THE TECHNOLOGY FACTOR

Nine Keys to Student Achievement and Cost-Effectiveness

Project RED
REVOLUTIONIZING EDUCATION

"Project RED is nothing less than a blueprint for remaking American education."

~ Angus King
Former Governor of Maine

The Greaves Group • The Hayes Connection • One-to-One Institute

Project RED
REVOLUTIONIZING EDUCATION

"Technology can play a huge role in increasing educational productivity, but not just as an add-on or for a high-tech reproduction of current practice. Again, we need to change the underlying processes to leverage the capabilities of technology. The military calls it a force multiplier. Better use of online learning, virtual schools, and other smart uses of technology is not so much about replacing educational roles as it is about giving each person the tools they need to be more successful—reducing wasted time, energy, and money.

By far, the best strategy for boosting productivity is to leverage transformational change in the educational system to improve outcomes for children. To do so, requires a fundamental rethinking of the structure and delivery of education in the United States."

~ *The New Normal: Doing More With Less*
Remarks of U.S. Secretary of Education Arne Duncan at the American Enterprise Institute panel, "Bang for the Buck in Schooling"
November 17, 2010

Project RED | The Technology Factor: Nine Keys to Student Achievement and Cost-Effectiveness

www.ProjectRED.org

Sponsored by Intel, Apple, Pearson Foundation, Qwest Communications, and eChalk.

Supported by the American Association of School Administrators (AASA), Association of Educational Publishers (AEP), Association of Educational Service Agencies (AESA), Association of School Business Officials (ASBO), the Consortium for School Networking (CoSN), The International Association for K-12 Online Learning (iNACOL), the International Society for Technology in Education (ISTE), The National Association of Media & Technology Centers (NAMTC), the National School Boards Association (NSBA), the Software & Information Industry Association (SIIA), and the State Educational Technology Directors Association (SETDA).

Published and distributed in partnership with MDR. www.schooldata.com.

THE TECHNOLOGY FACTOR

Nine Keys to Student Achievement and Cost-Effectiveness

The Greaves Group
The Hayes Connection
One-to-One Institute

Our students are different, and they need different learning opportunities. This report provides insight into how educational technology can power those new learning opportunities.

~ Anita Givens
Associate Commissioner
Standards and Programs
Texas Education Agency

Table of Contents

Project RED
REVOLUTIONIZING EDUCATION

"Project RED is nothing less than a blueprint for remaking American education—second-order change—not through more or better testing, charter schools, longer school days, more or even better teachers, but through fundamentally altering how we do education, the first real change in the process of education itself in a thousand years."

~ Angus King
Former Governor of Maine

Foreword

Every morning on the plains of Africa, a gazelle awakens, knowing that it must outrun the fastest lion, or be killed. At the same time, a lion awakens, knowing it must run faster than the slowest gazelle, or it will starve.

So it doesn't much matter whether you're a lion or a gazelle; when the sun comes up, start running.

~ African Proverb

Suddenly, and without much warning, the United States finds itself in the predicament of the lion and the gazelle. Instead of the easy grazing of the past sixty years or so, now running is not optional but imperative. Economic competition is global, focused, and unrelenting; there is no such thing as a "safe" job. Whatever it was that formed the basis of your state's economy 50, 25, or even 10 years ago is now at risk; and whatever it is that is coming next is hard to see or define, let alone prepare for.

This came home to me in the late nineties when the bloom of the dotcom bubble was beginning to fade, and the call-center jobs we all thought were the next phase of industrialism were disappearing almost as fast as they had come. It suddenly hit me that I had no idea what the citizens of my state were going to do for a living 20 (or even 10) years from now. And the events of the past ten years have only intensified this sense—and my conclusion that the recession we have been in for the past few years is more structural than cyclical.

The fact is that everybody in the world wants our jobs and the standard of living that comes with them, and for the first time ever, they have the means to take them.

So what do we do? Denial is always an option (probably the most common one at this moment), but that is surely not going to help us adapt to the new reality all around us. As my father used to say, no decision is a decision, and it is usually the wrong one.

Another option is to meet what is fundamentally an economic challenge with economic remedies—tax cuts and incentives; a new round of protectionism; lower interest rates; "streamlining" regulation; scouring public budgets for "fraud, waste, and abuse"; credit enhancements; investment in research and development—in other words, the usual suspects. These may be helpful on the margins, but none individually—or even the whole list—will fundamentally alter the trajectory of 21st century history, which is inevitably in the direction of intensifying global competition.

As I learned when I read this report, steps like these, while important and maybe even occasionally useful, represent "first-order change"—incremental improvement but not the kind of transformative action necessary to meet major, disruptive challenges. Sandbags and shelters are sufficient for most storms, but as we learned, when a Katrina hits, we need a whole new level of response.

And make no mistake, we are in the midst of an economic Katrina—huge, inexorable, and deadly—and it threatens to sweep away with it a great deal of what we have come to believe is our birthright.

But I believe there is something, actually one thing, we can and must do to give ourselves a fighting chance—dramatically improve both the output and efficiency of our schools. We cannot compete on wages or access to natural resources or capital, and besides, those are the currency of the age just past. The new competition is in innovation and invention, creativity, productivity, and vision. And the wellspring of all of these is learning—history and language, science and math, drama, music, and dance. We are seeing the fruition of the promise—and the threat—of industrialism. A person's economic future depends on brains, not brawn, and the best brains, or maybe more accurately, the best trained brains, will win.

But it is not about cramming more physics or Spanish into 16-year-old heads; it is about giving them the tools and techniques to teach themselves, both in school and beyond. In this connection, my friend Seymour Papert made the most profound observation I have run across on 21st century education: "It is no longer good enough for schools to send out students who know how to do what they were taught. The modern world needs citizens who can do what they were not taught. We call this 'learning learning.'"

In order to achieve this, we need change that is big and transformational, not gradual and incremental. It means twice the educational output, however measured, at something less than today's cost. It also means educational equity on an unprecedented scale; given the stakes, we simply cannot afford the massive waste of talent represented by failing schools and lost communities. And it means education that is at once more rigorous and more engaging, more collaborative and more inclusive.

Which brings me to this report.

Project RED is nothing less than a blueprint for remaking American education—second-order change—not through more or better testing, charter schools, longer school days, more or even better teachers, but through fundamentally altering how we do education, the first real change in the process of education itself in a thousand years.

The authors did not create this blueprint out of whole cloth and present it to us here as the latest in what seems to be a semi-annual iteration of "school reform"; instead, it is the product of old-fashioned research—a hard analytical look at what is working in schools and school districts around the country. And what is working is ubiquitous technology (a fancy way of saying that every kid has a laptop) fully integrated into the classroom by well-prepared and well-led teachers. The closer the student-computer ratio gets to 1:1, the better the results; the better prepared the teachers are to take full advantage of the potential of the technology, the better the results; and the stronger the leadership of the process by the principal, the better the results.

In a sense, I have been waiting for this report for ten years. It, along with the pioneering work of people like David Silvernail here in Maine, confirms what a small group (and I am not kidding when I say small) thought back in 2000—that a digital device in the hands of every student made total sense and was the tool upon which a truly transformed educational system could be built.

But the report also underlines our major learning here in Maine—that the computer is the necessary starting place, but alone is not sufficient to generate the transformational change we so desperately need. What we have learned is that it is all about the teachers and the leadership in the school; with great professional development and a new pedagogy, amazing things happen, but just handing out the laptops is not going to do it.

In this sense, Project RED confirms one of my most deeply held convictions about successful leadership—that execution is as important as vision. The vision of a digital device in the hands of every student, providing access to all the world, is a powerful idea, but it fails utterly if the network is down or the screen freezes or the teacher is unschooled in the techniques of technology integration. Through painstaking work, the authors here tease out the factors that can and do make it work—from school leadership to professional development to simple reliability and on down the list.

And so we are back to the lion and the gazelle. There is no doubt that when the sun rises, we had better run. The key question, however, is in what direction? Fortunately, this report gives us a pretty good map.

Angus King
Governor of Maine, 1995-2003
Sponsor of Maine Learning Technology Initiative
Brunswick, Maine
October 2010

Acknowledgements

Project RED was inspired by the desire to contribute to the re-engineering of education, through research and through sharing compelling stories of transformation.

First, and most importantly, we express our appreciation to the over 1,000 principals and other school administrators who took the time to complete a challenging survey. Without their work, we would have no findings.

Our sponsors were a tremendous help, and we are most grateful for their faith and foresight in funding an important piece of research. Our thanks go to Eileen Lento's team at Intel, Karen Cator's (before she advanced to the U.S. Department of Education) and David Byer's team at Apple, Mark Nieker's at the Pearson Foundation, Sharon Montgomery's at Qwest Communications, and Martin Brutosky's at eChalk. In particular, our lead sponsor, Intel, pushed us and supported us in every way. Chris Brown of Pearson Education and Paul Kuhne of eChalk contributed materially to the quality of the final product. And Kathy Hurley of the Pearson Foundation made many contributions to the success of the project.

Our supporting organizations also provided strong support throughout the process. In particular, Ann Flynn of the NSBA, Doug Levin of SETDA, Irene Spero and Keith Krueger of CoSN, and Mark Schneiderman of SIIA provided valuable resources and thoughtful insights.

Diane Rapley, our chief editor, and Dan Hoffman of the University of Denver, our crosstabs expert, provided invaluable assistance and wisdom that went well beyond their job descriptions. John Greaves gave us eye-opening insights into the power of predictive modeling and principle component analysis. Ian Hickey, our chief technical officer, could always be counted on to handle all things technical, from the website to the database. And Rodney Muth, Professor of Administrative Leadership and Policy Studies at the University of Colorado, Denver's School of Education and Human Development, provided advice as an education and statistics expert as well as a careful and subtle review of our draft report.

Fady Khairallah and our friends from MDR exceeded our expectations at every turn. They put tremendous data resources at our disposal, and they took on the key role of designing and publishing the final product. Moira McArdle and Colleen Galligan provided marketing insight and design savvy to this data-heavy report.

And, finally, to our spouses, whose counsel and patience can only be described as exemplary: Vylee Greaves, Tom Olkowski, Ph.D., and Samantha Gielniak.

To each of you, and to the many others who contributed to the quality of the work, we say thank you!

Thomas W. Greaves

Jeanne Hayes

Leslie Wilson

Michael Gielniak

This is the best education technology report I have read in my lifetime.

~ Dr. Mark Edwards
Superintendent
Mooresville Graded School District
Mooresville, North Carolina

Hemera/Thinkstock

Chapter 1

Project RED Goals and Strategies

Goals

Although data gathered over the years have indicated that technology has not achieved the same impact in education as in other sectors of the economy, it has become clear that a few pockets of excellence are successfully transforming schools with technology using specific implementation strategies. The urgent need to understand those successful implementation strategies provided the impetus for Project RED.[1]

America's Digital Schools 2008[2] had revealed that only 33% of school districts with 1:1 schools considered their academic improvement due to technology to be significant: the Project RED team saw this as an opportunity to identify the strategies behind those improvements and provide guidelines for other schools. This became the first goal of the survey.

Recognizing the connection between education and the economy,[3] Project RED established a second goal: to research the potentially positive financial impact of technology in schools. Surprisingly, very little work has been done on the financial impact of technology in education, unlike the private sector.

Because debate in recent years has questioned whether students perform better when they have continuous access to a computing device, Project RED established a third goal: to examine the impact of 1:1 computing on student performance and education budgets.

Many studies, including earlier research by Project RED team members, have addressed district-level activities and the importance of district-level leadership. However, Project RED deliberately adopted a school-level focus in order to observe principal, student, and teacher behaviors as closely as possible; correlate student performance to school-level activities; and ensure that school-to-school implementation variances did not mask correlations to student performance.

[1] See Appendix D for details on the Project RED team.

[2] Greaves, T. & Hayes, J., *America's Digital Schools*, MDR, 2008.

[3] Belfield, Clive & Levin, Henry M., *The Price We Pay: Economic and Social Consequences of Inadequate Education*, Brookings Institution, 2007.

Scope

Many surveys and studies have examined the impact of educational technology. Unfortunately, most have covered only one school or a few schools, and the study interest areas have covered only a sparse matrix.

Project RED provides unprecedented scope, breadth, and depth:

- 997 schools, representative of the U.S. school universe, and 49 states and the District of Columbia
- 11 diverse education success measures
- 22 categories of independent variables, with many subcategories
- Comparison of findings by student-computer ratios (1:1, 2:1, 3:1, etc.)
- Comprehensive demographic data correlated to survey results

Given the array of factors and variables, a variety of analysis techniques were required, including regression analysis, principal component analysis, and predictive modeling (see Appendix B). The survey has been augmented by interviews and additional information, generously provided by school and district administrators.

Hypotheses

The goals of the survey led to three hypotheses that were tested by Project RED:

- Properly implemented educational technology can substantially improve student achievement.
- Properly implemented educational technology can be revenue-positive at all levels—federal, state, and local.
- Continuous access to a computing device for every student leads to increased academic achievement and financial benefits, especially when technology is properly implemented.

