



K12 Open Technologies Implementation Study #2 Large Scale Student Desktop Linux Program Indiana State

Overview

Many experts believe that the real potential of technology cannot be achieved until there is a one-to-one student-to-computer ratio. However, the costs associated with one-to-one—combined with the other changes required for successful implementation—have been beyond the means of many schools. Today, low-cost open source operating systems and application software are making one-to-one a possibility for more schools.

Indiana sponsors one of the most extensive statewide programs to provide class sets of low-cost student workstations using Linux on the desktop. The Indiana Affordable Classroom Computers for Every Secondary Student (InACCESS) grant program has placed more than 22,000 workstations in 24 high schools across Indiana. While InACCESS is a state funded, top-down initiative, its philosophy and methods are applicable to districts seeking to stretch scarce technology funds. There are many models for one-to-one implementation; InACCESS is a classroom model in which classrooms in a single subject area are fully equipped with non-mobile workstations. In Indiana's language arts classrooms, one-to-one computing is used for online research, frequent writing, and collaboration and for tapping the organizational support supplied by instructional management systems. Success factors for this grant program are simplicity, flexibility, and support.

Background

Demographics: Indiana has 1,034,000 students in public schools; 300,000 high school students. The majority of schools have a student-to-computer ratio of between 5:1 and 8:1. About half the computers are in a lab environment. Indiana ranks in the top five states for student-to-computer ratio.

Requirements: Move toward a one-to-one ratio while smoothly integrating these new computers into a heterogeneous school-computing environment.

The trigger: In 2001 Michael Huffman from the Indiana Department of Education spent a year evaluating how technology was being used. He found that computing resources were either overbooked or not reaching students. Students were spending an average of only 35 minutes per week using computers. Often the few classroom computers were used with early finishers and occasionally for special projects. On the other hand, lab computers were so heavily scheduled that few classes could gain access more than once a week. To realize the potential of technology, Huffman said that Indiana needed to get more computers in front of students on a regular basis and needed to move toward a one-to-one computing environment. With a million kids in the state of Indiana, however, these changes had to be done in the most cost effective and equitable manner possible.

Accomplishments: Indiana established the InACCESS grant program to enable schools to purchase classroom sets of low cost computers that use open source operating systems. Schools were able to keep the OS costs down to \$5 per year. In all four sites interviewed for this article, acceptance among teachers and students has been high. Access to technology is starting to grab the interests of previously disengaged students. Classroom management and organization have improved.

Implementation

Initial Research and Evaluation

In their initial design of InACCESS, the Indiana DOE had definite criteria that were outlined in a comprehensive 80-page technology plan.

- **Affordability:** initial cost of \$400-\$600 including the desk; refresh cost of \$200-\$300
- **Sustainability:** minimal ongoing investment
- **Repeatability:** one-to-one model can be used in any typical high school
- **Openness:** to minimize software costs
- **Compatibility:** supports other Indiana programs such as online testing and end of course assessments
- **Commonality:** solution is a common denominator with elements readily accessible to participating schools
- **Scalability:** eventually will be able to serve 300,000 users

The Learning Curve

Initially Huffman and his team considered an "every student gets a laptop" model but rejected this approach because of the initial expense, high replacement cost, and security issues. It made more sense to select individual classrooms and curriculum areas that had a propensity for technology use, fully install these, and provide professional development for associated teachers. High school language arts curriculum was believed to be a natural fit because so many aspects of associated traditional instruction can be enhanced with the computer.

Indiana's first pilot program equipped three classrooms at three high schools with 30 computers per room. They found an adequate \$199 desktop with a \$99 monitor through a discount chain. A suite of open source applications was selected and loaded on the machines with identical images. According to Huffman and other proponents, the pilot proceeded without major problems, and InACCESS was encouraged to expand the program.

