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Laptop Computers in the K-12 Classroom. ERIC Digest.

Over the past decade, many schools have investigated the educational possibilities of mobile computing. More recently, an increasing number of K-12 schools are implementing the use of laptop computers. Improvements in portable computing technology and examples of successful pilot programs using laptops and other portables have inspired many K-12 schools to consider laptops for their students.

EMERGENCE OF LAPTOPS IN SCHOOLS

Organized laptop programs in higher education date as far back as 1988 when Drew University in Madison, New Jersey, began providing notebook computers (paid for from tuition) to all incoming freshman. Now more than 50 postsecondary institutions worldwide require at least some of their students to use laptops (Brown, 1999). Throughout the 1990s, a number of private schools in the United States and abroad began requiring ownership of laptops. In 1996, inspired by the successful use of laptops in Australian schools, the Microsoft Corporation and Toshiba began one of the most high-profile programs now underway, currently known as Microsoft's Anytime Anywhere Learning (AAL) Program (Healey, 1999). Technology corporations, such as NetSchools (http://www.studypro.com/), NoteSys Inc. (http://www.notesys.com/), Apple (http://www.apple.com/education/), and others are promoting the use of laptops in K-12 education, providing hardware packages for schools, and in some cases, software and technical support as well.

TRANSITIONS TO LAPTOPS

How are schools integrating laptops into their technology infrastructure? Microsoft commissioned an ongoing study of Anytime Anywhere Learning, published as the Rockman Report. In their study, Rockman (1998) identified five models of laptop use currently in place at the K-12 level:

* Concentrated-each student has his or her own laptop for use at home or in school

* Class set-a school-purchased classroom set is shared among teachers

* Dispersed-in any given classroom, there are students with and without laptops

* Desktop-each classroom is permanently assigned a few laptops for students to share

* Mixed-some combination of the above models.

Each model has potential advantages, either in terms of instructional benefits, ease of implementation, or savings. In the concentrated model, teachers are free to integrate technology fully into instruction as well as assignments, since all students have access to a computer for homework, study, and projects. In the class set and dispersed models, teachers are free to integrate laptops during the school day; however, there may still be students within the same class who lack access to a computer in the home, so integration options are more limited. In the desktop model, although the computers are

owned and maintained by the school, a student working on a computer-based project during the school day might be allowed to take the laptop home to complete their work. Also, teachers are better able to reconfigure their classroom setup to suit their technology integration needs. Laptops can also take the place of desktops in a traditional lab setting. For example, the Cuba-Rushford School District in Allegheny County, New York, created a 70-computer laptop lab. These computers are available for checkout to their middle and high school students. For many schools, the primary advantage of laptops over desktops is in creating opportunities for all students to have access to a computer both during and outside of the school day.

PORTABLE ALTERNATIVES

Traditional laptops are not the only portable computers appearing in elementary and secondary institutions. Some schools uncomfortable with the high cost of laptops have explored the advantages of lower-priced portables designed for K-12 students. The AlphaSmart and DreamWriter, for example, make it possible to provide each student with a rechargeable portable that can be used for word processing or keyboarding instruction at a fraction of the cost of a traditional laptop. Some mini-portables do more than word processing. Casio's Cassiopeia Computer Extender, for example, includes the graphing program Maple as well as Geometer's Sketchpad, a dynamic geometry program. This mini-portable can therefore be used in math and science instruction at the high school level. In addition to scaled-down portables, manufacturers are also designing full-scale laptops with younger students in mind. The StudyPro, for example, is a durable infrared wireless laptop with few moving parts marketed specifically for K-12 use. Also, Apple's AirPort wireless network hub is another wireless technology designed to meet the needs of laptop schools. With wireless networks, schools can allow multiple users to share a single network connection, as well as avoid some of the hassle and expense of physical cabling.