The Project RED survey analyses support these hypotheses. The insights gained through the study should prove valuable to any school planning to implement ubiquitous technology.

Education Success Measures (ESMs)

The success or failure of a school program can be determined in numerous ways. As any educator will tell you, test scores are important, but they are only one measure of success. The Project RED team analyzed over 4,000 pages of reports and evaluations from technology-rich implementations, primarily from 1:1 programs, and found little commonality in the success factors measured by schools.

Lacking a national consensus, we chose 11 education success measures that provide a balanced view. Many appear frequently in the research literature, and a few are new to this study (primarily those related to financial impact, which is rare in the literature).

These 11 ESMs were selected in order to elicit the most valuable information for our hypotheses with the fewest number of variables. This filter eliminated many "nice-to-know" variables, such as student attendance. The measures were divided into two groups, those that affect students in all grades and those that affect students in high schools.

All Schools

1. **Disciplinary action rate.** The frequency of disciplinary actions is a strong, leading indicator of academic success or failure. Fewer disciplinary actions mean that students are more likely to be engaged in learning. Also, every disciplinary action costs time and money.
2. **Dropout rate.** Dropouts are an extreme indicator of the lack of academic success and lead to high personal and societal costs.
3. **High-stakes test scores.** Any school improvement program needs to have a focus in this area.
4. **Paper and copying expenses.** This factor is a proxy for other similar school expense centers. Paper and copying machine expenses are more significant than often realized, particularly when labor is included.
5. **Paperwork reduction.** This factor is a proxy for efficiency savings attributable to technology. When paperwork is reduced, teachers have more time to spend on educationally productive tasks, and schools save other costs (such as storage and records retention).
6. **Teacher attendance.** Substitute teachers cost the district money and may impact student performance.

High Schools

7. **AP course enrollment.** This factor indicates the quality of curriculum and instruction and reduces the time required to graduate from college, saving money for the state and for families.
8. **College attendance plans.** This factor indicates the quality of curriculum and instruction and facilitates students' educational planning.
9. **Course completion rates.** This factor indicates student engagement, achievement, and school quality. Conversely, course failure has severe negative academic and financial implications.
10. **Dual/joint enrollment in college.** This factor indicates a high level of student achievement and savings in future college expenses. The state saves money in subsidies for higher education and starts receiving tax revenues earlier.
11. **Graduation rates.** This factor indicates school quality and effective curriculum, instruction, and student planning. Multiple indicators, such as graduation and course completion rates, allow for better triangulation on a self-reported survey.

Survey Questions

Questions regarding 22 independent variables, some with subcategories, were chosen for their potential to provide insight into the ESMs. As with the education success measures, many variables could not be included due to the limitations of survey size and the effects of survey fatigue. The number of subcategories in each variable is noted in parentheses.

Project RED was designed to provide data for later analysis of the relationships between the 22 independent variables and the 11 education success measures.

1. Types of devices (6)
2. School usage patterns (7)
3. Levels of use by subject (14 subjects, 6 levels of use)
4. Primary impetus of the program (11)
5. Sources of funding (9)
6. Parental involvement—measured by face-to-face meetings or trainings (1)
7. Teachers—when issued devices, relative to students (1)
8. Technology plan quality (6)
9. Program sustainability (1)
10. Pedagogical models (4) and usage patterns (6)
11. Classification of types of classroom use (12) and frequency (7)
12. Principal training—types (6) and frequency (5)
13. Principal's leadership role (5) and frequency (5)
14. Teacher professional learning—categories (8) and frequency (5)
15. Professional learning budget (3)
16. Technology systems reliability (5)
17. Network accessibility (3)
18. Internet connection speed (5)
19. Student-computer ratio (5)
20. Grades covered (1)
21. Year of implementation and length of implementation (1)
22. Type of institution (1)

Results Summary

Project RED is the first large-scale national study to identify and prioritize the factors that make some technology implementations perform dramatically better than others, demonstrate that schools employing a 1:1 student-computer ratio and the key implementation factors outperform other schools, and reveal significant opportunities for improving education return on investment (ROI) by transforming teaching and learning.[4]

A few schools are beginning to implement practices that have the potential to revolutionize schools. The capability and knowledge exist to move schools steadily toward a new paradigm—a goal that can be accomplished over time by redesigning schools to a new level of technology integration and by changing legislation, policy, facilities, professional learning, leadership skills, and more. Technology is a powerful facilitator, but it cannot by itself meet any educational objective.

Education policymakers and school leaders have a choice. Do we continue on, ignoring new solutions, or do we study the research, seek confirmation of the Project RED findings, and use the detailed information to build a new kind of school that will define America for the next 100 years?

[4] Project RED uses ROI as it is more widely known. Other measures, such as Value of Investment (VOI), spearheaded by CoSN, and VA, or Value Added, are also used in education.

Creatas Images/Thinkstock

Chapter 2

The Case for Radical Change

In early 2009, all indicators pointed to a perfect storm on the horizon in the U.S. education system. Although the requirements for student achievement had been increasing, student performance remained essentially flat, despite the fact that education spending had increased at over twice the rate of inflation between 1965 and 2005.

In addition, although the rate of change outside of schools had always been faster than inside schools, the advent of the Internet had widened the gap to an unacceptable degree. The implosion of the economy created an additional storm front, and it appeared that the financial picture for schools was unlikely to improve for decades, if at all.[1] The U.S. Department of Education was explicit about future education funding. "Plan on doing more with less" was the order of the day.

A radical response is needed to address this situation. Since the microcomputer revolution began in schools around 1980, educators have been looking forward to the day when computer technology would provide an answer. However, even schools with a 1:1 student-computer ratio have failed to accomplish this goal.[2]

For the first 20 years of the microcomputer revolution, the technology was the problem, but now the current uses of technology are the problem. They are not transformative. They simply add efficiencies and with relatively small effect sizes.[3]

Today's response must be transformative, based on second-order rather than first-order change, to prepare our students for the challenges of this century.

First- and Second-Order Change

When the Pony Express introduced faster horses, better horse feed, and lighter-weight papers, the incremental improvements in speed constituted a first-order change. Then mail delivery by train provided a second-order change. Within the change cycle in any industry or area of endeavor, incremental first-order changes and intervening plateaus are generally followed by transformative second-order changes.

[1] California is a prime example. By law, school finances are capped at 50% of the state budget. Increasing education spending at twice the rate of inflation is not feasible.

[2] Greaves, T. & Hayes, J., *America's Digital Schools*, MDR, 2008.

Unfortunately, almost every effort in school reform is focused on first-order change, and most change mechanisms are weak, with little impact. At the federal level, this has been consistently the case since the 1958 National Defense Education Act.

First-Order Change

A simple way to determine first-order change is by examining potential outcomes. If the proposed changes do not have the potential to cause a 2X improvement, they can be safely classified as first-order change.

Almost all educational technology initiatives are first-order changes. Even if they are well implemented, their impact is limited.

First-Order Change

"First-order changes are reforms that assume that the existing organizational goals and structures are basically adequate and what needs to be done is to correct deficiencies in policies and practice. Engineers would label such changes as solutions to quality control problems.

"For schools, such planned changes would include recruiting better teachers and administrators; raising salaries; distributing resources equitably; selecting better texts, materials, and supplies; and adding new or deleting old content and courses to and from the curriculum.

"When such improvements occur, the results frequently appear to be fundamental changes or even appear to be changes in core activities, but actually these changes do little to alter basic school structures of how time and space are used or how students and teachers are organized and assigned.

"First-order changes, then, try to make what exists more efficient and effective without disrupting basic organizational arrangements or how people perform their roles."

~ Cuban, Larry, *The Managerial Imperative and the Practice of Leadership in Schools*, 1988, SUNY.

[3] Effect size is a way of determining the impact of an intervention. Effect sizes vary from 0 to 1. The larger the effect size, the more pronounced the change. The typical effect size of technology ranges from 0 to .4. A principal change has an effect size of .6. See Hattie, John, *Visible Learning: A Synthesis of Over 800 Meta-Analyses Relating to Achievement*, Routledge, 2009.

Second-Order Change

Project RED defines second-order change as follows:

- Student performance levels double, at a minimum.
- The change mechanism is broad scale and addresses all student populations.
- The changes are scalable to the largest educational entities.
- Changes are sustainable and can withstand the vagaries of the economy and other factors.

Second-order change is extremely difficult, and the Project RED data indicate that it may be impossible to achieve in schools with a student-computer ratio higher than one student per computer.

Examples of second-order change in schools are:

- Change mechanisms in place to address each student with personalized instruction programs
- Exchange of seat-time requirements for demonstrated proficiency in coursework
- Change in focus from teacher to student as customer

The Project RED data illustrate that substantial improvements in academic success measures and financial ROI are tied to second-order changes where the re-engineering of schools is facilitated by the judicious use of ubiquitous technology (see Chapters 8 and 9).

Second-Order Change

"Second-order changes, on the other hand, aim at altering the fundamental ways of achieving organizational goals because of major dissatisfaction with current arrangements. Second-order changes introduce new goals and interventions that transform the familiar way of doing things into novel solutions to persistent problems. ...Engineers would call these solutions to design problems... The history of school reform has been largely first-order improvements on the basic structures of schooling established in the late nineteenth century."

~ Cuban, Larry, *The Managerial Imperative and the Practice of Leadership in Schools*, 1988, SUNY.

Example 1: A More Efficient Learning Environment

Using a computer program to run flash cards is a first-order change. Costs may actually go up. But if the program is adaptive and shows students only the cards they need to see, then some time can be re-allocated to improving performance in other areas. This is nice but still a first-order change.

If the program tracks student performance behind the scenes, identifies mastery issues, and provides instructional feedback, the flash cards can go away. This is a beginning second-order change.

A system that tracks all the students all the time can use advanced analytics to pinpoint the root causes of lack of progress and provide remediation. Identification of the skills not learned and an accelerated teaching and learning cycle lead to a more efficient learning environment and greater cost-effectiveness—a second-order change.

Example 2: Increased Productivity

If students receive assignments and turn them in via the learning management system rather than on paper, the school enjoys savings in copying costs and teacher time—a nice first-order change.

If schools move to digital instructional materials, the cost of copying black line masters is reduced. Schools can also see which materials are actually used, by whom, and when. And they can adjust purchasing requests to minimize costs—this is a first-order change that could set the stage for second-order change.

Best of all, instructional materials usage can be tied to student performance over large sample sizes, insight can be gained into what works for which populations, and the most effective materials can be automatically deployed on a student-by-student basis.

Learning what works for specific populations can dramatically reduce the cost of remediation by personalizing instruction. If schools know what works, they purchase redundant products and services less often. This is a second-order change.

Magnitude of Change and Impact on Stakeholders

From *School Leadership That Works*, McREL, 2005

"Magnitude of change refers not to the size of the change but rather the implications of the change for those who are expected to implement it or will be affected by it. ...It is important to note that the magnitude of change lies in the eye of the beholder and that the same change may have different implications for different stakeholders. Our research suggests that leaders need to understand whether changes are first- or second-order for staff members and differentiate their leadership styles accordingly."

First-Order Change	Second-Order Change
An extension of the past	A break with the past
Consistent with prevailing organizational norms	Inconsistent with prevailing organizational norms
Congruent with personal values	Incongruent with personal values
Easily learned using existing knowledge	Requires new knowledge and skills
School Leadership That Works, McREL, 2005.	

A Case Study of Second-Order Change: NextSchools™

Imagine a new breed of NextSchools, where the objective is to double the rate of learning, and the primary characteristic is a relentless focus on personalization and student-centricity. Achievement is constant and time can vary. If students need more time to master a particular course, they get it.

NextSchools students move at their own pace, and the system is designed to facilitate self-directed and self-paced learning and minimize the amount of time where progress is not being made. Robust formative and summative assessments are part of the daily routine and provide just-in-time information for students and teachers to support adjustments and remediation.

Online subject-specific experts, as well as mentors and trainers, are available to support the NextSchools classroom teacher if needed. Productive partnerships with the community, business, and industry fuel a relevant, real-world approach to teaching and learning concepts and skills throughout the curriculum.

The NextSchools vision is based on the Project RED findings.

Grades K-8

The NextSchools curriculum goes as deeply as possible into each concept and skill using inquiry, problem- and project-based research scenarios. Average students today read two million words by the end of eighth grade, and high-performing students read four million words. In a NextSchools, every student reads a minimum of four million words, and students enter high school with the foundation for literacy success.

Grades 9-12

The emphasis is on individualized education plans tied to an individualized curriculum and unique goals and aspirations. Core subjects are pursued in a deep, personalized manner. Students can elect to take courses tailored for future careers, such as health care, IT, engineering, manufacturing, or journalism. Content is tied to real-life problems, issues, and experiences and tailored to students' unique plans.

