

The \$100 XO Laptop: A Review of a Third-World Educational Effort

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The \$100 laptop, also called the XO Laptop, was conceived and developed by a group of Massachusetts Institute of Technology Media Lab personnel. Others later joined this effort, including individuals from the computer industry, academia, the arts, business, and the open-source community. Subsequently, a non-profit foundation was established known as the One Laptop per Child (OLPC) Foundation to further facilitate the development, manufacturing, marketing, sales, and distribution of the XO Laptop to impoverished countries.

Introduction

In the past decade there have been many worthwhile initiatives directed towards improving the educational climate in impoverished or under-resourced countries. However, seldom has there been a project whose mission has such an innovative, education slant, and one that is solely devoted to helping educationally underserved children throughout the world (Figure 1).



Figure 1. A student at the Chavalina School in the town of Chinchá, Peru works on a class XO Laptop project in July 2008. Photo used with permission of OLPC Foundation.

The \$100 laptop, also called the XO Laptop, is a small 3.2-pound Kermit the Frog-colored laptop (Figure 2). The laptop was initially developed by a core group of faculty and researchers at MIT's Media Lab in Cambridge, Massachusetts (MIT Media Lab 2008). The One Laptop per Child Foundation was later established to further develop, produce, and distribute the laptop in keeping with the stated educational mission. The XO Laptop represents a true synthesis of academic, technical, and private sector collaboration.



Figure 2. The XO Laptop is a compact, but full-functioning computer, as seen in these closed and open photos.



Figure 3. Display ad seen at the Indianapolis International Airport in November 2007.

Television ads in North America promoted the XO laptop for two weeks during November and early December of 2007. Ads placed prominently within large city airport concourses also promoted the innovative laptop (Figure 3). The OLPC Foundation's "Give One, Get One" program was unique as well, and required the buyer to purchase two XO Laptops for a total of \$ 399 USD. By doing so, the buyer received one laptop to keep, and a second laptop was shipped to a deserving child in a third world country. The buyer also received a tax deduction for the contribution of the second laptop.

Self- Empowered Learning

The mission of the One Laptop per Child Foundation is to promote and enhance the education of the nearly two billion of the world's educationally deprived children. By keeping the cost of the XO Laptop low, governments of underdeveloped countries have been able to purchase these small laptops in large quantities, and have distributed them as learning tools throughout many impoverished regions of their countries (Figures 4, 5, 6). Research studies have indicated that laptops promote hands-on learning, and provide a valuable tool for acquisition and retention of knowledge (Toshiba / NSTA Laptop Learning Challenge



Figure 5. Students in Mongolia receive instruction about their Laptops during the XO implementation phase in January 2008. Photo by Carla Gomez Monroy; used with permission of OLPC Foundation.



Figure 6. Primary school students in Mongolia work on collaborative assignment in January 2008. Photo by Carla Gomez Monroy; used with permission of OLPC Foundation.



Figure 4. Students from Nigeria's L.E.A. Galadima Primary School are shown with their XO Laptops in June 2007. Photo used with permission of OLPC Foundation.



Figure 7. The XO features a built-in SD memory card slot is located on the screen's bottom edge.

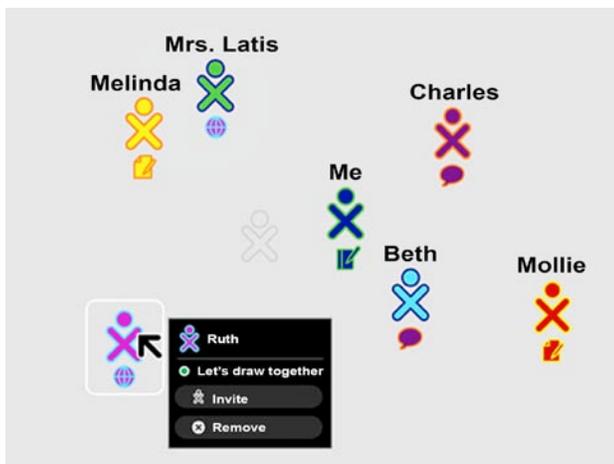


Figure 8. The XO's "My Neighborhood" screen reveals other students in the classroom. Students may invite others to join them in an activity.

