Research Findings on the Effects of One-to-One Student Computing

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The previous paper established why technology is important for the future of our students. This paper focuses on the academic research on the effects of one-to-one student computing.

Between 2000 and 2008, a number of large-scale initiatives such as the Maine Learning Technology Initiative (MLTI), the Freedom to Learn Initiative, and the Microsoft Anytime Anywhere Learning Program were funded, and a number of studies were released on the effects of one-to-one computing on student learning.

Following the publicity surrounding these initiatives, school districts across the country began to implement one-to-one programs on their own. Often, these were pilot programs at a single school or in a single grade level. Many of these school districts did not conduct academic research; to the extent they did, it was often qualitative and in the form of case studies. As a whole, the results of these qualitative studies have been mixed.

More recently, researchers have narrowed the focus of their research to why some one-to-one programs have been more successful than others. Accordingly, in this paper, we will examine the research on student achievement, student engagement, and cost savings as well as what researchers are discovering about what it takes to effectively implement these programs for success.

Student Achievement

Numerous studies have shown that technology leads to higher scores on standardized testing. For example, a number of research reports have been released on the MLTI, one of the largest technology initiatives in the country, which has shown increased student achievement since its inception in 2002. In this program, Maine provided laptops for seventh- and eighth-grade students. In 2009, the program was expanded to include high schools. These reports (Lemke & Martin, 2003; Muir, Knezek, & Christensen, 2004; Silvernail & Gritter, 2007) showed that students in the program scored higher in science, math, writing, reading, and social studies than students who did not participate in the program.

In another study (Bebell & Kay, 2010), five schools in Berkshire, Massachusetts participated in a one-to-one computing program in which all students were given a laptop. Student achievement scores on the statewide test scores rose over time when compared to comparison schools and statewide test scores.

Similarly, Gulek and Demirtas (2005) conducted a comparison study involving 259 students at Harvest Park Middle School in Pleasanton, California. In 2001, the school implemented a Laptop Immersion Program, in which every student used a laptop computer for various daily activities. Gulek and Demirtas looked at students' overall cumulative grade point average (GPA), end-of-course grades, writing test scores, and standardized test scores pre- and post-immersion. Before the laptops were implemented, both groups scored the same on standardized tests in English language arts (ELA), math, and writing and had similar overall GPAs. However, after one year of the program, the laptop group showed higher achievement in the measured areas.

Writing

One of the most replicable findings on the impact of technology on student achievement is in writing. For instance, a meta-analysis (Goldberg, Russell, & Cook, 2003) of 26 research studies found that the quantity and quality of writing was higher in classrooms where every student had a computer. The study also found that adding technology improved collaboration in the writing process and simplified the revision process.

Likewise, students in the MLTI have shown significant improvement in their writing scores on statewide tests (Silvernail & Gritter, 2007). The study found that the more students used their laptops, the better they scored on standardized tests in writing.

Finally, Rockman ET AL (2000), a California-based research group, conducted a three-year evaluation of Microsoft's Anytime Anywhere Learning Program, which provides schools with laptop computers, software, and training. Rockman's study replicated other study findings in that students in laptop programs scored higher on writing assessments than their peers who did not have access to laptops in school.

Reading

Additional studies have shown that technology can have positive effects on student reading achievement. Studies led by Warschauer (2006, 2008) concluded that the addition of technology makes it possible for "literacy processes [to become] more public, collaborative, authentic, and iterative, with greater amounts of scaffolding and feedback provided" (2008, p. 64). Technology also makes it possible for students to access online materials at their own level, collect more real-time data, and create digital archives of student work.

In another study conducted by Suhr, Hernandez, Grimes, and Warschauer (2010), two fourth-grade classes in the same district were compared. One group had laptops, while the other did not. The researchers were looking for gains in ELA. After two years' participation in the program, students with laptops outperformed students without laptops on changes in the ELA total score and in the two subtests that correspond most closely to frequent laptop use: writing strategies and literary response and analysis.