The Carnegie unit and related seat time are replaced by the demonstration of skill and knowledge related to unique goals and plans. Most students pursue higher education courses (one course in Grade 9, two in Grade 10, and so on) via dual enrollment, Advanced Placement, internships, and externships, as well as coursework online and inside and outside the school walls. The strategic partner organizations provide mentors or guides.

Students who are not ready for higher education receive remediation in high school or earlier. Given the deeper learning and higher standards for course completion, remedial courses and their related costs are reduced dramatically. Remediation becomes the exception rather than the norm.

Addressing the Grand Challenge

In today's educational landscape, very little effort is directed toward radical improvements where students learn at twice the rate and half the cost, as outlined in the fourth grand challenge of the 2010 National Educational Technology Plan.[4] Sadly, this concept is talked about rarely, if at all, despite the call to action in the grand challenges.

The Project RED team estimates that first-order change yields savings of $30 billion a year at best, while second-order change could yield savings of $100 billion a year or more (see Chapter 9) and significantly improve student performance.

Project RED provides a radical response to the situation faced by U.S. schools today—a way for school districts and policy leaders to begin to address the grand challenge and navigate the perfect storm successfully using second-order change principles.

[4] U.S. Department of Education, Office of Educational Technology, *Transforming American Education: Learning Powered by Technology*, Washington, D.C., 2010.

If technology is to be truly effective, it must be carefully and thoughtfully woven into the entire fabric of the school and learning. Done right, it changes both the appearance and nature of education.

~ Calvin Baker
Superintendent
Vail School District
Vail, Arizona


Hemera/Thinkstock

Chapter 3

Major Findings

An analysis of the Project RED data revealed seven major findings of interest to schools embarking on or already administering a technology implementation. Attention to these findings can help schools achieve a higher degree of success.

Finding 1: Nine key implementation factors are linked most strongly to education success.

Schools are in a technology implementation crisis. Although educational technology best practices have a significant positive impact, they are not widely and consistently practiced.

Effective technology implementation in schools is complex, with hundreds of interrelated factors playing a part. A failure of just one factor can seriously impact the success of the project.[1] For example, one commonly reported problem is insufficient Internet bandwidth to support the substantial increase in devices in a 1:1 implementation. This leads to student and teacher frustration and reduced usage levels.

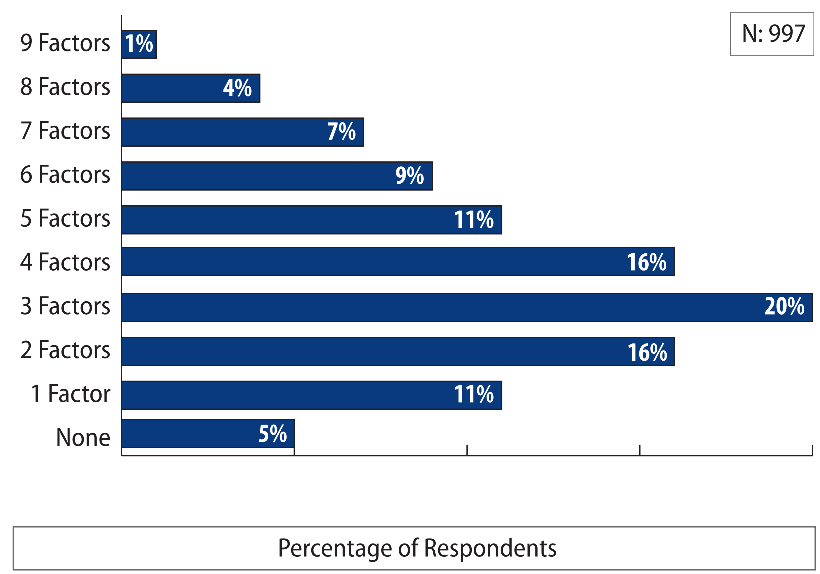
Project RED has identified the nine key implementation factors (KIFs) that are linked most strongly to the education success measures discussed in Chapter 1. (See Appendix B for a complete description of the methodology process.)

Key Implementation Factors

(Rank Order of Predictive Strength)

1. **Intervention classes:** Technology is integrated into every intervention class period.[2]
2. **Change management leadership by principal:** Leaders provide time for teacher professional learning and collaboration at least monthly.
3. **Online collaboration:** Students use technology daily for online collaboration (games/simulations and social media).
4. **Core subjects:** Technology is integrated into core curriculum weekly or more frequently.
5. **Online formative assessments:** Assessments are done at least weekly.
6. **Student-computer ratio:** Lower ratios improve outcomes.
7. **Virtual field trips:** With more frequent use, virtual trips are more powerful. The best schools do these at least monthly.
8. **Search engines:** Students use daily.
9. **Principal training:** Principals are trained in teacher buy-in, best practices, and technology-transformed learning.

Chart 3.1. Few schools deploy many key implementation factors



Only 1% of schools have implemented all nine KIFs, and most schools have implemented three or less. Given the nature of the nine items, it is clear that money is not the issue.

[1] The factors are in many cases multiplicative. A*B*C*D = E, rather than additive, A+B+C+D = E. If one factor goes to zero, the whole project may fail.

[2] English Language Learners (ELL), Title I, special education, and reading intervention programs.

This indicates a crisis. Occasionally the Project RED team visits a 1:1 school or meets leaders at conferences, and we are asked to comment on the value of their technology implementation. Without exception, the 1:1 schools that are performing poorly or only marginally better than non-1:1 schools are addressing very few of the KIFs. However, sadly, schools demonstrate considerable resistance to this concept.

The presence of computers in a school is a first-order change that does not guarantee improved achievement. In the medical world, the prescription and regimen associated with a drug is as important as the drug itself, and positive and negative drug interactions must be reviewed. The same applies to educational technology. Implementation best practices are as important as the technology itself.

The Project RED data suggest that schools are either not aware of implementation best practices, or they are ignoring them. Follow-up interviews make clear that both factors are in play. Even when schools are aware of best practices, they may choose to ignore them for reasons of politics or expediency, leading to sub-optimal results.

These findings show that providing a computer for every student is the beginning, not the end, of improving student performance.

Finding 2: Properly implemented technology saves money.

Substantial evidence shows that technology has a positive financial impact, but for best results, schools need to invest in the re-engineering of schools, not just technology itself.

Evidence supporting the second Project RED hypothesis: *Properly implemented educational technology can be revenue-positive at all levels—federal, state, and local.*

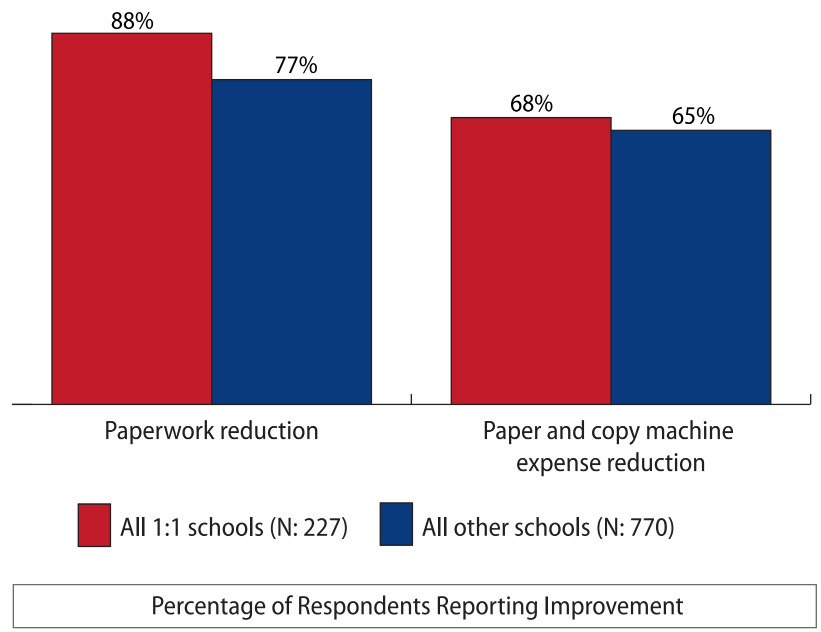
Project RED respondents report that technology contributes to cost reductions and productivity improvements—the richer the technology implementation, the more positive the impact.

The financial impacts reported include direct cost reductions as well as indirect revenue enhancements that are only realizable at the state level. Examples of state-level costs that can be saved include moving from paper-based to electronic high-stakes tests and the re-teaching of students who fail courses. (See Chapter 9 for a full exploration of this topic.)

Examples of Cost Savings

Re-engineering. As with academic achievement, if technology is deployed in first-order change paradigms, then savings will occur. But they will occur to a much greater extent if schools re-engineer the system to optimize cost-effectiveness. Not all uses of technology improve cost-effectiveness, but properly implemented technology has the greatest impact.

Chart 3.2. 1:1 Schools experience greater savings



Copying and paperwork expenses. Project RED estimates that 1:1 high schools with a properly implemented Learning Management System (LMS) could cut their copy budgets in half. Labor accounts for roughly 50% of the total cost. Assuming the cost of a copy machine is $100,000 per year for a 1,500-student high school, on a national basis this equates to savings of $739 million a year for high schools alone.

Instructional materials. The use of instructional materials can be tied to student performance over large sample sizes, so that educators can identify what works for which populations and deploy the most effective materials on a student-by-student basis.

Dropout rate. One broad financial impact of technology is a reduction in dropout rates. The huge economic cost of dropouts is well known,[3] but 1:1 schools are cutting the dropout rate and impacting state revenues as well as local costs.

The greatest financial benefit results from the difference in lifetime tax revenues between a dropout, a high school graduate, and a college graduate. On average, these additional tax revenues range from $448,000 (females) to $874,000 (males).[4]

If 25% of those dropouts graduated from high school and 25% of those graduated from college, the increase in tax revenues would be $77 billion per year per graduating class. The aggregate positive financial impact of all students after 40 years of changed schools would be $77 billion times 40 years or three trillion dollars a year.

Systems cost reductions. Post-survey interviewees often report that another cost issue is the number of duplicate or redundant systems in districts. While Project RED did not measure this factor, we believe that very few districts have one single data entry source. The cost of redundant data entry, data cleaning, redundant software packages, and associated training and support is substantial.

[3] Belfield, Clive & Levin, Henry M., 2007.

[4] Ibid.

Finding 3: 1:1 schools employing key implementation factors outperform all schools and all other 1:1 schools.

A 1:1 student-computer ratio has a higher impact on student outcomes and financial benefits than other ratios, and the key implementation factors (KIFs) increase both benefits.

Evidence supporting the third Project RED hypothesis: *Continuous access to a computing device for every student leads to increased academic achievement and financial benefits, especially when technology is properly implemented.*

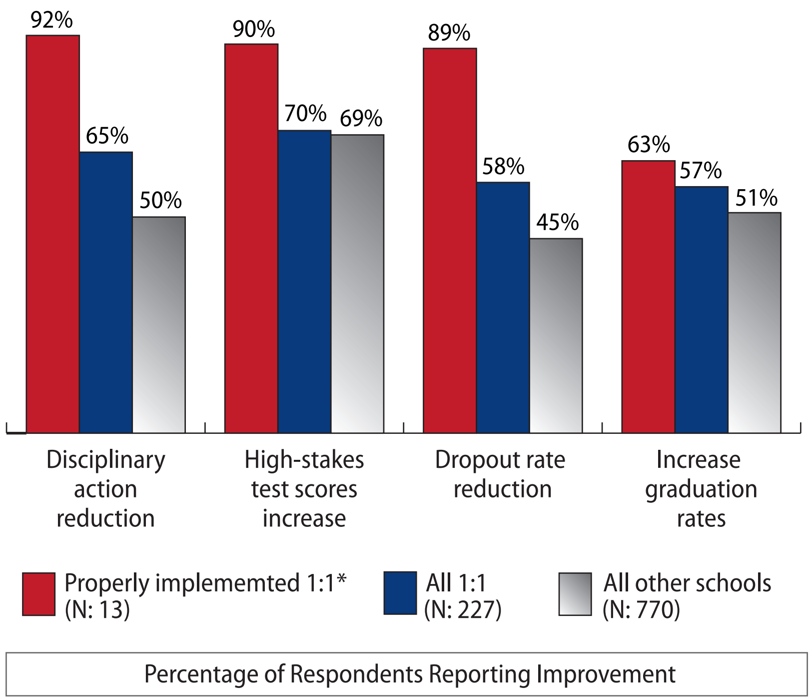
In general, respondents say that schools with a 1:1 student-computer ratio outperform non-1:1 schools on both academic and financial measures, but Chart 3.3 illustrates a more interesting finding—the positive impact of the top four KIFs (see Finding 1):

- Intervention classes that use technology in every class period
- Principal leading change management training at least monthly
- Online collaboration among students daily
- Core curriculum using technology at least weekly

In light of the national agenda for education reform, the 31-point difference in dropout rate reduction, the large reduction in disciplinary action, and the large improvement in high-stakes test scores are particularly significant.