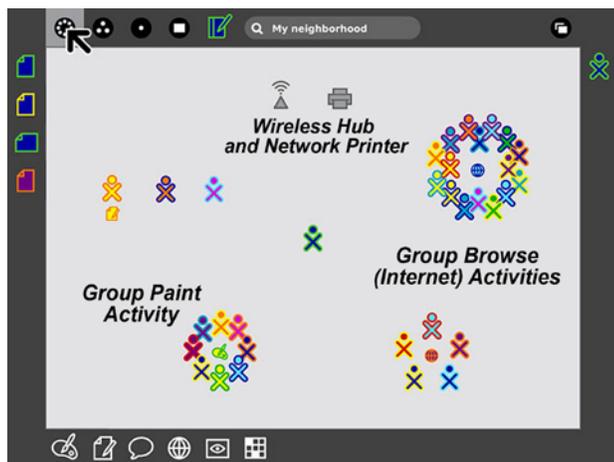


Figure 9. "My Neighborhood" shows individual student and group activity within the classroom. Also seen are the wireless router and the classroom's networked printer.

website; Efa et al. 2004). Another noteworthy aspect of this effort is that the XOs are not intended to become community (or school) property. Rather, the students are given the laptop to keep as their own. With this laptop ownership a very positive dynamic occurs. This individual ownership engages the student on a personal level, promotes pride and responsibility, and enhances a student's feelings of self-confidence and self-worth. As many teachers and educational psychologists have suggested, these attributes are important keys to learning (Russell et al. 2008; Poutasi 2008).

The Hardware

This remarkable, rugged laptop has most, if not all, of the necessary hardware, software, games, and Wi-Fi components to make this computer both educationally sound and fully functional in classrooms throughout the world. The laptop features a built-in video camera, audio inputs, stylus writing areas, three USB slots, as well as SD flash card reader slot (Figure 7). The XO laptop features an open source Linux operating system, and includes an extraordinary range of preloaded software called "Activities," deemed most valuable for enhancing both primary and middle school education.

The laptop has built in Wi-Fi capabilities allowing for easy World Wide Web access where Internet service is available. The laptop also features an auto-configuring "Mesh" routing protocol (based on the 802.11s standard) allowing students to effortlessly network within a classroom or small group. This Mesh Network functionality works in the absence of an existing wireless network. As each laptop has both Wi-Fi broadcast and Wi-Fi reception functions, each laptop automatically links with other nearby XO Laptops in the classroom. The laptop screen automatically displays an icon that represents each student's XO laptop, without manually configuring any complex network settings (Figures 8, 9). Students are able to invite others into their online study group for collaborative discussion or completion of group assignments.

Instead of a standard internal hard drive containing a motor, delicate actuator arms, and magnetized platters (that could all subject to shock if the laptop were dropped), the XO laptop features one gigabyte of SLC NAND flash storage with a high-speed flash controller. Flash memory is termed non-volatile, meaning that the storage device does not need power to maintain or store information. The XO laptops have AMD Geode LX-700 processors (clocked at 433 MHz) and ship with 256 Mb of RAM. The laptop has no internal cooling fan, and therefore is completely silent. The XO laptops have relatively low processor speeds with slow start-up and software launch times, especially when compared to today's higher-powered machines. However, once booted, the computer and the software programs are very responsive.

