



Learning from Laptops

With ubiquitous computing trials starting up every year, what have we learned about how laptops affect what—and how—students learn?

Whether it's called a laptop program, one-to-one computing, ubiquitous computing, or 24/7 access, schools and school districts around the country are exploring the benefits and challenges of what happens when every student has a laptop computer. As with every effort to change schools, there are variations in how laptop programs are designed, funded, and implemented, but the basic structure of a laptop program is that each student in a classroom, a grade level, or an entire school has a computer to use at school, and often, to take home, too.

Our research group has been studying ubiquitous computing programs for the past 10 years. In that time, we have learned a great deal about what happens to teachers, to students, and to parents and community members when the power of one-to-one computing is made available. Our findings, and those of other researchers in this area, are reliable, and the conclusions are clear. We consistently find substantive impacts on teaching and learning, on teachers and students, yet we continue to have difficulty tying full-time access to computers to the outcomes of standardized tests currently in use. Our belief is that, while computers are powerful interventions for both students and teachers, what they do with them is not what is tested.

Providing computer access for every child has been tried in various forms for about 15 years. Indiana's Buddy Project and Apple Computer's ACOT program are two pioneer efforts in which every student was provided with a computer at home. The impetus for today's laptop programs started seven years ago when Toshiba and Microsoft introduced the Anytime, Anywhere Learning program, begun a few years earlier in Australia. The initiative grew quickly, capturing the imagination of both independent and public schools. For some, it was an expansion of the school's existing technology program; for others, it was a dramatic way of introducing technology to the school, leaping into an area that earlier had been minimally supported. With the falling prices of laptops, more and more schools and school districts are considering initiating ubiquitous laptop programs.

Large-scale, dramatic efforts, such as those in Maine or in Henrico County, Va., have placed laptops in the hands of tens of thousands of students. Other smaller laptop projects may engage only a single classroom or all the classrooms in a single grade. Many of these initiatives will expand their program from year to year, adding a grade level each year. For example, a school may start a laptop program with the lowest grade in a building—the seventh grade in a secondary school or the ninth grade in a high school—and each year's entering class will be

outfitted with a laptop. Growing the program from year to year provides time for teacher training and the development and evolution of support and maintenance services.

Another recent strategy has been to acquire classroom sets of laptops, stored on a recharging cart, so that any classroom in a school can have an experience with ubiquitous computing. Most times these class sets serve as a portable lab, rather than offering continuing access at home and in school. As schools monitor the program over time, many see the benefit of permitting students to take the computers home at the end of each school day and keeping the computers with a group of students for several weeks at a time, so they can benefit from full-time access.

My best guesstimate is that one in five school districts is currently trying a laptop program in one or more of its schools. The computer vendors like it, as do many of the community advocates who see that technology has an important role to play in teaching and learning, as well as helping to reduce the digital divide. It's one of the most compelling school-change interventions we have seen in decades, but it isn't about laptops—it's about what students do when they have full-time access to powerful tools, the same tools found in offices and on the desks of professionals in all fields. These tools are the same ones needed to accomplish the work of school: tools for writing, conducting research, simulating problems, manipulating formulae, making presentations, and organizing information.

What Have We Proved?

There are numerous reasons that schools and school districts elect to initiate a laptop program; frequently, several rationales are combined to win the endorsement of school boards and parents. Whether the program is shown to be successful in the end depends in large part on which rationale was the driving force behind it. While research from the most recent laptop trials is too preliminary to draw definitive conclusions, there is enough consistency in their findings to help guide the expectations of other laptop programs.

Given the substantial investment required to initiate a laptop program, many districts that adopt one expect that full-time access to technology will improve student

academic performance, that standardized test scores will rise. As policymakers and community members increasingly focus on rigorous assessment and adequate yearly progress to drive instructional decisions, support for ubiquitous laptops may be tied to these scores.

The answer to whether giving every student a laptop will enhance student achievement on tests is—and always has been—a strong “it depends.” Those administrators and board members who insist on a specific test score gain as the return on investment are, more likely than not, going to be disappointed. Authentic assessments may be a more realistic strategy for measuring the value that laptops bring to the classroom, but the cost and difficulty of this approach to testing militates against its use.

Ubiquitous laptops may not be the direct tools for teaching and learning what is on the tests, but they are associated with learning strategies that show up on tests. Computers don't provide content, they offer the tools to access, manipulate, and organize content. This supports one of the other arguments for funding laptop initiatives: that students will be developing 21st-century skills as they apply technology to problem-solving, communications, self-management, and thinking. How students use technology—for writing, online research, organizing information—appears more closely tied to these 21st-century skills than to standardized tests.