Finding 3 illustrates that properly implemented 1:1 schools are well positioned to enjoy substantial improvement in the education success measures (ESMs), as well as positive financial benefits. These findings, while significant, would probably improve if schools were willing to re-engineer their academic processes to exploit the availability of 1:1 computing, matching the benefits experienced in other segments of the economy.

Chart 3.3. 1:1 Works when properly implemented



*Properly Implemented 1:1: Those schools practicing the top four key implementation factors (intervention classes every period, principal leads change management, online collaboration daily, core curriculum weekly).

Interestingly, the data show that 2:1 schools resemble 3:1 or higher-ratio schools more closely than 1:1 schools, demonstrating that 1:1 schools may be fundamentally different in a pedagogical sense, analogous to the fundamental difference between pay phones and cell phones.

The bleak long-term economic outlook may have an impact on the adoption of educational technology, which is considered an expensive proposition in schools. And, certainly, 1:1 computing is more expensive than 3:1 in terms of the initial outlay expenditure.

But other factors are at work that will have a positive impact on 1:1 adoption. Device costs and total cost of ownership are both declining. It can be argued that connectivity, application availability, community of practice, and the knowledge base in schools for successful implementations are all improving.

And, as discussed in Chapter 9, there are a number of positive financial implications attached to 1:1 computing, particularly when "properly implemented." These factors all point to the possibility that the rate of 1:1 adoption will accelerate in the future, especially as perceived costs come down (price elasticity) and as more schools become comfortable with technology, either directly or by observing peers and colleagues.

Finding 4: The principal's ability to lead change is critical.

Change must be modeled and championed at the top.

The impact of a good principal has been widely documented.[5] Good principals also contribute to distributive leadership, in which team members surrounding the principal play an important role.[6]

As shown in earlier studies, strong district leadership is also essential for successful schools.[7] All levels of leadership are important, individually and collectively, including school boards, superintendents, and assistant superintendents for curriculum, instruction, technology, finance, and operations.

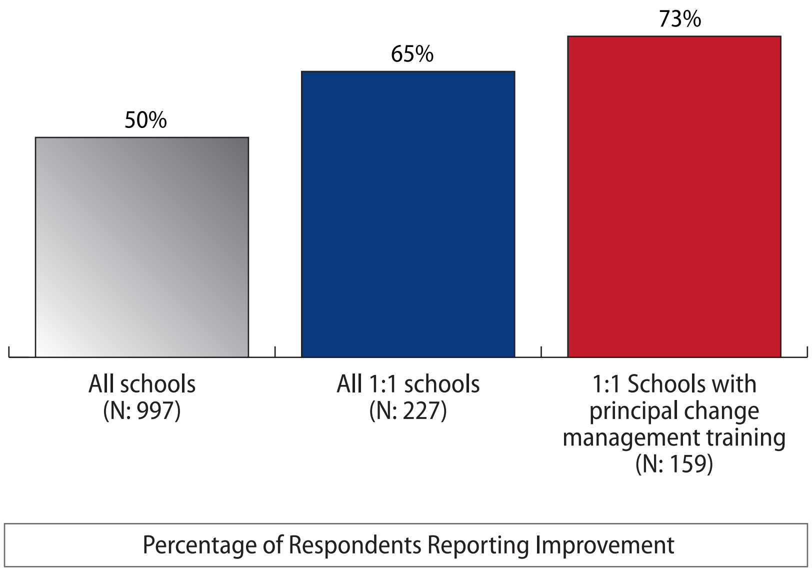
The Project RED analysis shows that within the school the principal is one of the most important variables across the 11 education success measures, suggesting that change leadership training for principals involved in large-scale technology implementations is of paramount importance.

[5] Hattie, John, 2009.

[6] Fullan, M., 2001; Spillane, James P., 2006.

[7] Greaves, T. & Hayes, J., 2006.

Chart 3.4. Disciplinary actions reduced due to technology and principal leadership



As the above chart shows, all schools benefit from technology, and the benefits improve somewhat in 1:1 schools. But when principals receive specialized training and technology is properly implemented, the benefits increase even more.

Since the principal is the driver of professional development within the school, principals must lead the change management that is required to transform a school. They also must lead in the use of data to inform instruction and in the movement from teacher-led to student-centered instruction. These skills may be new to principals who have served primarily as managers in traditional industrial-age schools.

In decentralized school systems, principals are also important to financial improvement. As the trend to decentralization continues, teachers may continue to use traditional paper-intensive copier-based solutions unless the principal models desired behaviors. For example, good principals lead by sending out meeting notices via email instead of hard copy, host online collaborative discussions and communities of practice, and perform classroom observations to ensure technology is being properly used.

Finding 5: Technology-transformed intervention improves learning.

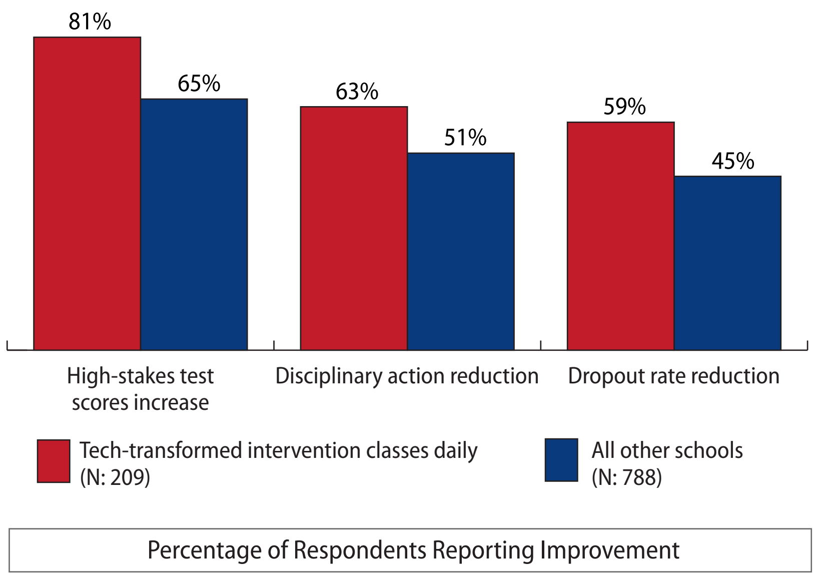
Technology-transformed intervention classes are an important component in improving student outcomes.

Project RED defines technology-transformed intervention classes as those where technology plays an integral role in the class. Generally every student has a computer, and the curriculum is delivered electronically. Students move at their own pace. The teacher is heavily involved but spends most of his or her time in one-on-one or small-group mode rather than lecture mode.

Project RED found that technology-transformed interventions in ELL, Title I, special education, and reading intervention are the top-model predictor of improved high-stakes test scores, dropout rate reduction, course completion, and improved discipline. No other independent variable is the top-model predictor for more than one ESM.

This finding also illustrates the power of the student-centric approach enabled by technology, where students typically work at their own pace. Each student can take the time required to complete the course with demonstrated achievement. A few students will take longer than the traditional semester length, but not many.

Chart 3.5. Technology-transformed intervention classes lead to education success



This finding has significant financial implications. The direct cost of a repeated class is approximately $1,000 per student per class. In schools with technology-transformed interventions, the repeat failure rate is far below the repeat failure rate of re-teaching in the traditional lecture mode.

Finding 6: Online collaboration increases learning productivity and student engagement.

Online collaboration contributes to improved graduation rates and other academic improvements.

Collaboration and interaction among students have long been viewed as important factors in improving student achievement, and participation in study groups is a good predictor of success in college.[8]

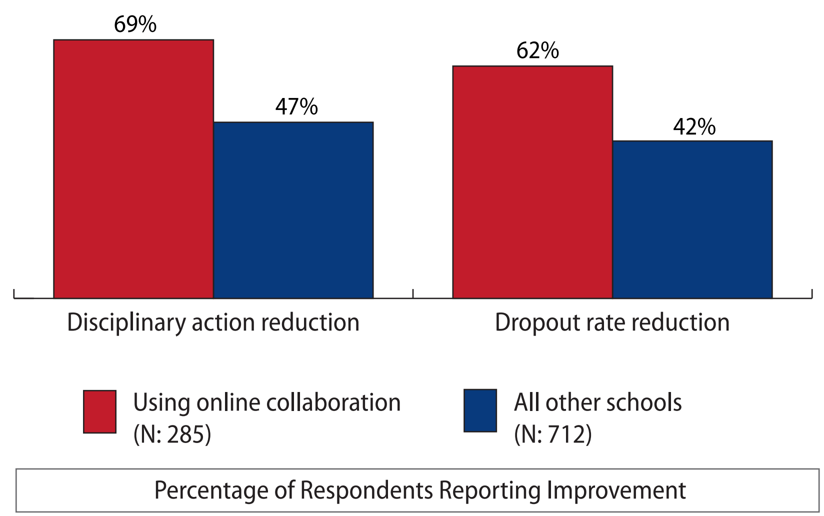
In the past, collaboration and study groups were generally limited to face-to-face interaction,[9] but with the advent of the Internet, students quickly adopted IM or chat, email, or even video conferencing to reach out to peers, allowing for many new collaboration experiences.

The relationship between electronic collaboration and improved performance is subject to some debate, but many students say that if they are stuck on a particular concept, they can use electronic collaboration to quickly query a peer and find an answer.

Web 2.0 social media substantially enhance collaboration productivity, erasing the barriers of time, distance, and money. Collaboration can now extend beyond the immediate circle of friends to include mentors, tutors, and experts worldwide.

Rapid technological advances in the fields of collaboration and social media will no doubt expand the benefits and the level of participation. For example, recent cell phone applications can instantly aggregate access to multiple social media sites.

Chart 3.6. Online collaboration increases student engagement



[8] Richardson, R. & Skinner, E., 1992.

[9] Enterprising students have for years sought out technology-based collaboration methods. A *Cleveland Plain Dealer* article in 1958 featured one of the Project RED authors using Morse code over ham radio to do homework.

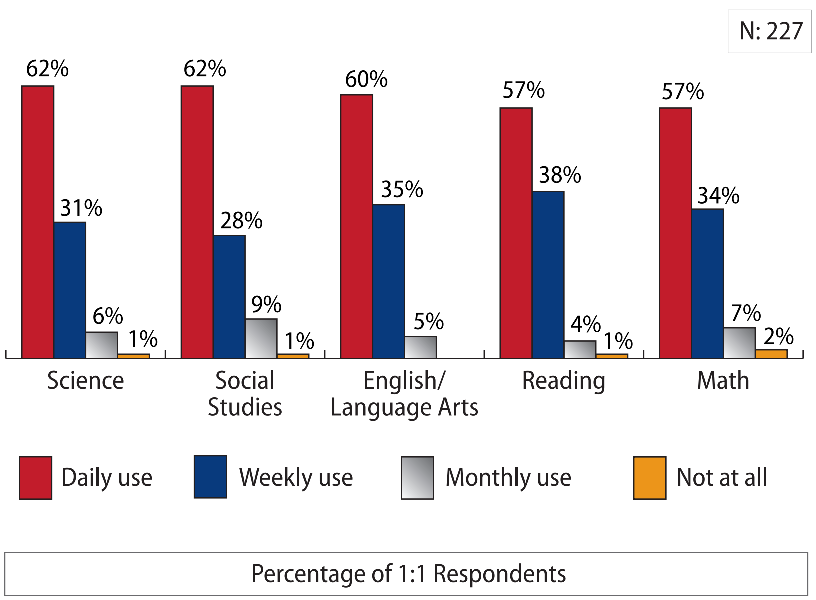
In 1:1 schools where online collaboration tools are used at least daily, discipline is somewhat or greatly improved 69% of the time versus 47% of the time in other schools. Dropout reduction is somewhat or greatly improved in 62% of schools versus 42%.

Finding 7: Daily use of technology delivers the best return on investment (ROI).

Schools must incorporate technology into daily teaching to realize the benefits.

The daily use of technology in core classes correlates highly to the desirable education success measures (ESMs). Daily technology use is a top-five indicator of better discipline, better attendance, and increased college attendance.

Chart 3.7. Use of digital content by 1:1 schools



In 1:1 schools, daily use of technology in core curriculum classes ranges from 51% to 63%. Unfortunately, many 1:1 schools report using the technology on only a weekly basis or less often for many classes.

It may appear surprising that in 40% of 1:1 schools, where every student has a laptop, students do not use the technology on a daily basis. The anecdotal evidence suggests a few answers:

- Some schools move into 1:1 computing based on top-down directives and do not enjoy stakeholder buy-in.
- Many schools have inadequate levels of professional development. *America's Digital Schools 2006* provides strong support for this argument.
- Schools buy the hardware but no courseware. In one large implementation, the hardware vendor who won the bid allocated only 50 cents for software, requiring the schools to supplement the software out of their own budget.
- The laptops are used for less transformative activities. For example, students may be asked to use their computers to view a single website and then write a two-page report by hand on lined paper.
- Computer use is limited to tool use, such as PowerPoint or word processing, with some limited web browsing. Broader uses including digital content with meaningful integration are not employed.