Huffman ran pilots for two years beginning in 2003. Initially, the keyboards that came with the machines were inadequate so officials decided to spend another \$5 per machine for better keyboards. There were difficulties making authentication systems work with Microsoft's Active Directory. Updating to the MIT version of Kerberos solved some of these problems. Recognizing that districts and individual schools were going to decide the system that was right for them, a variety of Linux distributions were tested to determine which were adequate.

Other One-to-One Models

It must be noted that there are other views of what one-to-one computing is, or should be. Some feel that it is essential to have continuous access to technology; students should have their own computer that travels with them wherever and whenever they want to work. This model is most often realized with student laptops that are kept 24/7 year round. For example, The Maine Learning Technology Initiative (2002-2004) provided all 7th and 8th grade students and teachers with laptops. Maine has just renewed a four year, \$41M contract with Apple to continue the program. Preliminary studies document a host of benefits from this approach while other critiques maintain this approach is unsustainable. Other models like, "laptops on wheels," allow any classroom to have access because the computers are brought to them for a particular activity. The Indiana program provides access to most every student but only for a single subject. For the most part, students only have access to their files during that period. To be fair, these one-to-one approaches must be compared based on the same investment scope. If you had \$100,000 to spend, would you buy 100-200 laptops for individual students, or fully equip 200-300 classroom workstations that all students would have regular, yet limited, access to? And what would be the effect of either choice on learning?

Communication Strategy

The primary mode by which school leaders initially learned about the program was by word of mouth. The state office publicized the program through its website and conducted training on-site, at regional training centers, through webinars, and through the InACCESS website. InACCESS also runs a well-used blog for tech directors to share hints and success stories. All in all there has been comparatively little need for skills training for the new software. Students and teachers get up to speed quickly because the Gnome or KDE desktop is quite similar to Windows and StarOffice's features, and the interface is parallel to MSOffice. Most of the professional development for teachers focuses on how to use technology for teaching and learning and on specific training for Moodle, which has been widely implemented for instructional management.

Rollout Process

The 2006-2007 program provides up to \$190,990 per partner to equip five classrooms with 30 stations including monitors and desks. Approximately 25% of the budget is allocated for professional development. In order to enter the program, schools apply for an InACCESS grant, and awards are prioritized according to need. Applicants must show how their program will improve student learning in English/language arts, how it will be measured, how it will increase parental involvement and communication, how it will promote innovative curriculum practices, and how it integrates with their school improvement plan. Under the grant guidelines schools must install a full classroom set of 30 computers, spend no more than \$250 for each desktop system, and spend only \$5 per seat for the OS software. They may not combine the grant money with their own funds in order to buy more expensive machines.

InACCESS grant recipients may purchase approved computer systems through several pre-arranged vendors if they prefer. Hewlett-Packard and Dell will provision low cost workstations with Linux preinstalled. Other local vendors such as Wintergreen Systems provide a desktop system for not more than \$250.

The Indiana program emphasizes site-based decision-making. Districts are free to choose the kind of Linux and the particular suite of applications to install with it. Currently districts are selecting among Novell SUSE, Linspire, RedHat Linus and Ubuntu. The state provides images (an image is copy of a completely formatted hard drive that is used to make an exact clone of an installation) of these distributions for schools, although technology leaders often go directly to the official source sites. The state has negotiated favorable licenses for many of the core applications and operating systems.

Some of the applications that are frequently installed include:

- Gnome or KDE desktop: Linux workstations are installed with Windows-like GUI desktops. This means that students and teachers adapt quickly to the Linux world.
- StarOffice 8.3: an enhanced version of the OpenOffice program available through a statewide license from Sun Microsystems. The basic functionality is the same as OpenOffice but StarOffice provides more templates in its distribution.
- GIMP (Gnu Image Manipulation Program): for tasks such as photo retouching, image composition, and image authoring
- Moodle: course management system that can be installed on a local school server. Teachers use Moodle to support courses, provide quizzes, and share course content and lesson plans. Indiana has a statewide Moodle server for teacher use.
- IHMC CMAP: open source content mapping software for teacher or student use.
- Crossover Linux: a proprietary application from CodeWeavers, Inc. that allows Linux users to run Windows applications.