One of the larger studies (Texas Center for Educational Research, 2008) in the field of educational technology compared 21 middle schools implementing laptops to a control group of 21 non-laptop middle schools. Students in the laptop schools had greater student achievement on standardized test scores in reading than the control group.

STEM

There is less documentation in the literature on how one-to-one computing affects science, technology, engineering, and math (STEM) instruction. What the research does reveal is that in schools where one-to-one computing is implemented, technology is used less often in math and science than in ELA. In a study by Grimes & Warschauer (2008), ELA teachers used technology for 70% of class time, but math teachers spent only 23% of class time on technology. This may be due to a range of factors, such as the availability of suitable digital content and the readiness of teachers to integrate technology in teaching.

Other studies have shown that technology literacy improves in one-to-one laptop initiatives (Lowther, Ross, & Morrison, 2001).

Students with Disabilities

Another area of the research shows that technology improves student achievement for students with disabilities. Project RED is a nationwide study that included 997 schools from 49 states. The study looked at implementation factors that are predictors of improved student achievement in one-to-one computing programs where every student has a laptop. The study also examined cost savings when technology is properly implemented in schools. Project RED found that technology-transformed intervention classes, such as classes for English language learners,

Title I, special education, and reading intervention programs "are the top-model predictor of improved high-stakes test scores, dropout rate reduction, course completion, and improved discipline" (Greaves, Hayes, Gielniak, & Peterson, 2012, p. 16). Technology is important to students with disabilities because it allows students to work at their own pace and receive individualized, personalized instruction.

A report (Harris & Smith, 2003) on the perceptions of special education teachers on laptop use by seventh-grade students with disabilities in the MLTI showed that teachers saw the laptop program as highly beneficial to students with disabilities. Teachers reported that the laptops increased students' motivation, participation, and ability to work independently. The program also helped students with self-organization and the quality and quantity of their writing.

Student Engagement

One of the most-cited results related to student achievement is that the addition of technology positively affects student engagement (Metiri Group, 2006), motivation, attendance, and behavior.

One example of the positive effects of technology is the one-to-one computing program at Piscataquis Community High School (PCHS) in Maine. In 2002, PCHS gave every student and teacher received a laptop computer to use at home and at school; the school was also outfitted with wireless Internet access. A study conducted by the Mitchell Institute (2004) reported gains in improved student motivation and interest in school: the school's daily attendance rate improved, and parents reported that their students were more motivated. In addition, both students and teachers reported that the laptop program improved the quality of student work.

Likewise, several studies on the MLTI also showed significant improvements in student engagement. For instance, one study showed a 7.7% increase in attendance (Lemke & Martin, 2003). Another showed increased engagement, reduced behavior referrals, and increased community support (Muir, Knezek, & Christensen, 2004). More specifically, during the first year of the Maine program, behavior letters sent home dropped by 54%, and attendance increased by almost 8% (Lemke & Martin, 2003). Project RED (Greaves et al., 2012) also found that schools that properly implemented one-to-one programs saw a drop in the number of disciplinary actions reported.

Cost Savings

When implemented correctly, technology programs can result in cost savings over time. School districts across the country with one-to-one computing programs have reported savings in costs associated with copying, textbooks, disciplinary actions, online professional development, electricity bills, facilities, and the processing of student data.

Cost savings arise in several ways. One way is through online formative assessments such as those administered through a learning management system (LMS), which decrease copying costs. Project RED (Greaves et al., 2012) estimates that high schools with one-to-one computing initiatives and a properly implemented LMS can reduce their copying budgets by 50%. Additionally, mobile computing devices make it possible to replace textbooks with digital resources, which is another source of significant cost savings.