Some educators have asked if technology has to be used daily to be effective or if daily use is overkill. In the judgment of the Project RED team, these questions may be valid in first-order change schools. If technology is just a tinkering around the edges, daily use may not matter or produce better results. However, in second-order change schools, it matters a great deal because technology is embedded in the school and produces results beyond those expected by chance.

Technology-transformed learning is all about learning productivity. It is much faster to look something up on a computer than in a book, but if a student spends only 30 minutes a week on a computer, the maximum productivity benefit is less than 2%. Infrequent access precludes many productive applications. When students must constantly start, stop, and re-acquaint themselves with the technology, learning is further inhibited.

This finding applies to intervention classes, such as Title I and English Language Learning as well as to core curriculum instruction.

Research Basis

Belfield, Clive & Levin, Henry M., T*he Price We Pay: Economic and Social Consequences of Inadequate Education*, Brookings Institution, 2007.

Fullan, M., *Leading in a Culture of Change*, Jossey-Bass, 2001.

Greaves, T. & Hayes, J., *America's Digital Schools,* MDR, 2006.

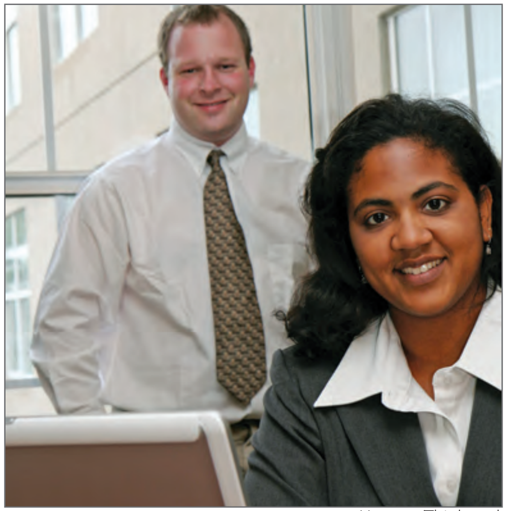
Hattie, John, *Visible Learning: A Synthesis of Over 800 Meta-Analyses Relating to Achievement*, Routledge, 2009.

Richardson, R. & Skinner, E., "Helping First-Generation Minority Students Achieve Degrees," *New Directions for Community Colleges*, 1992, 80, 29-43.

Spillane, James P., *Distributed Leadership*, Jossey-Bass, 2006.

Project RED's findings reinforce the significance of strong leadership at all levels. This is an important and valuable report.

~ Bill Hamilton
Superintendent
Walled Lake Consolidated Schools
Walled Lake, Michigan


Hemera/Thinkstock

Chapter 4

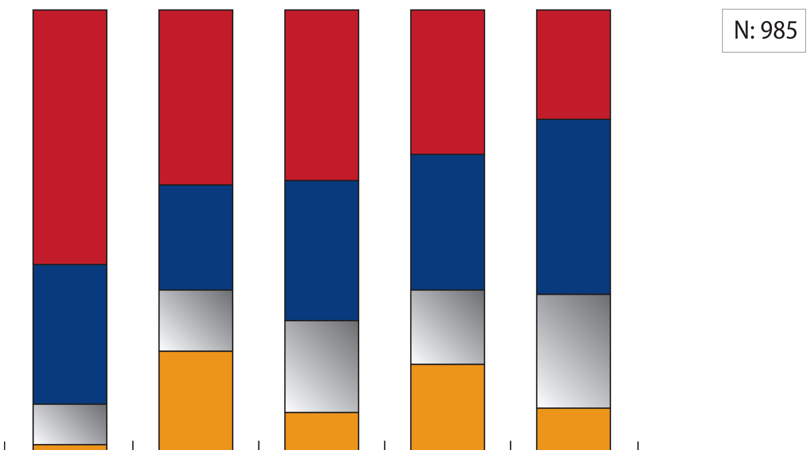
School Leadership

This chapter examines the expectations and observations of principals and other school leaders in regard to student and teacher use of technology for teaching and learning. It also explores how frequently technology is used for specific applications and for principal and teacher professional learning.

While strong district-level leadership is essential to the success of any educational endeavor, the focus of Project RED is on the contribution made by principals and other leaders at the school level.

Chart 4.1. How frequently do you expect your students to use technology in the following activities? (Q17)

Technology Tools Used: Top 5 Principal's Frequency Expectations



	Google or other search engines	Learning Management System (LMS) to receive assignments and submit homework	Collaboration with peers in own school	Communication with teachers via email, chat, or other electronic methods	Games and simulations
Daily use	55%	40%	39%	32%	25%
Weekly use	32%	24%	32%	31%	40%
Monthly/ semester use	11%	14%	21%	17%	26%
Not at all	2%	23%	9%	20%	10%

Percentage of Respondents

Read As

- More than half (55%) of the principals and technology leaders in respondent schools expect students to use search engines daily.
- 64% expect students to use an LMS daily or weekly.
- 71% want students to use technology-assisted collaboration tools with peers in the school daily or weekly.

The chart shows the top five usage categories, and Table 4.1 shows the remaining seven categories.

Table 4.1. Principal's expectations for technology use

Category	Daily Use (%)	Weekly Use (%)	Monthly/ Semester Use (%)	Not at All (%)
Spreadsheets, graphs, tables, and charts	22	37	35	5
Social media (e.g., blogs, tweets, wikis)	21	21	23	35
Student response systems (including clickers)	18	27	33	22
Collaboration with peers in any school	16	18	41	25
Online formative assessments	14	28	45	13
Online summative assessments	11	21	52	15
Virtual field trips	7	16	61	16

Demographic Highlights

Collaboration with peers

- High schools are more likely than elementary or middle schools to expect daily collaboration with peers in any school or their own school using technology.
- Schools with low to medium household incomes are more likely than schools with very low or very high household incomes to expect use of collaboration with peers in their own school.

Communication with teachers

- Schools in the Northeast and Central regions are more likely than schools in the Southeast to expect students to communicate with teachers electronically many times a day.
- Schools in urban areas are more likely than schools in suburban or town and country areas to expect students to communicate with teachers electronically many times a day.
- Schools with medium household incomes are more likely than schools with low household incomes to expect students to communicate with teachers electronically many times a day.

Games and simulations

- Schools in the Southeast and Central regions are more likely than schools in the Northeast or West to expect students to use games and simulations at least daily.

Google or other search engines

- Schools in the Central and Northeast regions are more likely than schools in the West region to expect use of search engines at least daily.
- Schools with very low poverty percentages are more likely than schools with higher poverty percentages to expect use of search engines many times a day.

LMS used for assignments and homework

- Schools in the Central and Northeast regions are more likely than schools in the Southeast region to expect LMS use many times a day.
- Schools in urban and suburban areas are more likely than schools in second city or more remote areas to expect LMS use at least daily.

Online formative assessments

- Schools in the Northeast are more likely than schools in the Southeast to expect no use of online formative assessments.
- Schools in town and country areas are more likely than suburban schools to expect the use of online formative assessments many times a day or at least daily.

Online summative assessments

- Schools in the Northeast and Central regions are more likely than schools in the West to expect the use of online summative assessments at least daily.

Social media

- Schools in the Central and Northeast regions are more likely than schools in the Southeast to expect the use of social media many times a day.
- Schools in urban and town and country areas are more likely than schools in suburban or second city areas to expect the use of social media many times a day.
- Schools with very low household incomes are more likely than schools with high or very high household incomes to expect no use of social media.

Spreadsheets, graphs, tables, and charts

- Schools in the West are more likely than schools in the other regions to expect the use of spreadsheets many times a day.
- Schools in the Southeast are more likely than schools in the Central or Northeast regions to expect no use of spreadsheets.
- Schools with very low poverty or very low minority percentages are more likely than schools in more affluent or diverse areas to expect the use of spreadsheets at least daily.

Student response systems

- Schools in the Southeast are more likely than schools in the Northeast to expect the use of student response systems many times a day.
- Schools in urban areas are more likely than schools in suburban, second city, or town and country areas to expect no use of student response systems.
- Schools with very high poverty are more likely than schools with lower poverty to expect the use of student response systems at least daily.

Virtual field trips

- Schools with low instructional materials expenditures are more likely than schools with high instructional materials expenditures to expect no use of virtual field trips.

Implications

Instruction

The important role of school leaders in ensuring quality instruction, professional learning, and student achievement is well established. The expectations of the principal drive performance and the foundation for those expectations must be driven by research and best practices.

If the principal expects students and teachers to use technology tools frequently, they will do so. Research shows that motivation and engagement increase when students have consistent access to digital learning tools.

Finance

If principals expect frequent use of technology tools in the classroom, the expectation will ensure a return on the school's investment. When students and teachers use technology resources to communicate, teachers can respond quickly to student needs and make appropriate instructional adjustments, and research and collaboration tools available on a just-in-time basis can expedite more productive teaching and learning. This will decrease the need for remediation.

Policy

Quality principal leadership is essential for effective schools and for student achievement. Professional development and university-level preparation, as well as on-the-job and intern experiences, are needed to ensure this kind of leadership. Opportunities include online publishing collaborations, wikis, blogs, and learning communities that collaborate on subscription sites offering up-to-date resources.

School leadership is a key factor for student achievement, and mandates for quality principal development are very helpful. University-level professional growth programs can ensure that theory becomes practice through robust internships, on-the-job coaching, and accreditation. They must include a high level of education technology theory and practice for both instructional and administrative purposes.

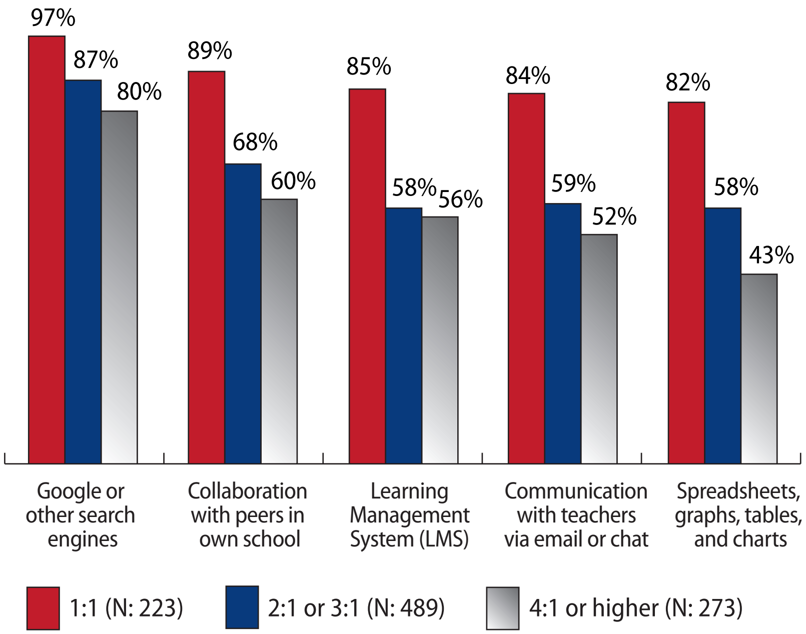
Industry

The increased expectations of schools and the increased use of technology tools, gaming, and simulations present new opportunities.

As Learning Management Systems and collaboration, communication, and gaming tools become integrated into daily teaching and learning, schools need user-friendly and age-appropriate tools, especially those that enhance elementary and middle school student collaboration, along with appropriate professional development. Learning platforms that incorporate these tools and that can be easily integrated into existing infrastructures will be attractive to schools.

Chart 4.2. How frequently do you expect your students to use technology in the following activities? (Q17)

Technology Tools Used: Top 5 Principal's Frequency Expectations



Percentage of Respondents by Student-Computer Ratio Responding at Least Weekly

Read As

- Principals in 1:1 schools expect more frequent technology tool usage than those in schools with higher student-computer ratios. For example, 97% of principals in 1:1 schools expect weekly use of search engines, compared with 87% of those in 2:1 or 3:1 schools and 80% of those in 4:1 or higher-ratio schools.
- *Significance of 1:1 technology:* Principals and other leaders in 1:1 schools have much higher expectations that technology tools will be used for collaboration, research, and instruction. Principals in 1:1 schools report 20 to 30 percentage points higher expectations for usage than schools with 2:1 or higher student-computer ratios.

The chart shows the top five usage categories, and Table 4.2 shows the remaining seven categories.

Table 4.2. Principal's expectations for student weekly use by student-computer ratio

Category	1:1 (%)	2:1 or 3:1 (%)	4:1 or Higher (%)
Games and simulations	75	62	62
Online formative assessments	62	40	28
Social media (e.g., blogs, tweets, wikis)	61	38	32
Student response systems (including clickers)	53	46	37
Online summative assessments	46	31	23
Collaboration with peers in any school	41	33	28
Virtual field trips	32	20	20

Project RED Commentary

Technology is often under-utilized in schools, but when full utilization does occur, several outcomes can be observed.

