

**Securing a Learning Return On Your Educational Technology Investment:
A Policymaker's Guide to Applying the
Lessons Learned from Research**



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Schools have purchased computers and other new technologies in hopes of raising student achievement and increasing motivation to learn. As more and more schools look to technology to support student learning, the question arises, "What do we need to do to maximize the return on our technology investment?" WestEd RTEC recently released a paper called *The Learning Return on Our Educational Technology Investment* that seeks to answer this question. The paper offers suggestions related to issues such as teacher training, access to technology, and long-term planning that policymakers should seriously consider as they seek to help shape the future of technology integration in our schools. A full copy of the paper is available at <http://www.wested.org/cs/wew/view/rs/619>.

The paper highlights 10 lessons learned from the research that answer the question, "Under what conditions does technology have the most benefits for students?" We have summarized those 10 lessons below and have included after each entry some suggestions to help apply those lessons when creating education policy. Our hope is that these suggestions will help to ensure the maximum learning return on your state's technology investment.

Lesson # 1: Technology must be matched with learning goals - In order to understand how best to derive benefits from technology, it is important to consider that computer-based technology includes a wide variety of applications and uses. How to get the most from the technology, then, depends in part on what you are trying to accomplish by using it. A distinction the authors found helpful comes from the work of Thomas Reeves (1998) who describes learning "from" computers as different from learning "with" computers. In terms of this framework, learning "from" computers occurs when the technology functions essentially as a tutor, as in courseware that offers mathematics or science drill and practice, or provides phonics lessons. By contrast, students learn "with" computer-based technology when they use the technology as a tool for problem-solving, conceptual development, and critical thinking, as in Internet-based research, creating multimedia as part of a project-based curriculum, etc..

- Keep current on the research about technology integration and develop policies that reflect the research and promote research-based teaching and administrative practices.
- Develop or provide model lessons that demonstrate effective use of technology to support content standards
- More in-depth information on the difference between learning “from” and learning “with” technology can be found at www.westedrtec.org

Lesson #2: Technology is only one piece of the puzzle – Technology by itself will have little impact without accompanying reform at the classroom, school, and district level. Studies of IBM's Reinventing Education program showed that students' reading skills improved in tandem with technology use in schools where the leadership had committed to a school reform plan with clear, meaningful educational goals. In contrast, technology has been shown to be less effective when learning objectives are unclear and the focus of technology use is diffuse (Schacter, 1999).

- Don't deal with technology in a vacuum. Provide funding to schools that develop plans aligned with educational goals.
- Require schools and teachers to align technology-enhanced lessons with the content standards.
- When developing opportunities for funding, build in language that requires schools to demonstrate how they will be integrating technology into the whole system. This, in and of itself, can provide the incentive to get schools thinking about the role of technology in new, more effective ways.

Lesson #3: Adequate and appropriate teacher training is vital - A variety of studies indicate that technology will have little effect unless teachers are adequately and appropriately trained (Office of Technology Assessment, 1995; 2000). Until teachers feel adequately prepared to integrate technology with their instructional program, technology will not be seen as an instructional resource. Research has shown that teachers who are more knowledgeable about the use of computers use them more frequently and in a greater variety of ways. They are also more likely to have their students use technology in tasks that require higher-order thinking. In a paper discussing the cost, utility, and value of technology, Wahl (2000) suggests that organizations should spend 30 percent of their budget on equipment and 70 percent on the "human infrastructure" to support ongoing training and technical assistance.

- Ensure that provisions for funding professional development include sufficient resources for technology training - follow the 30/70 rule.
- Adequate directions and formulas should be given so that ongoing, research-based, professional development is available to teachers.

- Provide incentives and rewards. See http://www.portical.org/Presentations/Barnett/pd_principles/39834/index.html and http://www.portical.org/Presentations/Barnett/pd_examples/44898/index.html for elements of an effective professional development program.

Lesson #4: Changing teacher beliefs about learning and teaching with technology is an integral part of the process - Integrating technology into instruction is a difficult, time-consuming process; only those teachers who believe that technology use will lead to significant benefits for their students will undertake the associated challenges. Teachers need time to observe for themselves the impact of technology use on learning and teaching in their colleagues' classrooms, and to work with models and mentors who can help them with the change process. ACOT researchers believe that the shifts in teachers' beliefs occurred when teachers began to see firsthand the benefits of technology use (Sandholtz et al., 1997).