Some InACCESS schools have added as many as 300 new machines, yet none have reported having to add additional technical support staff. This is remarkable because student machines are heavily used, and “uptime” is especially critical in the one-to-one setting. Microsoft-based sites are having a harder time working with the Linux machines than Novell districts. Some schools are using Zenworks from Novell or Ghost for Linux to make reloading student machines with a fresh installation as easy as a click of a button. In order to control tech support requirements most districts are installing all machines with uniform images. Many use remote installs and automation to wipe the machines clean and reinstall every year. Other schools are experimenting with Linux Terminal Server and Ardence (see more on Ardence below)

Stories from the Field

Michigan City (Indiana) Area Schools

Kevin McGuire at Michigan City Area Schools has had two years of experience with the InACCESS computer grant program. The district now has 300 computers in 10 one-to-one English classrooms. McGuire's team began its quest with the need to consolidate teacher and student office applications. Originally teachers were using MSOffice and students were using MSWorks; often the files were incompatible. The district installed StarOffice on school PCs, which started its consideration of other open source applications. RedHat Linux was evaluated, but it had trouble locking down the OS satisfactorily. Given that the district runs a Novell network, it made most sense to choose Novell Linux Desktop (NLD). The basic installation includes StarOffice and Crossover software to enable legacy Windows applications. Initially, images were prepared using Norton Ghost for Linux imaging software but the district now uses Zenworks. A clean desktop install is performed every year.

Additional technical support staff has not been required; the existing five-member team supports all 3,500 machines. McGuire attributes this to the procedures and systems that were already in place. Furthermore, open source computers tend to have very few technical issues. During the first rollout of the new NLD OS, there was problem with accessing student user directories, due to a client issue. The district had to wait three months for a solution from the vendor; during that time the machines were used only for web browsing. Currently there is a problem with Firefox running Safari montage and QuickTime in a proprietary assessment package. The district estimates a useful life of five or six years for the systems, which cost \$560, including a 17" LCD monitor.

According to McGuire, teachers are getting up to speed with comparatively little training. Surprisingly, the more experienced teachers (some of whom have taught there for 30 years) seem to do better than new teachers. This is counter intuitive because many experts assume that newer teachers are the first to adopt and actively integrate new technology into the classroom. McGuire thinks this is because experienced teachers have better classroom management skills and can

keep thirty one-to-one students focused and on task. He has found that even teachers who are reluctant technology users soon become enthusiastic about InACCESS.

Moodle is extremely popular and many teachers are using at least its basic functions as a course organization tool. In some classes the first thing students do is log into Moodle where they keep a daily journal and access the assignment for the day. This helps students immediately get on task.

McGuire says, “Don’t be afraid. Problems can be solved.”

Connersville High School

Carla Beard at Connersville High School is a classroom English teacher, English department chair, and one of the appointed “go-to” people for technology. When the school heard about the state grant program, they jumped at the opportunity and have now completed two rounds. The school has open source computers in all 10 English classrooms, for a total of 300. Beard had no experience with Linux until fall 2005 and now feels completely comfortable. The computers are imaged with Norton Ghost and are installed with SuSE Linux, StarOffice, CMAP, and NVUE. The grant also paid for a subscription to the Criterion writing tool from ETS.

The school has had very few technical problems with its implementation. The technical support team had originally planned a terminal server strategy but hit a technical dead end. They then installed hard drives in the desktop computers and now install the software by CD. The first image for the machines failed to have the sound cards enabled and users could not right click on flash drives. After fixing a simple setting, all the machines were re-imaged. Other than these problems, most of the technical problems have been hardware related: broken keyboards, pencils poked through LCD monitors, and similar issues certainly not unique to an open source implementation. No new support staff were added. There are three “go-to” teacher/tech people who fix small problems and diagnose issues before forwarding them to the building technology person. Beard reports, “There is nothing that we want to do that we can’t do with our open source computers.”