Search engines

Search engines power up self-directed learning and discovery. Search engines play a critical role in the personalization of teaching and learning. When students use search engines for research, learning deepens and teachers can help students build their information literacy skills as they learn to assess the availability of resources and quality of different sites.

Learning Management System

Schools with an LMS and a computing device for every student enjoy significant productivity advantages. Teachers and students can communicate one-on-one, instruction can be consistently customized based on formative assessments, and the time saved on giving and collecting assignments can be re-allocated to instruction. Research has shown that these advantages are directly tied to student improvement in core curricula. As learning management systems become dramatically more user-friendly and powerful, they are being used more and more widely and transforming how teachers deliver instruction and how students and parents relate to teachers.

Collaboration

Students who collaborate with peers are more highly engaged, learn complex concepts, and improve their reading and math achievement. Learners experience greater school success when they engage in social interactions with their peers and benefit from support, discussion, and feedback.

Student-teacher communication

More frequent communication with teachers helps students improve their performance. Social norms may inhibit students from asking questions in class, but electronic questions can be asked and answered inside and outside of class, allowing for anonymity and privacy while securing the attention of the teacher.

Games and simulations

Quality games and simulations provide learning opportunities far beyond those of textbooks. They evoke a much deeper learning experience by calling on higher-level critical thinking and problem-solving skills. Learners synthesize and analyze strategies to achieve content-related goals.

Spreadsheets, graphs, tables, and charts

These programs provide productivity advantages and preparation for the world of 21st century skills. Students spend less time adding and subtracting numbers and more time applying, analyzing, synthesizing, and strategizing the use of data.

Social media

Social media engage students and provide another way to ask and answer questions tied to academic performance. Learners engage in school more successfully when social networking activities are part of the teaching and learning process.

Student response systems

These tools let every student participate in classroom activities, allowing teachers to determine where each learner is on the achievement continuum and individualize instruction, learning resources, and remediation. This process can be anonymous or open for group viewing.

Online formative assessments

Just-in-time insight into student progress allows teachers to personalize and adjust instruction. This translates to time savings, increased time on task, and regulation of the learning experience. Infrequent assessment causes students to spend too much or too little time on each objective, with serious academic consequences. Teachers also save time on grading papers, distributing tests, and entering grades.

Online summative assessments

Similarly, results are more timely. Also, online assessments have been shown to save money when compared with print.

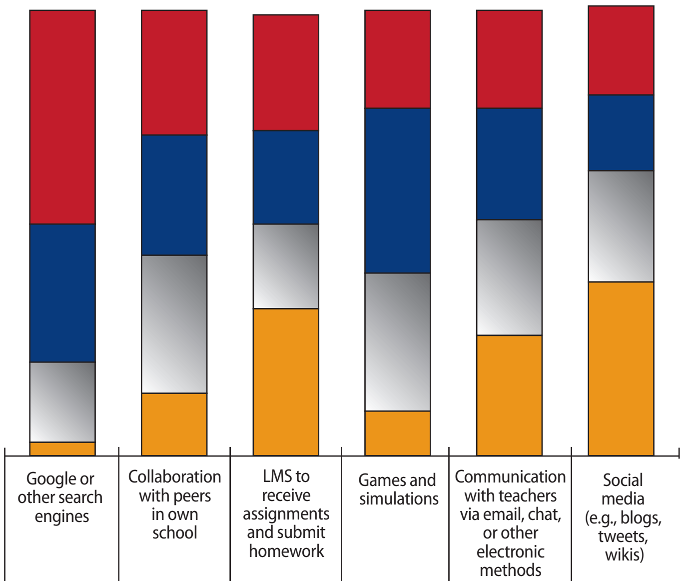
Virtual field trips

Students need a broad range of experiences for academic success. Virtual field trips provide these experiences as well as significant cost savings to districts.

Chart 4.3. How frequently do students actually use technology in the following activities? (Q18)

Top Technology Use by Type: Top 6 Actual Use

N: 980



Google or other search engines	Collaboration with peers in own school	LMS to receive assignments and submit homework	Games and simulations	Communication with teachers via email, chat, or other electronic methods	Social media (e.g., blogs, tweets, wikis)	
48%	28%	26%	22%	22%	20%	Daily use
31%	27%	21%	37%	25%	17%	Weekly use
18%	31%	19%	31%	26%	25%	Monthly/ semester use
3%	14%	33%	10%	27%	39%	Not at all

Percentage of Respondents

Read As

- 48% of respondents report that their students actually use search engines daily (although 55% of respondents expect daily use).
- The greatest consistency between the expected and actual behavior of students is in the weekly use of search engines. 32% of principals and technology leaders expect weekly use, and 31% of students are actually using the Internet weekly.
- The second highest correlation is in the daily and weekly use of games and simulations. 25% of school leaders expect daily gaming and simulations, and 22% of students are actually engaged in these activities on a daily basis. 40% of respondents expect weekly use, and actual student use is 37%.
- 39% of school leaders expect that students will collaborate with peers daily, whereas only 28% report actual daily use.
- 40% of school leaders expect that their LMS will be used on a daily basis, whereas only 26% report actual daily use.

In addition to the most frequently cited categories shown above, other categories and their respective use levels are shown in Table 4.3.

Table 4.3. Actual student use as observed by principal

	Daily (%)	Weekly (%)	Monthly/ Semester Use (%)	Not at All (%)
Spreadsheets, graphs, tables, and charts	15	30	46	8
Student response systems	11	20	39	31
Collaboration with peers in any school	9	11	38	42
Online formative assessments	8	21	51	19
Online summative assessments	6	16	56	22
Virtual field trips	3	12	58	28

Demographic Highlights

Collaboration with peers in any school

- Schools in the Central region are more likely than schools in the West to report collaboration with peers in any school at least daily.
- Schools in urban areas are more likely than schools in suburban and town and country areas to report no collaboration with peers in any school.

Collaboration with peers in own school

- Schools in the Southeast are more likely than schools in the West to report collaboration with peers in their own school at least daily.
- High schools and combined schools, as well as schools with very large enrollments, are more likely than elementary or middle schools, as well as schools with smaller enrollments, to report collaboration with their peers in their own school at least daily.
- Students in schools with very low or low poverty levels are more likely than schools with very high poverty levels to report collaboration with peers in their own school or in any school at least daily.

Communication with teachers via email

- Elementary schools are more likely than high schools to report no communication with teachers via email.
- Schools with very low household incomes or very high poverty are more likely than schools with higher household incomes or lower poverty to report no communication with teachers via email.

Games and simulations

- Middle schools are more likely than elementary schools to report the use of games and simulations many times a day, while high schools are more likely than combined or middle schools to report the use of games and simulations at least daily.

Google and other search engines

- Schools in the Central and Northeast regions are more likely than schools in the Southeast or West to report the use of search engines many times a day.
- Schools with very low poverty or very low minority percentages are more likely than schools with high poverty or higher minority percentages to report the use of search engines many times a day.

Learning Management System

- Schools in the Northeast are more likely than schools in the Southeast to use an LMS many times a day.
- Schools with very low poverty are more likely than schools with very high poverty to use an LMS many times a day.

Online formative assessments

- Schools in the Northeast and West are more likely than schools in the Southeast to report no use of online formative assessments.
- Schools with very low-medium poverty are more likely than schools with very high poverty to report no use of online formative assessments.

Online summative assessments

- Schools in the Northeast are more likely than schools in all other regions to report no use of online summative assessments.
- Schools in urban areas are more likely than schools in suburban, second city, and town and country areas to report no use of online summative assessments.

Social media

- Students in the Central region are more likely than students in the Southeast or Northeast to use social media at least daily.
- Students in schools with low poverty or low minority percentages are more likely than students in schools with higher poverty or minority percentages to use social media at least daily.

Spreadsheets and graphs

- Students in schools with larger enrollments are more likely than students in lower-enrollment schools to use spreadsheets and graphs at least daily.

Student response systems

- Schools in the Northeast are more likely than schools in the Central or Southeast regions to report no use of student response systems.
- Schools with elementary grades are more likely than middle or high schools to report no use of student response systems.
- Schools in urban areas are more likely than schools in outlying areas to report no use of student response systems.

Virtual field trips

- Schools in the Southeast are more likely than schools in the Northeast or Central regions to report virtual field trips at least weekly.
- Schools in the West are more likely than schools in the other regions to report no virtual field trips.

Implications

Instruction

The relationship between student use of technology tools and school leaders' expectations is consistent with the research that demonstrates the important role of leadership in improving student outcomes. Another factor is the accessibility and functionality of technology tools. Consistent access to the Internet exposes students to information for research, analysis, problem solving, and global and local connections.

When integrated into teaching and learning, these resources allow for productivity in knowledge access, evaluation, and real-time content aligned with standards. Gaming and simulation solutions are increasingly higher quality, tied to real-life issues and requiring higher-order thinking and skill sets. They provide a superior alternative to time-extended lab and research experiences with discrete learning activities and analysis.

Finance

The expanded use of digital resources reduces the need for hard-copy resources and textbooks. Digital subscriptions, open source, games/simulations, and teacher- or student-created content all lead to budget savings. Consistent Internet access may require additional up-front resources, but the return on that investment is realized when leaders, teachers, and students move from static tools to dynamic Internet-based tools.

Policy

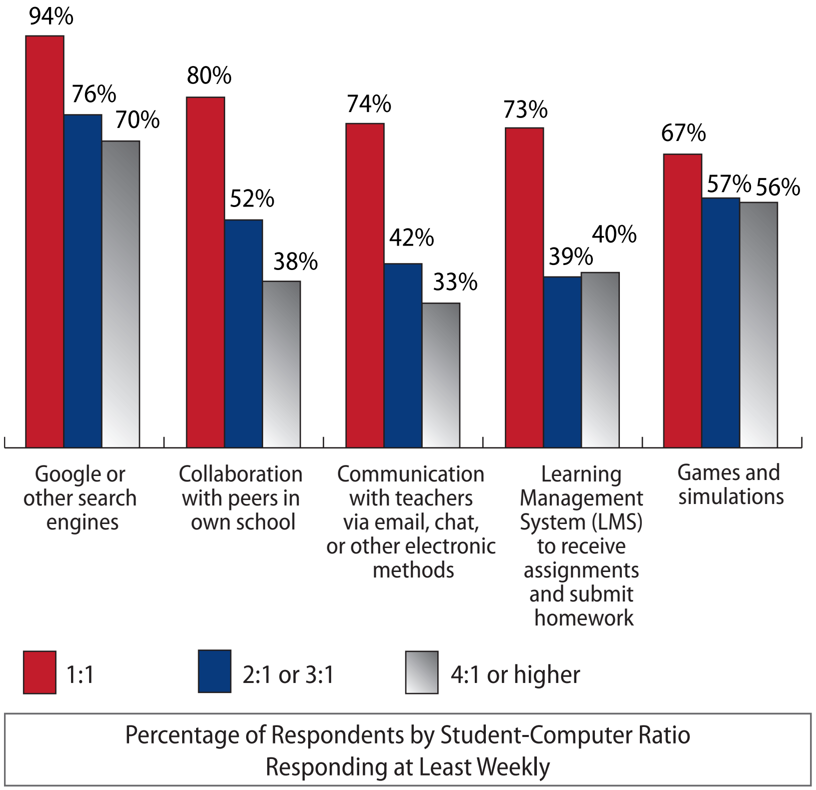
The world is moving from static to dynamic digital resources. Uninterrupted access to the Internet is imperative for a globally competitive education system. Educators, business, and industry will be well served if key decision makers push for resource allocation for last mile and infrastructure development that leads to consistent digital access. Of equal importance is professional training for educators on the effective application of web-based resources in the curriculum and instructional programs.

Industry

Other than in the daily use of search engines, education is still in the embryonic stages of implementing robust technology instruments. This offers industry the opportunity to create user-friendly and grade-friendly instruments that incorporate technology tools, particularly collaboration and Learning Management Systems based on research and best practices in the areas of personalization, formative assessment, and data-driven instruction. Schools will also be looking for the integration of quality professional development.

Chart 4.4. How frequently do students actually use technology in the following activities? (Q18)

Technology Tools Used: Actual Use Estimated – Top Five



Read As

- The highest rate of consistency between the expected and actual rates of student behavior in 1:1 environments is around the use of online search engines. 97% of respondents expect weekly use, and 94% of respondents report actual weekly use.
- The second highest correlation in 1:1 environments is between the expected and actual use of peer collaboration tools. 89% of respondents expect weekly use, and 80% of respondents report actual weekly use.
- Respondents in environments where the student-computer ratio is higher than 1:1 have larger percentage gaps between the expected and actual student use of technology tools.
- *Significance of 1:1 technology:* For over 50 years, education research has pointed to the influence of educators' expectations on student performance. Today, those expectations make the difference between whether or not students use technology tools integrated into learning, affecting their level of preparation for the global economy.

The chart shows the top five usage categories, and Table 4.4 shows the remaining seven categories.