- Make sure the resources (time, money, institutional support, etc.) legislated to provide professional development for teachers and administrators are adequate to support and sustain change.
- Model the integrated use of technology in all levels of education by working to ensure that all systems within the school and district (administrators, teachers, district offices, data managers) are using technology to its best effect.

Lesson #5: Sufficient equipment: An adequate computer-to-student ratio should be determined - Without sufficient access to technology, of course, even well-trained, highly motivated teachers will not be able to integrate technology effectively into instruction. A RAND study (Glennan & Melmed, 1996) of technology-rich schools suggested that the most successful of these schools had a high density of computers and high access to them. While there is no magic number, research suggests that a student computer ratio of 5:1 or 4:1 will provide the level of access needed to attain the level of use where technology can best affect student achievement.

- Make technology funding contingent on schools' demonstrating that an adequate student-to-computer ratio is part of their plan.
- Technology plans should not rely on donated or outdated equipment. Be sure that adequate resources for new equipment are provided as part of funding opportunities or budgets. If donated equipment is accepted, develop minimum standards for acceptance that provide guidance for evaluating donated equipment.
- Understand the issues and research that address the digital divide and legislate accordingly. Places like Digital Divide Solutions (<http://www.asu.edu/DigitalDivideSolutions/>) and the Benton Foundation's Digital Divide Network (<http://www.digitaldividenetwork.org/content/sections/index.cfm>) are

dedicated to bridging the digital divide and provide vital resources and information.

Lesson #6: Accessible equipment: Classroom access is best – In a study in West Virginia, researchers found that students who had access to computers in their classrooms showed more improvement in basic skills than those who received instruction in computer labs. In addition, teachers who had computers in the classroom reported greater confidence and competence in using computers and spent more time using them (Mann, 1999). Finally, classroom connectivity to the Internet was found to be the best predictor of teachers' professional use of technology, and connectivity with four or more student computers was found to be the primary determinant for whether teachers directed student research involving the Internet (Sivin-Kachala & Bailo, 2000).

- Create policies that encourage schools to provide adequate numbers of in-class computers. Legislate funding to help schools move technology out of the computer lab and into the classrooms.
- Make Internet access a priority for all schools and districts, and provide funds to train teachers to use it appropriately.

Lesson #7: Computer access at home holds great benefits - Not surprisingly, students who have computers at home do better than students who don't. A New Jersey study focusing on seventh, eighth, and ninth graders, showed that students who had sustained access to technology (i.e., access at home and at school), as well as email and the Internet did significantly better on standardized writing tests than students who had access to similar technology only at school.

- Create policies that ensure students will have afterschool access to school technology. Lend your support and influence to efforts that would transform schools into community learning centers, open after hours, with access for all.
- Encourage partnerships with organizations and businesses that provide laptops, battery operated keyboards and Personal Digital Assistants (PDA's) for students to use at home.
- Promote policies to encourage parents and other adults to augment their technology skills.

Lesson #8: Long-term planning is the first step - Research suggests that technology should be implemented only after a planning stage in which administrators and other stakeholders develop clearly articulated standards and goals and a clear vision of how the technology is to be integrated into the mission of the school or district. The most successful schools in IBM's Reinventing Education program, were willing to allocate time and other scant resources for planning how best to use the technology to improve instruction (Trotter, 2001).

One common and costly mistake made by schools and districts when developing school budgets is to fail to take into account the ongoing costs of maintaining, supporting and replacing computer equipment. In some schools, printers sit idle because money was not budgeted to replace ink cartridges, toner, or paper. Schools and districts who spend most or all of their technology funds on initial purchases of software and hardware can end up with no means of supporting those purchases.

- Be involved in local efforts for long-range planning, and make sure that the plans are research-based. Make public how you or your staff can be involved in developing and supporting these plans. Be sure that the Office of Education or Department of Education has an up-to-date research-based plan itself.
- Involve all stakeholders in the planning process.

Lesson #9: On-site technical and instructional support must be provided -

Although adequate access to technology is a key factor in successful implementation, researchers have also found that a major barrier to technology use is the lack of technical support. Even teachers who enjoy using computers will stop using technology if the equipment is unreliable. Many teachers lack adequate troubleshooting skills — not to mention time — to fix equipment, especially if it breaks in the middle of a lesson. The ACOT project found that the most crucial determining factor in whether teachers successfully integrate technology into their classrooms was the level of support they received from school and district administrators. The effective use of technology requires an adequate school and district infrastructure and must include timely, on-site technical and instructional support.