Every new teacher is paid to attend a summer training session. Teachers begin by using StarOffice for word processing and Moodle on the school server to prepare worksheets and administer quizzes. Beard describes this as the “shallow end of the pool”— a familiar place to start. She hopes they will go beyond this level to engage in instruction that only technology enables. “Teacher fear” is one barrier that she works to overcome. “Students are more willing to be imperfect” she says. When teachers put the software in front of students they all learn it quickly and help each other.

In her own classrooms, Beard estimates that students spend at least 50% of their class time working on computers. They do their research on the web and use online dictionaries. She assigns webquests in which students prepare a series of wikis as they complete three book reports over the year. The first wiki focuses on plot summary, the second focuses on setting, and the third focuses on character development. By the end of the year the classroom wikis constitute a fairly extensive resource for students. Beard has been using free external wiki hosting (www.wikispaces.com) because students had not at that time become proficient in using the Moodle wiki feature. (See her class wiki at amlitwiki.wikispaces.com.)

Beard sees more student enthusiasm and more writing since moving to one-to-one. Sometimes student multi-tasking is a problem as students' minds are out on the web instead of in the classroom. She likes to be flexible prescribing computer use; some students use the computer for research but prefer to do their writing long hand.

Connersville hopes to expand the program to social studies, geography, and economics classes.

Rush County Schools

Melissa Taft is district technology coordinator for Rush County Schools. At the end of June 2006 InACCESS approved their grant to equip five language arts classrooms at Rushville Consolidated High School. The school already had hardware bids, which were quite constrained because of the grant price guidelines and conditions. By Labor Day all the machines were installed and operational.

Rushville opted to go with the Ardence system in lieu of hard drives, which avoided overloading the technical support team with 150 new machines. Being a Novell district they installed the Novell Linux Desktop on a single computer with a hard drive and then sent this image up to the Ardence server. The server then distributed the image to all the desktops as they booted from the network. The Ardence system allows for customized desktops for various user groups. At the time of this writing, all the Rushville one-to-one machines are used in the same courses so they had identical images. There are a few ongoing issues with Ardence working with NLD.

The InACCESS grant gave extra points to applicant districts that established a partnership with an experienced entity that had already been through the process, could mentor them, and therefore increase the chances of success. Rushville partnered with a neighboring district that had experience with one-to-one Linux and used Ardence. The partner helped Taft choose applications and configure the systems. Taft emphasized that it would have been a much more difficult process without the help and guidance of their partner.

Taft attended a one-day Moodle training, after which she trained the grant teachers for several days during the summer. The training focused on Moodle because most teachers were already familiar with MSOffice and could easily switch to OpenOffice. After school began, each teacher set up a class web page, and teachers now use Moodle to administer quizzes, provide assignments, and support forums, chats, and journaling.

Alexandria Community Schools Corporation

Alexandria Schools had tried a pilot one-to-one laptop program but soon realized that they could not afford this approach for all students. District cutbacks were limiting classroom space for dedicated computer labs. District technology coordinator Dan Ice was looking for a way to expand the one-to-one program when he received his first grant from InACCESS in 2004. He equipped four classrooms (two language arts and two science) with 30 computers each on a VLAN. SUSE 9 was installed with StarOffice and Crossover. Ice's team initially used Clonezilla for imaging the machines, which proved to be inconvenient because it required repeated re-imaging. For example, when the science teacher found a Linux science program, Ice had to reinstall 60 computers. Crossover worked well for some of their legacy licenses for Inspiration and Criterion writing programs. Unfortunately, it did not work for the NWEA testing program, and Ice was forced to provide the computers with both Linux and Win 98 boot options.

By the second year, Alexandria Schools was so pleased with the results that it installed three additional one-to-one classrooms using its own funds (about \$25,000 per classroom). This time Ice opted for no hard drives and a thin client from Linux Terminal Server Project (LTSP). He

was concerned about extra heat from all the new computers and thought that removing the hard drives was one way to manage that issue. That solution is expected to greatly reduce the complexity of technical support. The Alexandria school board supports Ice's one-to-one plans as long as no overtime or new technical staffing is required. The initial trials with four dual Pentium LTSP servers were not promising. The servers were either simply underpowered or had IO problems. Later it was discovered that the problem might have been in the particular release of Mozilla Firefox that had been downloaded. Ice plans to install the Ardence terminal program in the original one-to-one classrooms.