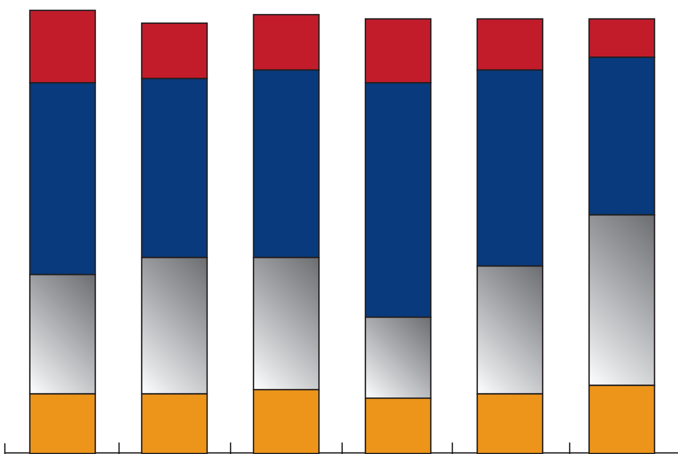
Table 4.4. Student use as observed by principal by student-computer ratio

Category	1:1 (%)	2:1 or 3:1 (%)	4:1 or Higher (%)
Spreadsheets, graphs, tables, and charts	66	43	32
Social media (e.g., blogs, tweets, wikis)	60	33	22
Online formative assessments	50	26	18
Student response systems (including clickers)	40	31	20
Online summative assessments	36	19	16
Collaboration with peers in any school	30	19	13
Virtual field trips	20	12	12

Chart 4.5. Did the principal receive training to prepare to lead a technology-transformed school? (Q19)

Principal's Preparation for Leadership in Technology Initiative

N: 979



The role of the principal in leading change	Best practices for improving academic success	What a technology-transformed classroom looks like	How to get teacher buy-in	Communicating with the community	Preparing for a successful computer distribution	
17%	13%	13%	15%	12%	9%	Course
45%	42%	44%	55%	46%	37%	Ongoing
28%	32%	31%	19%	30%	40%	No training
14%	14%	15%	13%	14%	16%	Don't know

Percentage of Respondents

Read As

- 45% of respondent schools say that the principal receives ongoing professional training in leading change, and 42% say that the principal is engaged in ongoing professional development around best practices for improving academic outcomes.
- 46% of respondents believe that their principals are being prepared on an ongoing basis to communicate with their communities about the technology-transformed school.

Demographic Highlights

Leading change

- In general, schools in the West provide less training than all other regions of the country.
- Schools with low and medium instructional materials expenditures are more likely to provide principals with short courses, while schools with high instructional materials expenditures are more likely to provide principals with ongoing training.
- Schools in the Central and Southeast regions are more likely than schools in the West to provide ongoing training.

Leading a technology-transformed school

- Schools in suburban areas are more likely than are schools in rural areas to provide ongoing training to principals on how to lead a technology-transformed school.

Ensuring teacher buy-in

- Schools with high instructional materials expenditures or high household incomes are more likely than schools with lower expenditures or lower incomes to provide principal training in getting teacher buy-in.

Best practices for improving academic success

- Schools with high expenditures or household incomes are more likely than schools with lower expenditures or incomes to provide principal training in best practices for academic success.
- Schools in suburban and urban areas are more likely then schools in rural areas to provide principal training in best practices for academic success.

- Schools with high poverty are more likely than schools with lower poverty to provide principal training in best practices for academic success.

Communications with the community

- Schools with high instructional materials expenditures or very high household incomes or very low minority percentages are more likely than are schools in less affluent or more diverse areas to provide principal training in communicating with the community.

Preparing for successful computer distribution

- Schools with high instructional materials expenditures are more likely than lower-spending schools to offer principal training in preparing for a successful computer distribution.

Implications

Instruction

Ongoing professional development for school leaders is essential for successful technology initiatives. Leading a technology-transformed school calls for different skills from those needed in a traditional industrial-age school. In order to meaningfully integrate technology into curriculum and instruction, leaders must transform traditional beliefs and teachers must rework traditional teaching practices. In order to set expectations and provide support, leaders must develop insights and skills related to first- and second-order change (see Chapter 2),[1] so that robustly infused technology can create a generative teaching and learning environment.[2]

When school leaders facilitate second-order change, systems become organic—possibilities and discoveries replace right and wrong answers. Students need guided practice in media and Internet literacy, which calls for agility, flexibility, trial and error, and up-front planning on the part of educators. Leadership in all these areas is key to successful technology-transformed classrooms.

Finance

Professional development for all educators, including principals, must be funded in the school budget to support the retooling of teaching practices, improved student outcomes, and higher performing schools.

Policy

Transformed school leadership is needed for school reform. Technology initiatives present new expectations and a shift from traditional to dynamic, self-discovered tools and resources. To effectively use these tools, school leaders need professional growth experiences that help them become nimble thinkers, skilled problem solvers, and confident facilitators of learner-centered models. They must also develop a keen understanding of each person's ability to embrace first- and second-order change. This is difficult work. It is easy to tinker at the edges without affecting the entire system, but only the revamping of the entire system leads to authentic school reform.

To be effective today, education leaders must constantly scan the environment and review new learning models, technology tools, and adaptations and quickly assess rapidly changing knowledge sources.

Education leadership programs need to support lifelong learning for administrators to make sure they can keep pace with the skills required for this century. Federal and state-level policies should require that school leaders pursue ongoing leadership development and demonstrate their skills through supervised practicums. School boards and district administrators must standardize expectations and accountability systems to help leaders develop and practice effectiveness in today's schools.

[1] According to McREL (2005), "First-order change implies a logical extension of past and current practices. Actions associated with a first-order change represent incremental improvements. First-order changes can be implemented with current knowledge and skills. Second-order change implies a fundamental or significant break with past and current practices. This type of change represents a dramatic difference in current practices. Second-order changes require new knowledge and skills for successful implementation."

[2] Klimek, Ritzenhein and Sullivan (2009) define generativity as "the capacity or ability to create, produce, or give rise to new constructs, new possibilities. Generative leadership is a way of being dynamic, of thinking systemically, and of acknowledging natural learning."

Industry

While organizational change theory has already been incorporated into business practice, it is just now emerging in education. Educators can learn best practices and strategies from business leaders and researchers in order to move their organizations forward. Industry can help unpack and adapt business practices so that they are relevant and user-friendly for educators and make the information available online.

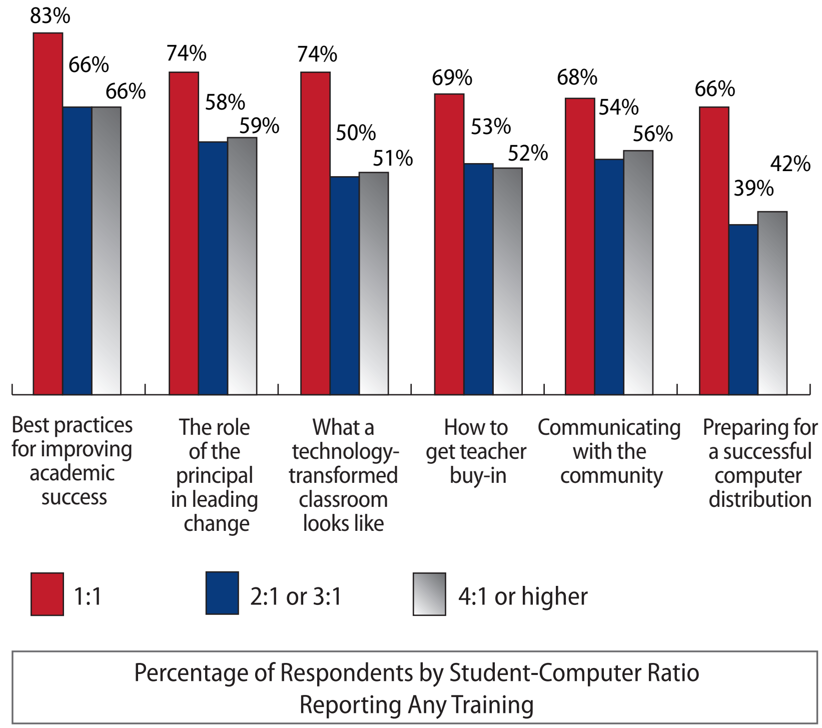
Project RED Commentary

Research makes clear that effective school leadership contributes to improved student achievement. Many educators agree that it is impossible for their school to rise above the capabilities of the principal. Key measures of principal effectiveness include:

- Skillful change leadership
- Conceptual and tactical understanding
- Real system reform versus tinkering around the edges
- Communication about best practices
- A shared and inspiring vision
- Stakeholder buy-in
- Consistent, open communication with and among stakeholders
- Planning for technology acquisition, implementation, and assessment

Chart 4.6. Did the principal receive training to prepare to lead a technology-transformed school? (Q19)

Principal's Preparation for Leadership in Technology Initiative



Read As

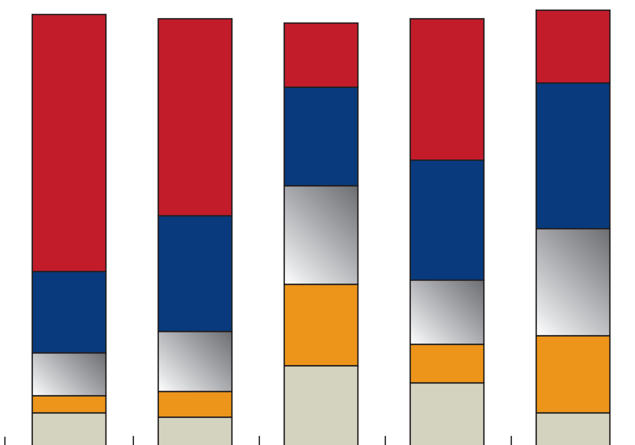
- Respondents report that principals in 1:1 environments generally have had more training than principals in 2:1 and higher-ratio environments in best practices for student success, leading change, the qualities of technology-transformed classrooms, teacher buy-in, community communications, and preparation for large-scale technology distributions.
- 83% of respondents in 1:1 environments report that principals received training in best practices for improving academic achievement. 74% of 1:1 respondents report that principals received professional development around leading change and the qualities of technology-transformed classrooms.

- 69% of 1:1 respondents report that principals received training in teacher buy-in, and 68% report that principals received professional development on communicating with the community about technology initiatives.
- *Significance of 1:1 technology:* The important connection here is between consistently available access to technology and the Internet on the one hand and principals' ability to lead in the enhanced environment on the other. Leadership is crucial to the effective integration and use of technology tools.

Chart 4.7. Describe the principal's role as the leader of the technology initiative. (Q20)

Principal's Leadership in Technology Initiative

N: 979



Models tech use in communications & administration	Regularly scheduled teacher collaboration	Online professional learning opportunities	Change management strategies to lead the school	Regularly scheduled professional learning	
60%	46%	15%	33%	17%	Weekly
19%	27%	23%	28%	34%	Monthly
10%	14%	23%	15%	25%	Quarterly
4%	6%	19%	9%	18%	Annually
8%	7%	19%	15%	8%	Not at all

Percentage of Respondents

Read As

- 60% of respondents report that principals are modeling the use of technology in their administrative tasks and communications at least weekly.
- 46% report that principals facilitate weekly time for regularly scheduled teacher collaboration, and 15% arrange weekly scheduled time for teachers' online professional learning activities.
- 33% report that principals are using change management leadership strategies on a weekly basis.

Demographic Highlights

Professional learning for teachers

- Principals in the Southeast are more likely than principals in the West to offer regularly scheduled professional learning for teachers at least weekly.
- Principals in very high poverty areas are more likely than principals in areas with less poverty to offer regularly scheduled professional learning for teachers at least weekly.

Collaboration

- Principals of elementary and middle schools are more likely than principals of high schools to offer scheduled time for teacher collaboration at least weekly.
- Principals in second-city lifestyle areas are more likely to offer regularly scheduled time for teacher collaboration at least weekly than principals in town and country or urban lifestyle areas.
- Principals in very high or high poverty areas or with a very high minority percentage are more likely than principals in more affluent areas or in areas with lower minority percentages to offer regularly schedule time for teacher collaboration at least weekly.

Online professional learning

- Principals in the West and Central regions are more likely than principals in other regions to offer no online professional learning opportunities.
- Principals in areas with very low household incomes or very high poverty are more likely than principals in schools in more affluent areas to offer online professional learning opportunities at least weekly.

Modeling technology use

- Principals in schools with very high poverty or very high minority representation are more likely than principals in more affluent or less diverse areas to model technology use at least weekly.

Change management

- Principals in rural areas are more likely than principals in urban areas to use no change management strategies to lead the school.
- Principals in schools in very high poverty areas or with very high minority percentages are more likely than principals in more affluent or less diverse schools to use change management strategies to lead the school at least weekly.

Implications

Instruction

Teachers must continually hone their ability to create and improve the 21st century computer-enhanced learning environment. Professional learning is essential for their growth in effectively integrating education technology. Commitment and high expectations lead to increased student success.