- Valuable information and resources on technical and instructional support for technology can be found through the Michigan Technology Staffing Guidelines (<http://techguide.merit.edu>), and at TechSETS (<http://www.techsets.org>).
- Contra Costa County offers online tech support at <http://www.cccoe.net/solutions/>

Lesson #10: Technology needs to be integrated within the curricular framework-

To use technology effectively, teachers must understand how its use fits into the larger curricular and instructional framework. The ACOT study found that student engagement remained highest when technology use was integrated into the larger curricular framework, rather than being an "add-on" to an already full curriculum (Sandholtz et al., 1997). The best courseware (software designed to be used in an educational program) will reflect curricular standards, take into account research on how students learn, and will promote concept and content. (Coley et al, 1997 and Silverstein et al, 2000).

- Develop funding guidelines that focus on making technology an integrated part of the overall educational plan and that demonstrate specifically how it fits into the curricular framework.

- Work toward including as part of district and school hiring guidelines an evaluation of how teachers and administrators have used technology in their schools and classrooms. Make evaluating the progress of technology integration in schools a standard feature to be included in all grant applications and awards. The Evaluation Toolkit at <http://www.wested.org/techplantoolkit> provides guidance and templates for this important process.

For technology to contribute positively to the learning experience, it is important to put together all ten pieces touched upon in this paper. By putting these pieces in place — and with ongoing attention, funding, and adjustments when needed — computer-based technology can play a significant role in contributing to a positive, productive learning experience for students.

Educational policy that promotes technology integration and the infrastructure needed to implement and support it is crucial to securing for our children the kind of learning that will help them meet the challenges of the 21st century. A solid learning return on our technology investment is certainly within reach. Knowing what works and creating policy that help schools and districts follow the guidelines revealed by the research are the first steps toward realizing that return.

Further resources and websites with information about the benefits of integrating technology in the classroom:

Curriculum

The International Technology Education Association (ITEA), Technology for All Americans - <http://www.iteawww.org/C.html>

*The National Educational Technology Standards (NETS) guidelines for administrators - <http://cnets.iste.org/tssa/index.html>

*California Learning Resource Network (CLRN) – an information service source for electronic learning resources that align to California Curriculum frameworks and standards – <http://www.clrn.org>

Professional Development

The CEO Forum Reports: 1) School Technology and Readiness, 2) Professional Development: A link to better learning – <http://www.ceoforum.org/reports.html>

*California Technology Assistance Project (CTAP) Region 3 - <http://www.ctap3.org/>

Capitol CUE – <http://www.capcue.org>

*Technology Information Center for Administrative Leadership (TICAL) – <http://www.portical.org>

*CTAP Online (California Technology Assistance Project) – <http://www.ctaponline.org>

Infrastructure (Connectivity and Retrofitting)

Digital California Project – <http://www.cenic.org>

National Clearinghouse for Educational Facilities, providing access to technology integration resources – <http://www.edfacilities.org/>

“Wire vs. Wireless: Technology in School Computer Networks,” a discussion between two facilities experts –

<http://www.designshare.com/Research/Wired/Wired1.htm>

*Sun Microsystems – <http://www.sun.com>

*Oracle – <http://www.helpushelp.org/>

K-12 Networking Infrastructure Guide – <http://www.ncrel.org/tandl/k-12infra/k-12infra.htm>

Hardware

CalSAVE – Cost effective technology for K-12 educators –

<http://www.calsave.org>

The Software and Information Industry Association, offering guidance about accepting donated computers –

<http://www.siaa.net/divisions/education/donatecomp.asp>

Tech Support

*TechSETS – <http://www.techsets.org>

Michigan Technology Staffing Guideline, Worksheets for calculating the level of tech support a school district will need – <http://techguide.merit.edu/>

Software

CalSAVE- Cost effective technology for K-12 educators – <http://www.calsave.org>

*California Learning Resource Network (CLRN) – <http://www.clrn.org>

*Sun Microsystems – <http://www.sun.com/staroffice/>

Total Cost of Ownership

Consortium for School networking: Taking TCO to the classroom –

<http://classroomtco.cosn.org/>

General Help and Information

*The Technology Planning Toolkit - <http://www.WestEd.org/techplantoolkit>

*Portical – The Technology Information Center for Administrative Leadership – <http://www.portical.org>

*The George Lucas Education Foundation (GLEF) – <http://www.glef.org>

* Partner of the Regional Technology in Education Consortium (RTEC) at WestEd.