In order to simplify the XO, the laptop has no fan or other moving parts. There is no built-in CD or DVD optical drive in these units. Students rely on the built-in wireless function to turn in their

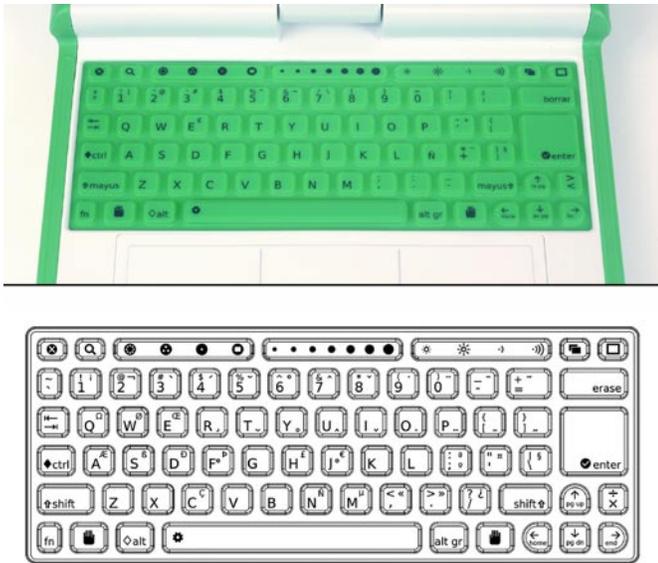


Figure 10. XO Laptop keyboards are made available in 24 languages. TOP: Moisture sealed Spanish language keyboard. BOTTOM: US International (English) language keyboard graphic.



Figure 11. The “Browse” Activity features a simple web interface for access to the World Wide Web via the XO’s built-in Wi-Fi capabilities.

classroom assignments, share image files, and communicate with teachers. If file storage becomes necessary, USB powered drives/devices can be added as peripheral equipment via any of the laptop’s three USB ports.

The laptop features a membrane-sealed, watertight keyboard that is well suited for humid, dusty, or even rainy environments. These keyboards have been designed to reflect the primary languages of the nations who will ultimately purchase these units. As such, the keyboards are available in English (US International), Spanish (Latin America), Portuguese (Brazilian), Amharic (Ethiopic), Arabic, Nigerian (Igbo, Hausa, Yoruba), French (Rwanda), Thai, Urdu, Cyrillic (Russian), Turkish, Nepali, Mongolian, Kazakh, Devanagari, Uzbek, Pashto, Dari, Armenian, Khmer, Pulaar, Italian, Kreyòl, and German languages (Figure 10).

A horizontal touchpad is located at the bottom of the sealed keyboard near the laptop’s two “mouse buttons.” This interactive touchpad is unusually wide and is divided into three working segments. The middle section functions as the finger actuated touch pad, while the center, left, and right pads are intended for writing with use of the XO’s green stylus.

The laptop’s 7.5 inch dual-mode 200 dpi liquid-crystal display supports a resolution of 1200 x 900 pixels in monochrome mode and 800 x 600 pixels in color mode, which is more than adequate for preparing a colorful graph, performing word processing, or viewing the World Wide Web (Figure 11). Included in the hardware are two Wi-Fi