Unfortunately, in most districts and states, students who have mastered composing and editing on the computer are required to take the writing portion of their high-stakes tests by hand rather than with their electronic tool. As students learn to take advantage of computers for writing, their writing strategies change—revisions in real time become easier and accepted as a normal part of the process. When writing by hand, revisions are laborious. Consequently, less revising is done and the writing quality on their assessments suffers. Enabling students to use the same technology tools on their standardized assessments that they use for their everyday work will more closely match the assessments with the 21st-century skills students are learning.

For some school systems, laptops that stay with the child in school and at home are a means of closing the digital divide—now all students can have access to a computer and



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the Internet. Lack of a computer at home is associated with less parental education and lower family income, with single parent homes, and with Hispanic and African American families. Even when children in these families have access to home computers, the technology is often older and has less functionality and power than children's home computers in wealthier, better educated, and white households. Because parents can learn along with their children in laptop programs, these efforts may also promote economic growth, helping parents master technology and obtain better jobs while helping communities move from the rust belt to the information economy.

Still another reason some districts desire to initiate a laptop program is to shake up the system, putting into place a large intervention that will motivate students and cause teachers to think differently about teaching and learning. But for all of these changes to result in improved

teaching and learning, teachers, students, administrators, and even parents and community members must adjust to their changing roles in the learning process.

Teachers and their Teaching

The introduction of laptops for all students is a considerable change in the average classroom, especially for the teacher. While there may be three or four computers in the back of the room, an open laptop on each desk is a dramatic shift from what a teacher normally sees. And for most, the first time is a little frightening. Just what do you say and do when every one of your students has a computer in front of him or her? Will they use it inappropriately? How do you change your lessons to take advantage of the opportunities that computers and Internet access offer?

Very quickly, an observer in a laptop classroom would see that there is less lecturing and more individual and group project work. Teachers discover that they don't have to provide all the information, that students can gather much of what is needed from the Internet. When teachers acknowledge that their students have the tools to do a lot of the work of school (of both teaching and learning), they adopt a strategy that lets students work on their own more, or work in small groups to undertake projects in line with curriculum standards. Students can do more work on their own and at their own pace, and the teachers can act more as consultants to them, offering individualized suggestions, mid-course corrections, and more frequent assessments of individual and group progress. Teachers are making use, or making greater use, of authentic assessments to evaluate the content and design of technology-rich products developed by their students.

Teachers also begin to see a shift in their role as instructional leader and master of all knowledge. First,

they certainly learn more about technology from their students (who are much more willing to put in the seat time to master a piece of software). Many students thrive in an environment where they have skills and knowledge to share and to trade. Trading with a teacher provides them with a sense of pride and empowerment. The shift to students-as-teachers goes beyond trading information. As students make presentations about their projects, both the other students and the teacher are the audience for information and ideas that may be new to the entire group, since the range of information sources is dramatically widened through the Internet. Teachers also need to be wary consumers, since students no longer copy from the encyclopedia, they cut and paste from a variety of Web sites.

Laptop programs also influence teachers by increasing their collaboration with other teachers in their building. Some of this collaboration is sharing information about the technology and finding solutions to technical problems; a great deal more is sharing ideas about how to manage a room full of young people equipped with computers. This classroom management problem is exacerbated by the recent adoption of wireless technology, providing high-speed access to the Internet all the time. Teachers need to quickly learn how to maintain the attention of students who have open laptops, how to deal with dead batteries and damaged screens, and how to help students learn about what is appropriate to do in school, rather than in the privacy of their home. Students looking at the Web sites of singers, movie and TV stars, sports teams, and clothing manufacturers are more likely to be the problem than students accessing sites on pornography and weapons. Games might be even a bigger problem.

Teachers in laptop schools evolve and share classroom management strategies that work for them. As in most classrooms where projects are common, there will always be some noise and movement as students collaborate. However, when students are seated in spreadsheet fashion (rows and columns), teachers worry when they can't see what is on computer screens. Some teachers take to wandering around the classroom, which keeps students on task (and in line), and yields a secondary benefit in being more available to work with a student having trouble with an assignment as they pass the student's desk. If students are working on individual tasks, those who finish early might have a list of Web-based problems to tackle or be assigned a personal journal to write on the subject being studied. Other teachers turn to online educational games to provide practice in skills. And teachers can always ask that the computers be closed (and some reading materials brought out).

Students and their Learning

For students, the changes are also substantial. While most have a computer at home (more than 70 percent do), having access all day in school is both a novelty and a challenge. How do students accomplish their work when they have a computer all the time? Is it just for school

or, since they carry it home, is it for all the things students want to do with a computer? School administrators and family members worry— will they lose it, will it get stolen?