The advent of one-to-one computing in Alexandria has created some new opportunities. The money saved has been used to try other technologies such as a classroom performance feedback system. The teachers use Discourse from ETS software to monitor written feedback from 30 students. Redirecting of student responses from a sometimes chaotic oral form to writing on the computer gives teachers more immediate and complete feedback about individual student learning. Students use MyAccess from Vantage Learning for online writing practice and assessment. Classroom behavior management has improved; in fact, one principal reports an 80% drop in disciplinary write-ups since the one-to-one classrooms were implemented. Teachers have been trained during summer academies. Students were trained by roving technical coaches who teach new software, such as the StarOffice presentation program. Ironically, Ice notes that 6th, 7th and 8th graders are more open to learning new software. They take it as a kind of challenge. The 9th and 10th graders are tired of novelty.

Ice plans to continue expanding the program until all language arts and science classes are fully equipped. He has 90 1.6 MHz AMD computers that he would normally retire, but he plans to use them to set up three or four more classrooms to run on the LTSP clients. He envisions a time when all students will have one-to-one access in most subjects. Ice doesn't have to convince teachers now. He notes, "Once one teacher gets it, they all want it."

Monroe County Schools Corporation

Monroe County is one of the few all-Microsoft network districts to participate in the InACCESS program. District technology leader Karen Portle has received two rounds of InACCESS grants to equip nine classrooms in language arts.

Portle has encountered several problems mixing Microsoft with Linux. She has had difficulty authenticating students who have logged in on the Linux workstations to access the Microsoft network. In order to access student "lockers" on the Windows network, students must navigate to the Windows server and login again. The Surf Control software used by the Windows network to control individual web access does not recognize the Linux login.

On the support side Monroe County uses approximately half of one aide's time at the high school to configure the Linux machines and work through the integration issues. Cost is also a debatable issue. Initially Portle adopted Novell SUSE, which cost \$10 per station per year, because they were not already a Novell shop. For a Windows XP license she pays \$50 per station and expects this to last at least five years. She has only one technical person who is familiar with Linux systems, and he is fully occupied with his current network duties. Portle speculates that if she had used the same low cost equipment but paid the higher initial XP fee she would have been able to use all the standard Windows networking features with no further technical support issues. She has since shifted from SUSE to Edubuntu Linux, which has no fees. Portle hopes to use their Windows-based Altiris software to do re-imaging of their Linux machines, thus simplifying the yearly support routine.

Despite the technical issues the Linux machines are well used, and teachers report that students are indeed writing more. Portle believes that they are moving along the learning curve, although she thinks they have had a harder time than other InACCESS districts using Novell.

Next Steps

Expansion

In 2007, Indiana DoE's Huffman expects to increase from 24 to 80 high schools participating in the InACCESS program. Various InACCESS schools are trying different kinds of Linux

distributions including Novell SUSE, Linspire, Red Hat and Ubuntu. Linspire has recently announced Freespire, a free distribution of its popular Linux with desktop GUI. Indiana DoE is implementing a Utah Test Item Pool Server (UTIPS), building a test item bank, and adding to the Moodle server for teacher exchange of courseware and resources.

The InACCESS program continues to experiment with Ardence Software as a variation on the terminal server approach. Student desktops and essential software are loaded from a server, but the processing of applications is done locally.

To this date no additional support staff have been required, although existing staff have had to assume additional responsibilities. As the number of one-to-one classrooms increases we must assume that eventually new staffing will be required, which must be added to the total cost of ownership (TCO). The state is attempting to determine how many computers can be added before requiring additional support staff.