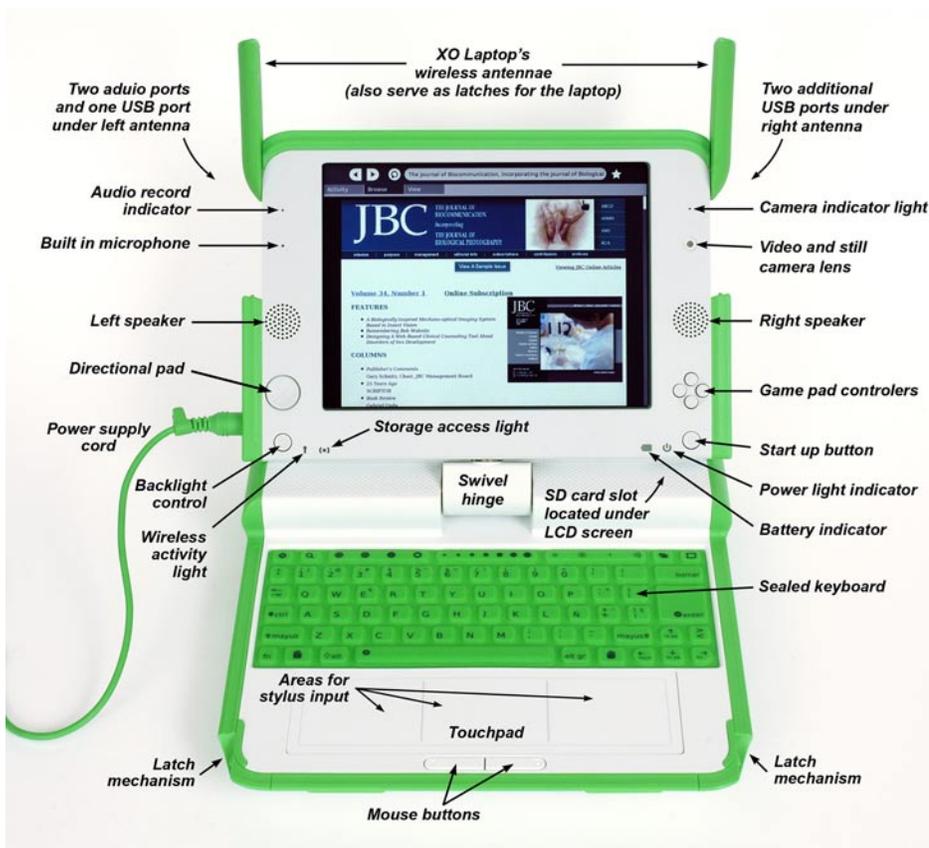


Figure 12. Labeled photo showing the numerous features of the XO Laptop’s hardware.



Figure 13. The “Record” Activity provides the student with the ability to record full motion video at 30 fps, as well as take still photos.

wireless antennae that also cleverly serve as the laptop’s two opening latches. A touchpad, three USB 2.0 ports, a slot for a Multi Media Card/Secure Digital (MMC/SD) memory card, a game pad controller, head phone output, built-in stereo speakers, a built-in video camera, and a microphone complete the laptop’s hardware features (Figure 12).

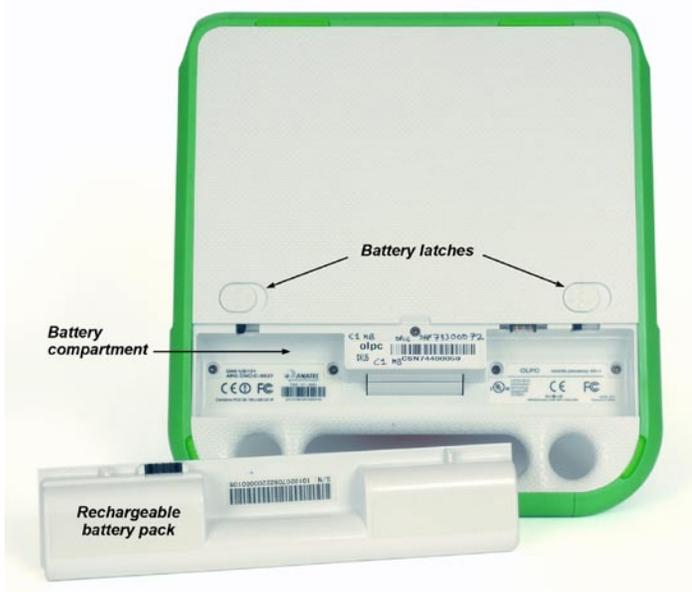


Figure 14. The XO features a rechargeable battery pack that can be removed and replaced via the latches found under the laptop’s base.

