smart and motivated, American style. In A. J. Elliot & C. S. Dweck (Eds.), *Handbook of competence and motivation* (pp. 457–488). New York, NY: Guilford Publications.

Rahman, A. (1999). Micro-credit initiatives for equitable and sustainable development: Who pays? *World Development,* 27(1), 67–82.

Rainie, L. and Horrigan, J. (2005). How the internet has woven itself into American life. Pew Internet & American Life Project. Retrieved January 11, 2013 from http://pewinternet.org/Reports/2005/How-the-internet--has-woven-itself-into-American-life.aspx

Reuters. (2010). *Kenya mobile phone penetration crosses 50 pct mark-govt.* Retrieved January 7, 2012 from Reuters.com, http://www.reuters.com/article/2010/08/23/kenya-telecoms-idUSLDE67M1JD20100823.

Richards, T. L., Berninger, V.W., Stock, P., Altemeier, L., Trivedi, P., Maravilla, K. R. (2011). Differences between good and poor child writers on fMRI contrasts for writing newly taught and highly practiced letter forms. *Reading and Writing,* 24 (5), 493–516.

Rogers, A. & Street, B. (2012). *Adult literacy and development: Stories from the field.* Leicester: NIACE.

Roper, C. (1983, February 10). French flock to computer center. *New Scientist,* 97 (1344), 357–361.

Roush, W. (2009). *Internet Archive opens 1.6 million E-books to kids with OLPC laptops.* October 24, 2009. Retrieved May 27, 2012 from the Xconomy.com website http://www.xconomy.com/boston/2009/10/24/internet-archive-opens-1-6-million-e-books-to-olpc-laptops.

Rural Poverty Portal. (n.d.) *Rural Poverty in Kenya.* Retrieved June 24, 2012 from http://www.ruralpovertyportal.org/web/guest/country/home/tags/kenya.

Santiago, A., Severin, E. Cristia, J., Pablo, I. Thompson, J. & Cueto, S. (2010). Experimental assessment of the program "One Laptop Per Child" in Peru. *IBD Education.* Retrieved May 23, 2011 from http://www.olpcnews.com/countries/peru/first_evaluation_results_from.html.

Smith, J., Bray, F., & Morawczynski, O. (2011). Examining the adoption, usage and outcomes of mobile money services: the case of M-PESA in Kenya. (Doctoral dissertation, University of Edinburgh, 2011). *Center of African Studies PhD thesis collection.*

Snow, C. E., Barnes, W. S., Chandler, J., Goodman, I. F. & Hemphill, L. (1991). *Unfulfilled expectations: Home and school influences on literacy.* Cambridge, MA: Harvard University Press.

Solomon, G. & Perkins, D. (2005). Do technologies make us smarter? Intellectual amplification with, of, and through technology. In Sternberg, R. J. and Preiss, D. (Eds.), *Intelligence and technology: The impact of tools on the nature and development of human abilities* (pp. 71–85). Mahwah, N.J.: Lawrence Erlbaum and Associates.

Somerset, A., (2009). Universalising primary education in Kenya: the elusive goal. *Comparative Education.* 45(2), 233–250.

Sperber, D. & Hirschfield, L. A. (2004). The cognitive foundations of cultural stability and diversity. *Trends in cognitive sciences*, 8(1), 40–46.

Street, B. V. (2005). Recent applications of New Literacy Studies in educational contexts. *Research in the Teaching of English, 39*, 417–423.

Sullivan, J., Vander Leest T., and A. Gordon. (2008). *Work and play in the information age.* Seattle: University of Washington, Technology & Social Change Group (TASCHA). Retrieved January 11, 2013 from http://tascha.uw.edu/publications/work-and-play-in-the-information-age.

Swing, E. L., Gentile, D. A., Anderson, C. A., Walsh, D. A. (2010). Television and video game exposure and the development of attention problems. *Pediatrics,*126, 214–221.

Thomson, K., Purcell, K. and Rainie, L. (2013). Arts organizations and digital technologies. Pew Internet & American Life Project. Retrieved January 11, 2013 from http://pewinternet.org/Reports/2013/Arts-and-technology.aspx.

Toyama, Kentaro. (2011, February). Technology as amplifier in international development. Proceedings of the Association for Computing Machinery iConference 2011, Seattle, WA, 75–82.

Joint United Nations Programme on HIV/AIDS (UNAIDS). (2010). *UNAIDS Report on the Global AIDS Epidemic 2010.* Accessed May 13, 2012, from http://www.unaids.org/globalreport/Global_report.htm.

United Nations Educational, Scientific and Cultural Organization (UNESCO). (2010). *World Data on Education.* (p. 9) Accessed September 9, 2012, from http://www.ibe.unesco.org/fileadmin/user_upload/Publications/WDE/2010/pdf-versions/Kenya.pdf

Uwezo, (2010a). Coast. *Annual Learning Assessment Report.* (pp. 51–62). Retrieved May 22, 2011 from http://www.uwezo.net.

Uwezo, (2010b). National. *Annual Learning Assessment Report.* (pp. 27–38). Retrieved May 22, 2011 from http://www.uwezo.net.

Vota, W. (2011). *Who is to blame for OLPC Peru's failure? An OLPC intern viewpoint.* Retrieved May 22, 2011 from the OLPC News website: http://www.olpcnews.com/countries/peru/who_is_to_blame_for_olpc_peru.html.

Walingo, M., & Musamali, B. (2008). Nutrient intake and nutritional status indicators of participant and nonparticipant pupils of a parent-supported school lunch program in Kenya. *Journal of Nutrition Education and Behavior*, 40(5), 298–304.

World Bank (2011). *World Development Indicators.* Retrieved January 7, 2012 from Google.com Public Data, http://www.google.com/publicdata/explore?ds=d5bncppjof8f9_&met_y=sp_pop_totl&idim=country:KEN&dl=en&hl=en&q=population+of+kenya.

World Bank. (2012a). *Ease of doing business in Kenya.* Retrieved May 27, 2012 from DoingBusiness.org, http://www.doingbusiness.org/data/exploreeconomies/kenya.

World Bank. (2012b). *Kenya.* Retrieved May 27, 2012 from http://data.worldbank.org/country/kenya.

Yuan, K., Qin, W., Wang, G., Zeng, F. Zhao, L. Yang, X., Liu, P., Liu, J., Jinbo, S., von Deneen, K.M., Gong, Q., Liu, Y., Tian, J. (n.d.). Microstructure abnormalities in adolescents with Internet addiction disorder. *PLOS One.* Retrieved January 6, 2013 from plos.org, http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0020708.