In a laptop classroom, there is much more independent learning since students now have access to powerful tools for accomplishing it. As independent learners, they also have to take on more responsibility for their learning. Students working independently have to monitor their own progress, identify the tools and resources they need to use, and know when to seek help. Not all students do equally well in this context, but many will surprise their teachers with their improved performance. Because there is much more project-based teaching, students are also more likely to collaborate, working with one another to accomplish a common goal. With project-based teaching comes presentations, so students are mastering presentation software and are getting regular practice in standing before their peers and teachers to inform and enlighten them.

Developing the ability to learn independently, collaborate with peers to accomplish work, and communicate the conclusions of your work are the core of 21st-century skills, and a highly valued set of competencies in the world outside of school. These accomplishments are seen in many laptop programs, especially those that permit students to take their computer home in the evening. Full-time access seems to encourage responsible ownership of the tools to do the work that students have, and students are likely to differentiate between using the computer for schoolwork and using it for non-school activities. Our research has shown that students will use their home computers for games and instant messaging, while saving their school computers for only the schoolwork.

One core academic area that is clearly influenced by access to ubiquitous computing is writing. Students are asked to write in almost all their classes and computers afford easier editing and rewriting, motivating students to edit more and write more. One of our studies showed that students in laptop classrooms wrote more than those in non-laptop classrooms and that their writing was qualitatively better. Blind assessment of prompted writing, using a rubric covering content, organization, language/voice/style, and mechanics, found that laptop students outscored their non-laptop

counterparts significantly on all four dimensions.

Laptop students also seem to be better learners. Among the things they tend to do more (in comparison to students who don't have laptop access) are taking notes while they read, underlining or highlighting a main idea, writing together with other students, re-reading papers before turning them in, and using in-

formation from a variety of sources. These activities appear to be associated with better learning and, one would hope, would show up on tests of academic performance eventually.

Individual students also benefit by serving as formal and informal tutors of both peers and teachers. In many cases, students in laptop programs also serve as teachers of their parents and siblings at home. Full-time computer access

provides them the opportunity to become experts in a range of software applications and this mastery, when shared with others, enhances self-esteem and the sense of personal accomplishment. For disadvantaged students, this benefit is a powerful incentive to be part of a continuing program, to participate in school, and to maintain good grades.

Changes for Parents and Community

There is often an enrollment surge in schools that announce a laptop initiative, suggesting that parents see the value of their children having access to technology. Laptop schools regularly report greater parental involvement (at least for the first few years). They see higher attendance at PTA meetings; increased communication via e-mail, phone, or face-to-face meetings; parent participation in tutoring programs and parent-student computer classes offered through the school; and more volunteering at the schools.

In some of the programs we've examined, parents and community members became increasingly involved in the teaching and learning process. They influenced the curriculum by taking an active role in daily classroom activities as well as acting as resources for project-based learning activities. Parents and community members also developed their digital-literacy skills. Parents, extended family, and community members (especially seniors) benefited from the opportunity to interact with laptop computers and the Internet at home as well as participated in school-sponsored workshops on specific software programs.



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At the End of the Day...

After his school's laptop program had been in place for a year or two, one headmaster was asked to explain the substantial increase in student test scores. The curriculum hadn't changed, the teachers were the same, and the only difference was the introduction of laptops for all students. "The computers did make a difference," he told me. "We promoted ourselves as a laptop school and enrolled a better group of students."

Obviously, this kind of improvement is not the change we seek when introducing laptops to a school. But laptop programs *are* an invitation to change—change what teachers do and how they do it; change what students do and how they do it. The effects of laptop programs appear to be the greatest on those 21st-century skills that make a difference over time and are the necessary preparation for productive work in school and beyond.

Surprisingly, the current press for improved test scores hasn't lessened the enthusiasm for ubiquitous computing. Whether it is seen as cutting edge or just necessary in today's world, ubiquitous computing has an appeal that will sustain its presence in many schools. <

District Technology Leadership

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- Teachers can customize instruction;
- Students are having a variety of learning experiences;
- Students are better prepared for 21st-century skills.

It's also gratifying to know that our efforts are getting noticed in the wider community. "Sound use of educational technology has benefitted the entire community," says San Diego Fifth District Councilor Brian Maienschein. "As young people are trained to succeed, our local businesses benefit from increased performance and aptitude. I am so impressed and pleased that the Poway Unified School District has created and implemented such an outstanding technology program."

Poway's move toward new learning environments was not accomplished simply because PUSD is a rich district. State funding is well below \$5,000/student (below the state average) and the free and reduced lunch count is below 10 percent, restricting E-rate funding and federal and state grants. Our success is attributable not just to financial resources, but to the planning, leadership, staff teamwork, and partnerships—including businesses, parent organizations, county office of education, and city—that have shaped the environment that Poway students have available to them today.

Are students learning more? Are they learning better? Time and data will tell. <

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