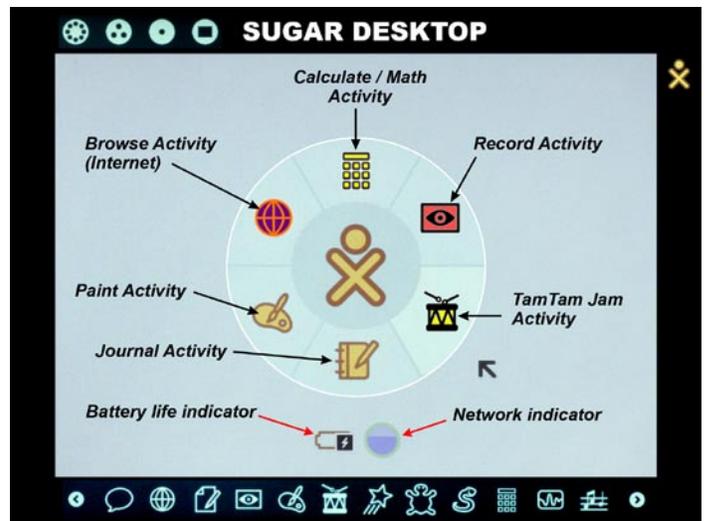


Figure 15. The XO’s desktop environment is called “Sugar” and features icons for the software “Activities.”

The XO’s built-in video camera captures video at 30 frames per second on an OmniVision CameraChip® sensor. This function allows for real-time video chatting, providing a resolution of 640 x 480 pixels. When using the “Chat” Activity, parents and teachers are able to chat by video when ever necessary (Figure 13).

For power, the XO Laptop incorporates a new battery technology and features a full 6-hour battery life, or an estimated 22-hour battery life if the student is reading in the monochrome book reading mode. The XO batteries cost a mere \$ 10 to replace and have been engineered to last for an unprecedented 2000 recharging cycles (Figure 14). In areas where electricity may be sporadic or even unavailable, a \$12 solar panel (only one foot square in dimension) is available for purchase. An innovative yo-yo pull-cord generator made by Potenco is also available for recharging the battery.

Software “Activities”

The XO Laptop features an intuitive desktop environment called “Sugar,” a simple graphical user interface designed for learning (Figure 15). The circular desktop configuration of Sugar displays the launched software applications that are ready for use. The XO’s software applications are called “Activities,” a term that is appropriately descriptive for children, and one that is almost universally understood. As innovative as the laptop itself, these Activities offer students a wide range of simply designed, media-rich programs to enhance the study of mathematics, biological science, physical science, geography, astronomy, computer science, and social science. These included programs compliment each other, and emphasize creative thinking, authorship, collaboration, and web-based learning.

The built-in software includes an efficient web browser called “Browse,” which is based on Mozilla’s Firefox (Figure 16). This browser uses the same Gecko HTML rendering engine as

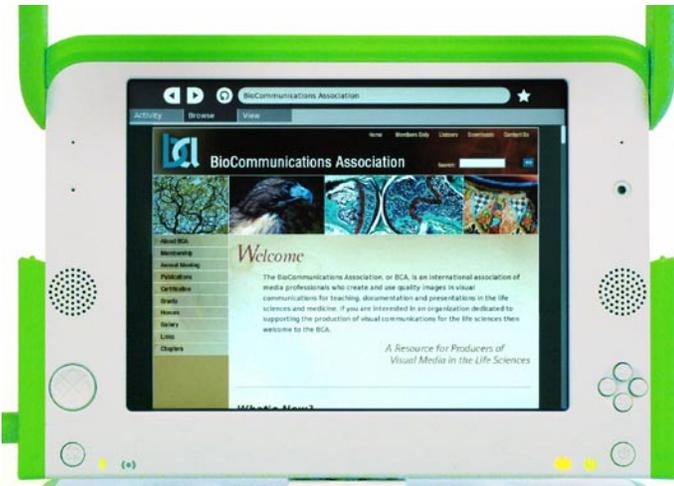


Figure 16. The “Browse” Activity allows for easy access to the BioCommunication Association’s (BCA) website.

