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Communication

Introducing Open Source and the Raspberry Pi to Schools in Developing Nations

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Several times my students and I have been involved with computing service projects for schools in both Central America and West Africa.¹ Several of these projects involved refurbishing computers and sending them overseas. However, when I went to West Africa in 2009, I realized that we needed to change our approach if we were best to help computing there. Some of the specific challenges and two partial solutions follow.

Particular Challenges

One of the challenges for schools in developing countries is the cost of proprietary software. This issue is compounded where the cost of software licenses is often significant in comparison with teacher salaries and other expenses. The temptation to pirate software is often strong, especially in countries where illegal copies of movies can be openly purchased at the market. To be sure, the issue of software piracy is not unique to developing nations; it is a topic that I regularly bring up with my own students.

A further challenge is the prevalence of computer viruses. Many of the computers that I encountered were laden with computer viruses and malware. In some cases this is caused by a lack of knowledge about anti-malware software, but in other cases, it is impossible to download security updates and virus definitions due to a lack of internet access. One person at a school in West Africa described to me an attempt to keep his software up-to-date by putting his computers in the back of his car and traveling to a location where

he could access the internet. Many of the viruses are spread by USB flash drives which are readily available and frequently used. One computer lab I visited in West Africa had a sign prominently posted on the door: "The Use of USB Flash Drives Is Strictly by Permission."

A third challenge is the use of old hardware which is often found in schools in developing countries. Recently I visited some Christian schools in Nicaragua, many of which were using old and outdated equipment. I visited computer labs cobbled together with a ragtag collection of vintage computers, many of which were ten years old or older and running outdated software. Many computer labs have been established using donations of old computers, but besides being bulky and expensive to ship, these old computers present many ongoing maintenance issues. These maintenance issues can be exacerbated by hot climates and an unreliable power grid, leading to premature failures of power supplies and corrupted hard drives. I have wondered what happens to these old, donated computers and monitors when they eventually fail. Older monitors and computer circuit boards contain many toxic chemicals such as lead and cadmium. In particular, older CRT (cathode ray tube) monitors contain a significant amount of lead. In

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the United States, the Environmental Protection Agency has established rules to ensure safe disposal of CRTs.² Unfortunately, many developing countries lack the facilities to properly handle e-waste such as CRTs. At worst, endeavors to donate old equipment amount to little more than sending our e-waste overseas.



A modest computer lab at a Christian school in Nicaragua.

A fourth challenge I encountered in West Africa is electrical power, ranging from the inconvenience of different plugs and voltage standards to unreliable power grids and unclean power lines. Taming unreliable power with the use of uninterruptible power supplies (UPS) helps, but it increases costs and adds the ongoing maintenance headaches of backup batteries. The need for reliable power is increased by the necessity for air conditioning in hot climates for computer labs running many workstations.

A fifth challenge is adequate computer maintenance and teacher training. It is necessary to ensure that there are local people to maintain and take ownership of the computers (often this task falls to the teachers as well). Some of our early service projects involved refurbishing computers to be shipped to recipients overseas. Although we felt good about an opportunity to serve, and students had fun organizing computer “install-fests,” I have grown skeptical of the wisdom of sending computers to places without local expertise and ownership to maintain them. The world of international development has many stories about failed projects where equipment was left rusting and languishing due to lack of local ownership, training, or a naive understanding of local culture.³

We have been exploring the use of open source software⁴ and Raspberry Pi hardware as a practical approach to begin to address many of these issues.

Open Source Solutions

In the last number of years, a vast amount of high-quality software has become available for free. Free software provides an alternative model to proprietary software. The term “free software” means that users have the freedom to run, copy, distribute, study, change, and improve the software.⁵ This movement has been called the “free software” or “open source” movement in which programmers collaborate over the internet and give their code away for free. In fact, copying, sharing, and contributing is encouraged.

We have made a conscious choice to use open source software in our overseas projects because we have found that it helps address some of the challenges described earlier. In particular, we have chosen to use Linux, a robust, freely available operating system that has many attractive features.⁶ First, because Linux is free, it helps avoid the temptation to pirate software and provides an excellent alternative that does not require any software licensing fees. There is also a wide variety of open source educational software available for Linux, including LibreOffice, a freely available full-feature office suite.⁷ Furthermore, Linux is typically immune from the wide variety of Windows viruses. What is more, the Linux operating system has a plethora of versions available, including some that are quite capable of running well on older computers with slower processors and with a modest amount of memory and hard drive space.⁸ On a recent trip to Nicaragua, we encountered older computers that we had refurbished on an earlier trip with Edubuntu Linux which were still working reliably in the field four years later.⁹



Participants in the Raspberry Pi workshop in Managua, Nicaragua, December 2014

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Open source software also lends itself to being more culturally appropriate. Because open source software is open and can be modified by anyone, people in various cultural settings can participate in its development and adapt the software so that it better serves local needs. Open source software has the possibility to improve communication and lingual norms by enabling people to translate menus, icons, manuals, and documentation into their local languages and dialects. Open source software provides options for the stewardship of hardware resources. Many new programs and operating systems require the purchase of newer hardware, encouraging people to discard older hardware even if it is still working well. In contrast, open source software includes many options for running on older or more modest hardware platforms. Expensive software licenses can exacerbate the “digital divide” in which legal use of software may exclude the poor, but open source software can be made freely available to all. Open source software also encourages sharing, which is one way of expressing the ethical norm to love our neighbor.¹⁰ This sharing can extend to “open source curriculum” resources and lesson plans shared among local teachers.