One-to-one environments also experience greater savings in human resources. For example, Project RED (Greaves et al., 2012) found that teacher attendance in one-to-one schools is higher than non-one-to-one schools, which reduces the need to hire substitute teachers. In addition, online professional development allows teachers and administrators the flexibility of learning on their own time and schedules, saving districts money in terms of substitute teachers and consulting expenses.

Furthermore, when districts streamline their platforms to automatically manage enrollment and pass other types of data to and from their student information system, they can realize substantial cost savings. If these efficiencies are not realized, it is common for student data be collected and re-entered many times by district staff, resulting in duplicated efforts, errors, and wasted time.

Challenges of One-to-One Computing Models

While some studies show gains in student achievement, the overall picture of the impact of one-to-one computing on student achievement is mixed. One reason for this is that many past studies treated technology as an undifferentiated characteristic of schools and classrooms (Wenglinsky, 1998; Zhao, 2003). Most studies have focused on the impact of the quantity of technology use (i.e., how much or how frequently technology is used) (Lei J. , 2010). However, research suggests that the quality of technology use—specifically, how the technology is used—is more critical to student outcomes than the quantity (Burbules & Callister, 2000; Lei & Zhao, 2007; McFarlane, 1997).

One of the largest studies that supports this view is Project RED. In this project, Greaves and his fellow researchers (2012) studied 997 school districts from 52 states. In Project RED, schools were ranked by how much student achievement had improved since the start of their one-to-one initiative. Researchers then looked for common factors among the highest achievers. They found that how the programs were implemented affected how successful they were at improving student achievement. This research and similar studies have identified several themes that affect the success of one-to-one programs, including leadership and vision, funding, project evaluation, and, most importantly, teacher professional development.

Leadership and Vision

Project RED (Greaves et al., 2012) identified several leadership factors that are key to successfully implementing one-to-one computing programs. One critical factor was principal training. Project RED found that to successfully lead a one-to-one initiative, a principal must effectively perform the following tasks:

- Model technology use
- Enable teacher collaboration time
- Use change management strategies
- Enable regularly scheduled professional learning opportunities for teachers

Funding

One-to-one computing initiatives often fail because sustainable funding strategies were not part of the initial planning process. Initiatives are often viewed as a "pilot," so districts only consider and budget for initial start-up funds. However, to ensure long-term success, a funding strategy must be in place to continually renew and refresh equipment, maintain infrastructure, and employ the staff necessary to support the program and provide the ongoing professional development needed to meet set learning objectives.

Project Evaluation

Another reason why one-to-one computing initiatives often fail is that leaders do not identify the plan's educational goals or track progress against those goals over time. These steps are important for informing stakeholders about the importance of the program. Collecting data on student outcomes related to the program is also important for informing professional development models throughout the program.

Teacher Professional Development

To fully realize the benefits of one-to-one computing, new teaching approaches are required. Findings from research conducted in one-to-one computing environments suggest that one-to-one computing leads to changes in pedagogy, such as more student-centered approaches (Donovan, Hartley, & Strudler, 2007; Zucker & Hug, 2008), flexible and constructivist teaching styles (Mouza, 2008; Rockman, 2003; Zucker, 2004), and delivery of learning episodes that are more project oriented and inquiry based (Swan, van t'Hooft, Kratcoski, & Schenker, 2005).

Likewise, research from the University of Michigan (Cox & Graham, 2009) indicates that to successfully integrate technology into their teaching, teachers need technical knowledge, content knowledge, and pedagogical knowledge. Pedagogical knowledge includes certain belief systems about teaching and learning that allow teachers need to succeed at integrating technology into their instructional practices. Specifically, teachers need time to collaborate, peer coaching, and time to adopt new teaching strategies.

Time to Collaborate

A study conducted by Zhao and Frank (2003) found that formal professional development opportunities such as inservices and conferences were ineffective. Instead, providing common times for teachers to get together and experiment or "play" without the pressure of producing a product were found to be most effective. Therefore, professional development programs that provide time for teachers to collaborate and share are more likely to be successful because they provide the conditions or space for communities of practice to form. Thorpe (2002) describes communities of practice as "groups that interact to achieve a shared purpose or enterprise" (p. 131). The group must exist long enough to "generate patterns of interaction and significant learning among participants" (p. 132).