Firefox, but is much simpler in overall design. This browser has been visually designed for ease of use, and offers students a look at the world through the Internet.

Pre-loaded XO programs include a wireless chat program (Chat), a memory and recall matching game (Memorize), and an advanced electronic circuit design program (SynthLab). Two musical instrument soundtrack programs are included called TamTam Mini and TamTam Jam (Figure 17). An advanced music program called TamTam Edit allows for even more creative soundtrack composition. As mentioned earlier, the recording Activity called “Record” allows the student to record video, still images, and audio captured via the laptop’s built in camera and audio microphone. This Record Activity allows a student to create stop-motion animation, time-lapse photography, 360-degree photo panoramas, and slide shows.

Organizational software called “The Journal” assists in recording, cataloging, and viewing student activities and class assignments. This Activity serves as a resource to review a student’s academic progress in a specific area of study. In addition, this Journal Activity is used to access files from any attached external storage devices, such as USB devices or SD memory cards. Once these devices are inserted into the XO, the device icons are displayed in the lower left corner of The Journal’s screen for easy access.

A more advanced specialty software called “Measure” allows a student to observe physical phenomena around him or her, such as the amount of rainfall during one rainy-season month, then record and plot this specific data in graph form. Students are also able to connect external sensors to the laptop and record (and store) phenomena such as magnetic fields, light intensity, heat, wind speed, etc. Electronic input voltages can be displayed and analyzed with the XO’s display actually functioning as an oscilloscope. The Measure Activity also allows a student to visually analyze external audio signals, voices, and other sounds via the XO’s built-in microphone (Figure 18).



Figure 17. Music and audio compositions can be created using TamTam, a suite of four music and sound related activities on the XO. TamTam Jam (shown here) is designed for younger children.



Figure 18. The “Measure” Activity allows for complex sound analysis via the XO’s display.

The XO “NewsReader” Activity provides a browser-like interface to view and read news of the world via RSS feeds (Figure 19). Regional news stories, current events, web-based educational programming, and political commentary help provide a window to the world for these deserving students, many of whom have been isolated from world events. Viewers are able to keep track of multiple RSS news feeds within the NewsReader Activity, and they also have the capability of downloading audio, video, and podcasts.



Figure 19. The “NewsReader” provides a browser-like interface for RSS feeds.



Figure 20. The “Distance” function provides an accurate measurement of the physical distance between two XO Laptops.

Activities called “Draw” and “Turtle Art” allow students to create free-form drawings and artwork with electronic paint and pencil. Students are able to utilize a small digital turtle to draw colorful art using snap-together, visual elements. Students can then share these illustrations with others on the student Mesh network either individually or within a small focus group.

The “Distance” Activity can precisely calculate the physical distance between two XO Laptops by digitally measuring audio signals generated between the two computers. First, an invitation



Figure 21. The “Read” Activity features an easy to use PDF and text reading program, and can operate in the monochromatic Book Mode to preserve battery life.

is sent to another student’s XO laptop. Once accepted, the first XO will send out an audio pulse. The second XO will reply with another audio pulse of its own, allowing both XOs to then calculate and display the distance between the two computers in meters (Figure 20).

“Pippy” is an introductory programming software based on Python, the dynamic object-oriented programming language found in the XO software. Pippy not only introduces children to basic aspects of computer programming, but also allows students to animate text and construct digital sounds. A source code feature allows students an opportunity to view and analyze the software code configured within each preloaded software. A student may even elect to change this native programming code and observe the resulting effect on the software. Of course, there also is a software-reset function to return any altered code to its original operating state. Included in the Pippy Activity are twenty functioning Python expressions for review.