Nevertheless, the need for adequate training remains essential. Each of our service trips have included workshops and training. Besides the technical training, we have been deliberate to include a perspectival aspect. People who work with technology can sometimes lose sight of the big picture when they focus on the “nuts and bolts” of technical work. In particular, well-intentioned Christian computing specialists must be careful not to inadvertently promote a “faith in science, technology, and material things.”¹¹ One potential pitfall is to think that the primary problem faced by the poor is a lack of technology or information, and that the key to bring flourishing to communities is to provide technology and access to information. Each of my trips to West Africa and Central America included workshops with local teachers and professors that covered the topic of developing a Christian perspective of computer technology.

Introducing the Raspberry Pi

Although open source software can run on older hardware, the challenge of using old and outdated computers remains. The recent work in Nicaragua

included the introduction of a nifty, new, little computer called the “Raspberry Pi.”¹² It is a device about the size of a deck of cards and capable of running a full Linux desktop operating system while consuming only 2.5 watts of power.¹³ It includes USB ports for connecting a keyboard and mouse along with a variety of other peripherals, an ethernet adapter, and an HDMI monitor connection. The Raspberry Pi was originally constructed for hobbyists, but promises to be an appropriate technology for use in schools in developing countries. Rather than shipping bulky, old, refurbished computers with all the associated problems, the Raspberry Pi is a very small device that can be easily shipped overseas. It is also manufactured to comply with RoHS (Restriction of Hazardous Substances) directives.¹⁴ It requires no fans or moving parts; instead of a hard drive it relies on a single microSD card for its storage. It runs a variant of Linux called Raspbian, and there are a wide variety of educational programs that can be run on it. What is more, it can be purchased new with a case and power supply for around \$60 US.

We recently brought thirty Raspberry Pi’s for a pilot project to see how they would work over time and temperature in a few Christian schools in Nicaragua.¹⁵ The project was launched in December 2014 with a four-day workshop for teachers on how to set up and configure the Raspberry Pi as well as introducing various educational programs.¹⁶ Once again, the workshop also included discussions on a Christian perspective of technology. The Raspberry Pi’s were distributed to a network of local Christian school computer teachers which calls itself



Some Christian school teachers in Nicaragua exploring the Raspberry Pi.

“RedProCom.” It is hoped that this group of teachers will develop expertise in the use and maintenance of the Raspberry Pi so that they can train other teachers. Local ownership and participation with groups such as RedProCom are essential.¹⁷ If the project proves successful, we hope to participate with local computer teachers and groups such as RedProCom to introduce more Raspberry Pi’s in other Christian schools who are currently struggling with the challenges of old and outdated computers. Because the Raspberry Pi has modest power requirements, it promises to be a suitable candidate for solar power for use at sites with an unreliable power grid. Already we have experimented with using solar power to run the Raspberry Pi and a flat screen monitor with promising hopes of developing it further.



An experimental setup for a solar-powered Raspberry Pi.

Conclusion

It is exciting and encouraging to see the growth in Christian schools in the majority world. Despite their growth, many of these schools face challenges such as the establishment of reliable and affordable computer facilities in the service of learning. It is my hope that some of the things we were able to share about open source software and the Raspberry Pi will help equip Christian teachers as they teach about computer technology and seek to do so from a Christian perspective. ♦

Notes

¹Our service projects have been in partnership with different organizations including Christian Reformed World Missions (CRWM) and EduDeo Ministries.

²<http://www.epa.gov/osw/hazard/recycling/electron/>.

³For an excellent discussion of many of these issues, see Steve Corbett and Brian Fikkert, *When Helping Hurts: How to Alleviate Poverty without Hurting the Poor ... and Yourself* (Chicago: Moody Publishers, 2009).

⁴For an introduction to the concept of open source software, readers are encouraged to read the article on open source software that appears in this same issue of *PSCF*.

⁵See the free software definition at <http://www.gnu.org/philosophy/free-sw.html>.

⁶On my recent return trip to Nicaragua I was delighted to see several Christian schools successfully running Linux. One lab I visited had mounted on the wall of their computer lab a large styrofoam cut-out of Tux, a friendly looking penguin which has become the mascot for the Linux operating system.

⁷One Linux distribution dedicated for educational use is Edubuntu, <http://www.edubuntu.org/>.

⁸An example is Puppy Linux, <http://puppylinux.org/>.

⁹In fact, a few of them had experienced hard drive failures but were still being used by turning them into thin clients using LTSP under EduBuntu Linux, <http://www.ltsp.org/>.

¹⁰In fact, the free software definition explicitly states one of the freedoms as “The freedom to redistribute copies so you can help your neighbor,” <http://www.gnu.org/philosophy/free-sw.html>.

¹¹Corbett and Fikkert, *When Helping Hurts*, 94.

¹²We used the Raspberry Pi model B+, <http://www.raspberrypi.org/>.

¹³We set up the Raspberry Pi’s with the Raspbian Linux distribution, <http://www.raspbian.org/>.

¹⁴http://ec.europa.eu/environment/waste/rohs_eee/.

¹⁵The Raspberry Pi project had help from Henry Brouwer and was done in partnership with Dave Stienstra from Nicaragua Christian Academy, a group of local computer teachers called RedProCom, the ACECEN (Association of Evangelical Christian Education Centers of Nicaragua), and EduDeo Ministries.

¹⁶The Raspberry Pi includes various educational programs including one named Scratch, a friendly tool for teaching children how to program, <http://scratch.mit.edu/>.

¹⁷Corbett and Fikkert, *When Helping Hurts*, 145–46.

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