Over time, teachers in these communities who collaborate "change and learn" (Bjørke, 2004). This idea was supported by a study conducted by Windschitl and Sahl (2002) on how teachers learn technology best. They found that teachers learn best when they were given opportunities to co-construct knowledge of how to integrate technology into the curriculum together. Zhao and Frank's research (2003) also found that this was one of the fastest ways for a new technology to flourish in the school environment. They concluded that teachers will respond to positive peer pressure to try new technologies. In other words, they mediate one another's progress toward learning goals (Grossman, Smagorinsky, & Valencia, 1999). This suggests that teachers need ongoing time to collaborate and explore together to change their teaching practices.

Peer Coaching

School-based peer coaching plays an important role in improving teachers' abilities to adopt and implement new learning practices. Several researchers have noted that workshops do not provide sufficient time, activities, or content necessary to promote meaningful change (Garet, Porter, Desimone, Birman, & Yoon, 2001). Joyce and Showers (1994) published two studies indicating that fewer than 10% of teachers implement new ideas learned in traditional training settings like workshops. They insist that the problem with these traditional approaches is that teachers often have no ability to apply what they learn in these workshops and no way to receive feedback when they do attempt to apply what they have learned (Joyce & Showers, 1994). Other researchers have echoed these beliefs, arguing that teachers need time to see new strategies modeled during the school day and opportunities to use these skills in developing and implementing a learning activity (Rodriguez & Knuth, 2000).

However, in studies of several schools that adopted a peer-coaching model, researchers found that when teachers combined participation in typical workshops with peer coaching for sharing and observation, 88% of teachers used new strategies in their classrooms effectively (Joyce & Showers, 1994; Joyce B. M., 1996; Richardson, 1999). A significant number of other researchers in the field of professional development agree that peer coaching and study groups that provide opportunities for ongoing discussion and reflection change teaching practice (Darling-Hammond, 1995; Darling-Hammond, 1996; Garet et al., 2001; Hargreaves, 1992; Little, 1993; Loucks-Horsley, 1998; Stiles & Hewson, 1996). In a review of research on effective professional development, Garet and several co-authors (2001) identified a number of characteristics of coaching that make it effective. In addition to providing immediate feedback and a chance for collaboration, they argue that coaching is successful because it occurs during the teachers' regular workday.

Furthermore, the research indicates that peer coaching can play an effective role in helping teachers integrate technology into their classrooms in ways that encourage active learning by their students. Several studies show that peer coaching has been used successfully to help teachers use technology in ways that promote engaged learning (Miller, 1998; Norton & Gonzales, 1998; Ike, 1997; Tenbusch, 1998; Fisher, Dwyer, & Yocam, 1996).

Time to Adopt New Teaching Approaches

Research indicates that it takes approximately 32 hours of professional development over three years before teachers feel comfortable using a new technology application in their instructional practices (Cradler, Freeman, Cradler, & McNabb, 2002).

Conclusion

The emerging research on one-to-one computing programs has produced a wide range of results. Many initial studies have occurred during the first two years of these programs. Some of these studies have reflected gains in student achievement as well as significant long-term cost savings. However, this research is likely premature, because many of the paradigm changes needed to fully leverage the benefits of one-to-one computing may take longer than two years to realize.

More recent research in the field tells us that how a one-to-one program is implemented has much more to do with its success than the quantity or the type of devices purchased. The research shows that when properly implemented, one-to-one computing can have powerful effects on student learning. Implementation factors that are linked to successful programs include sound leadership and vision, sustainable funding strategies, ongoing program evaluation, and continuous professional development. District leaders should carefully consider how they design their program to include these factors in their implementation strategy.

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