The “Etoys” Activity allows students to prepare rich-media projects, graphic models, simulations, and games for sharing over the XO Mesh network. Included within the Etoys Activity are graphics, text, images, presentations, web pages, videos, and MIDI sound files. This Activity promotes learning, while emphasizing student collaboration.

The “Read” Activity features an easy to use PDF/text reader and display program. The laptop itself is designed to enhance this reading activity, by allowing the user to rotate the display panel 180 degrees (Figure 21). Once it is rotated, the display then can be folded down onto and over the keyboard. As the screen is rotated

and folded, the LCD panel switches to a black and white mode, and the student is then able to read even in bright sunlight. In this monochromatic book mode, the laptop battery is estimated to last nearly 24 hours between charges.

“Calculate” is a simple calculator application, providing the basic math functions for middle school and older children. Calculate was designed to perform simple calculations, but additionally it supports more advanced arithmetic, algebraic, and trigonometric functions. This Activity includes an equation parser for parsing simple as well as more complex mathematical expressions.

Also included is an XO word processing program called “Write.” This word processing application is based on AbiWord, and is capable of supporting file formats used by Microsoft Word and

OpenOffice.org’s Writer. This program represents a basic text editing application and is similar to any modern word processing software. Students are able to write stories, compose more lengthy essays, edit written content, and insert images/tables into their page layouts.

A wide range of additional educational software is available for the XO including a collection of reading and writing assignments called “Schoolplay” and a collection of math-related assignments called “Math XO.” A polling, voting, and community analysis activity called “Poll Builder” promotes an understanding of local municipal elections. An Activity called “Moon” features lunar phase and lunar eclipse visuals, and “Star Chart” features detailed information about our planet Earth, constellations, and our neighboring planets. Other Activities like “Stopwatch,” “Spreadsheet,” “VideoChat,” “Collage,” and “Ruler” offer additional XO educational experiences.

Media Players, Games, and Puzzles

Many media and audio players, game-related Activities, and other XO Software Activities are available for download for the XO via the wiki.laptop.org website. One such educational game is Cell Management. This game is based on the biological mechanisms found within living cells, which assist the cells in their response to threats or changes in their environments. In this game the XO’s digital game board features a circular DNA bacterial strand, the cell’s guards are RNA polymerase, and the captives become RNA sequences. Other captives actually become proteins within in the cell.

“Produce Puzzle” is a game based on visual relationships with fruit and berries, wherein one learns basic algebra. “Sim City” promotes an understanding of how to build and maintain one’s own community or city. “Block Party” is a Tetris-inspired moving block game. “Connect-4” is a basic connect-the-dots game, requiring two XO laptops. Other educational games include “Jigsaw Puzzle,” “Slider Puzzle,” “ABC Flower,” “Maze,” “Math Game,” “Implode,” “Geoquiz,” “SpaceWars,” “DazzleDarts,” “KuKu,” “Memorize,” “Domino,” and “PacMan.”

Many media playback Activities are also available for the XO.



Figure 22. *The children the world over have been given access to libraries of knowledge with the XO Laptop initiative. Photo of the XO pilot program photo taken at the Arahway School in Peru by Carla Gomez Monroy, June 2007. Used with permission of OLPC Foundation.*

“DJ” is a simple audio playback function that allows one to cue up audio files for organized playback. Other audio Activities include “Watch and Listen,” “Sonata Music Player,” and “MPlayer,” the latter of which will play a wide range of supported audio formats including MP3.

Limited Microsoft Compatibility, at Least for Now

Of interest, Microsoft Word and PowerPoint are not currently supported by the Linux operating system. Accordingly, these two Microsoft software programs are not available on the XO, and these specific file types cannot be natively created as yet on the Linux based XO. However, pre-existing .doc, .ppt, and .pps files can be viewed on the XO Laptop.