Total Cost of Ownership

Determining the total cost of ownership (TCO) for any technology program is not simple, nor is it a common practice among school decision makers. The InACCESS program focused on keeping equipment and software licensing costs to a minimum by using open source operating systems. An in-depth analysis of Total Cost of Ownership has not been attempted. Such analysis would try to answer some other questions: How much technical staff time has been reallocated to deal with the new workstations? How much support and troubleshooting was provided by vendors as part of the rollout? How much peer support by other teachers, students, and aides is needed to make the program work? How much teacher time is spent with technology support issues? How is the support response time changed as a result of additional work load? How much down time is there as a result of support levels, and what effect does this have on effectiveness? In addition to TCO questions we should be asking questions about Value of Investment (VOI). These questions would deal with qualitative benefits such as improvements in learning and improved instructional management and accountability. One has to look at both the cost and value terms to accurately compare the Indiana one-to-one model with other one-to-one models and other technology initiatives in general. For more info on TCO see the CoSN initiative website

<http://www.classroomtco.org/>. Also see the CoSN VOI Initiative <http://www.edtechvoi.org/>

Benefits to K12

These are some of the benefits that one-to-one classrooms in the InACCESS program are reporting:

- Administration: Remote installation and desktop access make it physically easier to update and maintain hundreds of student machines. Terminal Server and Arden server approaches eliminate individual hard drives and further ease management of a large number of machines.
- Low training requirements: Similarity between the proprietary and open source OS/applications makes training comparatively easy.
- Instruction: When students have immediate access to computers they are more engaged and put their web skills to work. Teachers are able to move fluidly between different learning modalities.
- Classroom management: Instructional management tools like Moodle give teachers a time-saving structure for organizing course information, communicating assignments, informing parents, administering quizzes, and promoting student collaboration.
- Price: The purchase price per machine has dropped from \$1,000 to \$290.
- Compatibility: OpenOffice is compatible with MSOffice, so students have no trouble switching between open and proprietary applications. MS Windows emulators like Crossover allow a Linux desktop to run MS Windows API.

Summary and Lessons Learned

Indiana's InACCESS grant program has done a lot of things right, reflecting what we have learned in the last 20 years of one-to-one initiatives. The five-year plan for the program has kept focus on the principles of affordability, sustainability, repeatability, openness, compatibility, commonality, and scalability. The program had a simple goal of placing as many computers in front of students as possible. It provided guidelines but then allowed local decision making on distributions. By focusing on a single subject area, the program focused its impact and allowed a cohort of teachers to move together in molding their vision of a one-to-one environment.

Language Arts was a good first choice for a program focus because there is a long tradition of rich technical tools for this domain. The state allowed funds to be used for a few key content applications, such as Criterion, that increase the pedagogical value of these one-to-one implementations.

There is still work to be done in improving integration with the Windows environment. It would be useful to calculate a true Total Cost of Ownership, quantify the Value of Ownership for this program, and then compare this program with other kinds of one-to-one programs. Many of the benefits of the InACCESS program lay in the promise of one-to-one computing to improve the learning environment rather than the unique qualities of open technologies. However it unlikely Indiana's InACCESS program could have achieved one-to-one on this scale without the ease of implementation and cost savings afforded by desktop Linux and open applications.

Links

Ardence <http://www.ardence.com/enterprise/products.aspx?id=56>

Ghost for Linux <http://sourceforge.net/projects/g4l>

InACCESS <http://www.doe.state.in.us/INaccess>

UTIPS <http://www.utips.org>

Criterion and Discourse <http://www.ets.org>

Wikispaces <http://www.wikispaces.com>

Clonezilla <http://clonezilla.sourceforge.net>

Freespire http://wiki.freespire.org/index.php/Main_Page

MyAccess <http://www.vantagelearning.com>

Maine One-to-one Story <http://www.usm.maine.edu/cepare/mlti.htm>

CoSN Value of Investment Initiative <http://www.edtechvoi.org>

CoSN Total Cost of Ownership <http://www.classroomtco.org>