CLASSROOM EXPERIENCES

Educators who work with laptops have begun to explore their unique advantages. The 1999 Laptop Learning Challenge sponsored by Toshiba and the National Science Teacher's Association (http://www.nsta.org/programs/laptop/index.htm) recently recognized innovative uses of laptops in K-12 mathematics and science education. Some award-winning ideas showed students using laptops to facilitate group work, to analyze data immediately during a lab exercise, or to conduct scientific investigations in the field rather than in the classroom. Evaluators of the Copernicus Project, a multi-district laptop pilot program in Seattle, Washington, found laptops to be especially suited for writing activities, student projects, and presentations (Fouts & Stuen, 1997). Other uses for laptops include creating spreadsheets to solve math homework problems; creating book reports that inspire student creativity with presentation software such as PowerPoint or HyperStudio; or having students routinely hand in assignments via floppy disk or connect to the school network and save their work to a central file server for the teacher to review, add comments, and leave for the student to retrieve.

DOES RESEARCH SUPPORT THE USE OF LAPTOPS?

Several studies suggest educational benefits related to laptop use. Specific benefits noted include increased student motivation (Gardner 1994, Rockman, 1998), a shift toward more student-centered classroom environments (Stevenson, 1998; Rockman, 1998), and better school attendance than students not using laptops (Stevenson, 1998). In his study of a laptop pilot program in Beaufort, South Carolina, Stevenson (1998) also reported that students with laptops demonstrated a "sustained level of academic achievement" during their middle school years, as opposed to students not using laptops who tended to decline during this same period. He also noted that these academic benefits were most significant in at-risk student populations.
In their study of laptop use in middle school science classrooms, Fisher and Stolarchuk (1998) found that those laptop classrooms in which skills and the process of inquiry were emphasized had the most positive impact on student learning and attitudes. According to Rockman, a majority of teachers in laptop schools reported an increase in both cooperative learning and project-based instruction. Other research has not supported the educational benefits of laptop use.

Gardner (1993) found that the impact of laptops after one year was "at best marginal" on achievement in mathematics, science, and writing. Also, Fisher and Stolarchuk reported a more positive relationship between laptops and student attitudes than between laptops and academic achievement. Research into the educational use of laptops has only begun; relatively few K-12 schools have had laptops in place long enough to generate longitudinal studies of their impact on student achievement. It remains to be seen what additional research will reveal about the long-term impact of laptops on student achievement and outcomes.

EQUITY CONTROVERSY

With growing concern over equity in access to technology, laptop programs have become increasingly attractive. Whether through leasing programs, purchasing refurbished hardware, or obtaining technology grants, many schools hope to reduce their student-to-computer ratio by considering some form of laptop program. Critics point out the possibilities of theft, vandalism, and accidental damage. Newer "student-friendly" laptop models address some of these issues; not only are they more durable, but some have included theft-deterrent technology as well.
However, despite the creative educational possibilities of laptops and promise of equitable access for all students, added costs in the form of hardware, network costs, technical support considerations, and faculty training remain the greatest obstacles. The presence of laptops in a school does not necessarily imply student ownership; however, some schools are advocating or requiring student purchase or rental. Partnerships between schools, nonprofit organizations, and corporations can defray costs, but

ultimately parents share the expense with schools that hope to put a laptop in the hands of every child (Wishengrad, 1999). For this reason, there is concern among some that laptop programs may worsen technology inequities among students for families who are unable to assume these costs (Jameson, 1999). The controversy over laptops is not limited to issues of equity and cost, however; the Texas Board of Education recently made headlines by suggesting the state replace all textbooks with CD-ROMS and fund a laptop leasing program for all 3.9 million students with the estimated $1.8 billion in savings over six years (Mendels, 1998). Despite these issues, many educators hoping to bring the benefits of educational technology to more students continue to look for creative ways to overcome these obstacles.

SUMMARY

The future of mobile computing in K-12 education is still uncertain. Laptops may never become as common in classrooms as hand-held calculators. Solutions for issues of cost, technical support needs, security, and equitable access are challenging for many schools. Many schools with laptops, however, remain positive and enthusiastic about the changes observed and benefits their students derive from access to portable computers. Although many laptop programs are young and studies are still in progress, research has shown educational benefits from the use of laptops, particularly with respect to increasing student motivation and creating more student-centered classrooms. Continuing improvements in student portable computing technology as well as models of successful programs may make laptops an increasingly attractive option for K-12 educators and technology planners.

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