The OLPC Foundation has indicated this year that the XO laptop may eventually ship with both Sugar and the Windows XP operating systems providing dual-booting options. A joint press release from Microsoft and the One Laptop per Child (OLPC) Foundation has revealed that testing is underway with a goal of having the XO host both Windows and the Linux operating systems at some point in the future (Press Release 2008). Hardware and software development continues for the XO Laptop, and work has begun for the second generation of the Laptop to be called the XOXO or XO-2.

One Laptop per Child History

The XO project was formally introduced to international political leaders, selected journalists, and other invited intellectuals at the World Economic Forum held in Davos, Switzerland in January of 2005. Although Nicholas Negroponte, One Laptop per Child’s Chairman, had only a non-functioning prototype to show at this

first meeting, the attendees were summarily impressed with the scope and possibilities of the XO laptop project. Following this 2005 Forum, John Markoff, the well-known technology writer for *The New York Times*, appropriately called Negroponte “the Johnny Appleseed of the digital era” (One Laptop per Child website 2006).

In November of that same year, at the World Symposium on the Information Society in Tunis, United Nations Secretary Kofi Annan became intrigued with the small green XO Laptop and what it could mean for the world’s children. At a Press Conference with Negroponte, Annan commented, “This is not just a matter of giving a laptop to each child, as if bestowing on them some magical charm. The magic lies within - within each child, within each scientist, scholar, or just plain citizen-in-the-making. This initiative is meant to bring it forth into the light of day.” (One Laptop per Child website 2006). Annan welcomed the Laptop as an “expression of global solidarity.”

One year later at the 2006 World Economic Forum, a letter of agreement was signed by the United Nations Development Program leaders and One Laptop per Child’s Chairman. Under this agreement, these two organizations pledged to work together to deliver 5 to 10 million XO laptops during the next few years. Under this agreement, the United Nations Development Program would officially partner with OLPC and assist with the XO laptop distribution to schools in the least developed areas of the world (Pollack 2007).

Of interest, OLPC was originally funded by a number of sponsor organizations, including AMD, Brightstar Corporation, eBay, Google, Marvell, News Corporation, SES, Nortel Networks, and Red Hat, the company that created the Linux-based operating system for the XO laptop. Each of the original sponsoring corporations has donated two million dollars to launch the not-for-profit foundation. The foundation was chartered in the state of Delaware and now is headquartered in Cambridge, Massachusetts. Of interest, while Intel became a sponsor in July of 2008, the company resigned its membership in January of 2008, and is now pursuing an Intel-version of an affordable laptop in conjunction with Intel’s own World Ahead program.

Following an initial order of 20,000 XO Laptops, President Nambaryn Enkhbayar of Mongolia announced in November of



Figure 23. Students from the Bishwamitra Ganesh Lower Secondary School in Lakuribhanjyang in Lalitpur, Republic of Nepal. Used with permission of OLPC Foundation.

2007 his commitment to provide every child in his nation with a connected laptop by the end of 2010. Many world leaders have voiced similar goals. Ongoing efforts to provide third world students with XO Laptops have resulted in sales to (or commitments from) the governments and Educational Ministries of many countries. Included are Romania, Argentina, Brazil, Libya, Rwanda, Mexico, Mongolia, Nepal, India, Uruguay, Peru, Thailand, Suriname, Nigeria, Haiti, and Iraq.

Conclusion

While the XO Laptop will not become a replacement for a modern \$1000 (or more) laptop, it never was intended or designed to be so. Rather, the XO Laptop is a sharable educational tool that already has impacted learning on a wide scale. The laptop has fostered discovery of knowledge and individual creative expression, especially for those students who have experienced great educational hardship (Figure 22, 23). Nicholas Negroponte, the Chairman and founder of One Laptop per Child, has accurately emphasized the goal of this worldwide effort indicating, “It’s an education project, not a laptop project” (One Laptop per Child website 2008).

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For additional information regarding the XO Laptop, please visit:

<http://www.laptop.org>

<http://wiki.laptop.org/go/Activities>

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