Finance

When teachers are performing at capacity, the result is increased student achievement and matriculation and fewer dropouts. The need to retool and discipline ineffective teachers is reduced when every teacher is engaged in consistent learning opportunities. If teachers are meeting learner needs, there can be savings in remedial interventions, and teachers collaborating on student needs can reduce the need for costly special education referrals and services.

Policy

Federal, state, and local policies must set standards of leadership, accompanied by accountability measures, that ensure effective school transformation.

It is well established that educators need consistent, ongoing professional growth in pedagogy, best practices, research, content, curriculum, and the personalization of instruction. We also know that educators learn best through the on-the-job application of best practices, reflection with peers, and collaboration on how to implement theories in the classroom. Two important responsibilities of the principal as leader are to build these activities into the life of the school and model the expectations.

Industry

Recent U.S. Department of Education (USDOE) research shows that the most effective instructional platform is a combination of face-to-face and online learning.[3] And since schools have continual budget constraints, moving a large portion of the professional learning program to an online format makes economic sense.

Industry has an opportunity to provide top-quality, cost-effective learning experiences that are accessible 24/7, with a moderator who provides ongoing direction and feedback. This combination is likely to become the leading mode of educator preparation and lifelong learning and impact higher education and teacher and administrator preparation programs. The more contemporary and innovative the program, the more likely that educators will gravitate to the experience.

Another opportunity for industry is to develop advanced collaboration and productivity tools for educators. More and more principals are providing time for teacher collaboration and interaction, with joint problem solving and other forms of productivity. Moving these activities to online, web-, and cloud-based systems will be the way of the future.

[3] U.S. Department of Education, Office of Planning, Evaluation and Policy Development, 2010.

Project RED Commentary

The principal's leadership has a major impact on education technology usage and hence on student outcomes. This question provides insights into how principals guide the professional learning process and implement various options, each of which has different consequences in terms of time, cost, and results.

Models technology use

Teachers are more apt to follow leaders who practice what they preach.

Enables collaboration time

Unlike many professionals, teachers are very schedule-bound. Time to learn and collaborate must be built into their schedule. If release time is required, there may be a significant cost for substitutes.

Enables online professional learning

Blended professional learning, a combination of face-to-face and online, is generally accepted as the most efficient practice.

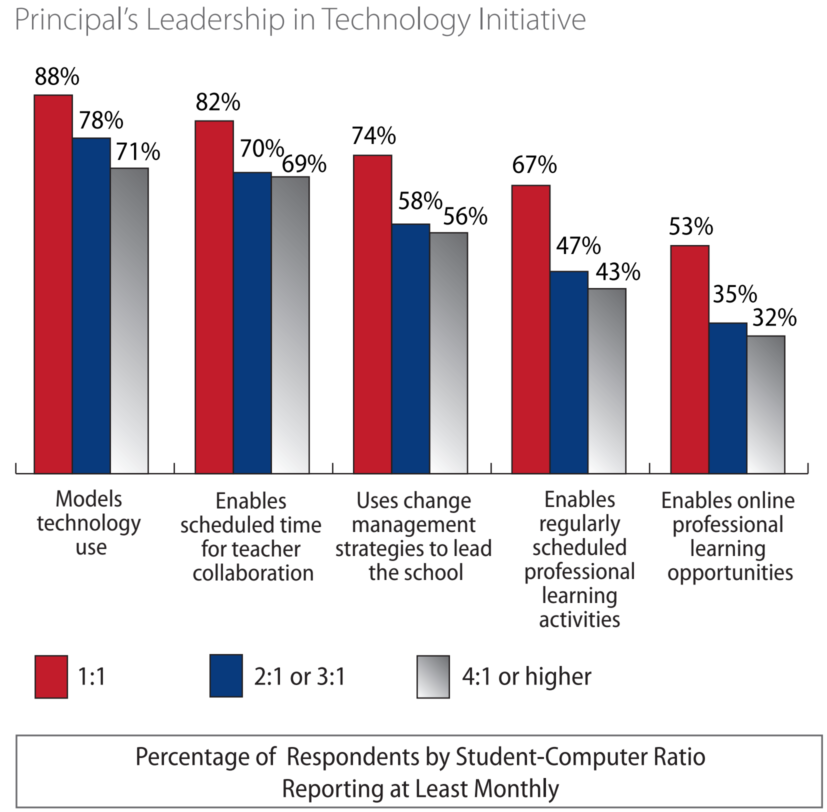
Uses change management strategies

Change leadership is perhaps the most critical aspect of effective technology adoption and implementation. Organizational change is a well-researched field. However, most school leaders are change leadership novices.

Enables regularly scheduled professional learning

Professional learning takes time, and principals control time. It also takes planning, and principals must drive the planning process.

Chart 4.8. Describe the principal's role as the leader of the technology initiative. (Q20)



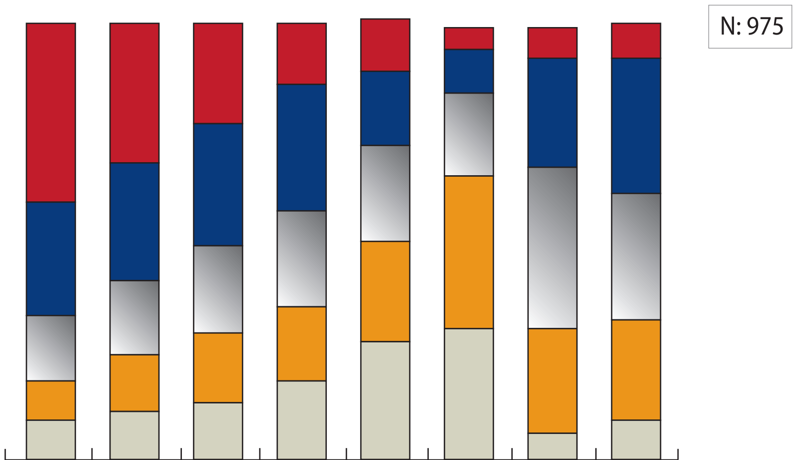
Read As

- Overall, respondents in 1:1 environments report a larger role for the principal as leader of the technology initiative than respondents in 2:1 and higher-ratio environments.
- 88% of respondents in 1:1 environments report that the principal models technology use on a monthly basis. 74% report that the principal uses change management strategies on a monthly basis.

- 82% of respondents in 1:1 environments say that the principal enables scheduled monthly teacher collaboration time, and 67% say that the principal enables scheduled monthly professional learning activities (53% online).
- *Significance of 1:1 technology:* Leadership is critical to the success of any school reform effort. In this case, the principals' behaviors highly influence those of teachers and students. More principals in 1:1 environments model and provide professional development for teachers than principals in environments with higher student-computer ratios.

Chart 4.9. In support of your tech program, how frequently does the typical teacher experience the following professional learning activities? (Q21)

Professional Learning Activities: Frequency for Teachers



Co-planning	Collaboration	Coaching	De-briefing on mentoring	In-class mentoring (shoulder to shoulder)	Online professional learning courses	District-provided professional learning	Faculty/dept training and meetings focused on integration of technology into the curriculum	
41%	32%	23%	14%	12%	5%	7%	8%	Weekly
26%	27%	28%	29%	17%	10%	25%	31%	Monthly
15%	17%	20%	22%	22%	19%	37%	29%	Quarterly
9%	13%	16%	17%	23%	35%	24%	23%	Annually
9%	11%	13%	18%	27%	30%	6%	9%	Not at all

Percentage of Respondents

Read As

- 41% of principals and technology leaders say that the average teacher is co-planning weekly with colleagues regarding technology integration, and 32% are collaborating weekly.

- 23% of respondents report that the average teacher is involved in coaching related to the technology initiative.
- 28% of respondents are engaged in monthly coaching, 29% are debriefing their mentorships on a monthly basis, and 22% are debriefing quarterly.
- 30% of respondents note that teachers are not accessing online professional development, while 35% report that teachers are taking online courses on an annual basis.

Demographic Highlights

Co-planning

- Teachers in the Northeast are more likely than teachers in the Central or West regions to co-plan at least weekly.
- Teachers in middle schools are more likely than teachers in high school or elementary schools to co-plan at least weekly.
- Teachers in very high or high poverty areas are more likely than teachers in elementary or high schools to co-plan at least weekly.

Coaching

- Teachers in the Southeast are more likely than teachers in the Central region to be offered coaching at least weekly.
- Teachers in schools with very low to medium household incomes are more likely than teachers in areas with high or very high household incomes to be offered coaching at least weekly.
- Teachers in urban areas are more likely than teachers in second city areas to be offered coaching at least weekly.

Debriefing on coaching and mentoring

- Teachers in the Southeast are more likely than teachers in other regions to debrief on coaching and mentoring at least weekly.
- Teachers in very high poverty or very high minority percentage schools are more likely than teachers in less affluent or more diverse areas to debrief on coaching and mentoring at least weekly.

District-provided professional learning

- Teachers in the West and in urban areas are less likely than teachers in other regions and metro areas to have district-provided professional learning.

Faculty departmental training

- Teachers in the West are more likely than teachers in other regions to have no faculty/departmental trainings on integrating technology into the curriculum.

In-class, shoulder-to-shoulder mentoring

- Teachers in the Northeast, Central, and Southeast regions are more likely than teachers in the West to receive in-class, shoulder-to-shoulder mentoring at least weekly.
- Teachers in urban areas are more likely than teachers in other metro areas to receive in-class, shoulder-to-shoulder mentoring at least weekly.
- Teachers in areas with very high poverty or low or very low household incomes are more likely than teachers in more affluent areas to receive in-class, shoulder-to-shoulder mentoring.

Online professional learning

- Teachers in the Southeast are more likely than teachers in other regions to be offered online professional learning courses and online professional learning communities at least weekly.
- Teachers in very high poverty or very high minority areas are more likely than teachers in more affluent areas to be offered online professional learning courses at least weekly.

Teacher collaboration

- Schools in the Southeast are more likely than schools in all other regions to report teacher collaboration at least weekly.
- Schools in urban areas are more likely than schools in second city, suburban, and town and country areas to report no use of teacher collaboration.

Implications

Instruction

It is well established that professional learning is crucial to teaching quality. A key component is combining new learning with on-the-job experience, reflection, and debriefing. Coaching and mentoring are ideal for adult learning because they fuel personal awareness through personalized reflection. Co-planning, collaborating, coaching, and debriefing are key elements for professional learning communities.

Teachers involved in these professional interactions are able to hone their skills by applying knowledge on the job and reflecting on and debriefing those experiences with colleagues. These teacher experiences translate to better classroom practices and highly informed instructional techniques, enhancing the opportunity for personalization.

While online professional learning is accessible and evolving, our respondent schools are participating at a low level. The national emphasis on productivity and accountability makes it increasingly imperative that teachers regularly access knowledge and information for enhancing teaching and learning. Online professional learning is cost-effective and expeditious for achieving this goal.

Finance

Professional learning that builds internal capacity rather than supporting episodic training events produces a tremendous return on investment. When teachers learn and grow together, the need for outside consultants disappears over time. Coaching, collaborating, and co-planning can be incorporated into a teacher's daily or weekly schedule using creative scheduling. And high standards for teacher growth and a way to achieve those standards increase teacher productivity and the focus on instructional techniques.

Each of these elements reduces the costs of travel and substitutes that occur when teachers must leave the school building for professional development. Funds saved can be redeployed toward improving student achievement. Blending online professional development with face-to-face is highly cost-effective.

Policy

Effective school leaders provide ongoing, embedded professional development in order to ensure best practices for new century education. Federal, state, and local policies should support the expectation that principals actively seek, develop, and implement robust professional learning for themselves and their teachers.

Increased internal capacity for building student achievement and teacher growth decreases external support costs. Virtual experiences are cost-effective, at minimum eliminating the costs of travel and substitutes. When educators become coaches and resources for each other, they begin to expect growth and use best practices, leading to increased student success.

Online professional learning will increasingly replace the need to travel to gain knowledge and skills. Online professional networks of best practices will increase just-in-time access to,[4] as well as the exchange and application of, quality instruction, although ongoing face-to-face interaction will still be essential in certain situations. The power of getting people to sit down together to work on a problem cannot be underestimated.

Industry

As noted earlier, recent USDOE research shows that the most effective instructional platform is a combination of face-to-face and online learning. Industry can benefit by helping schools relieve their ongoing budget issues by providing professional learning programs in online formats. Industry can ensure top-quality, cost-effective learning experiences, accessible 24/7, with a moderator providing ongoing direction and feedback. This combination will become the leading mode of educator preparation. Lifelong professional learning will also impact teacher and administrator preparatory programs. The more contemporary, responsive, and personalized the program, the more likely that educators will gravitate to the experience.

[4] For example, teachers can access a web page right before teaching a lesson on multiplying fractions, with all the information necessary to teach that standard and a brief video clip of effective ways to teach that standard.

Another opportunity for industry is to develop advanced collaboration and productivity tools for educators. More and more principals are providing time for teacher discussion and interaction, with joint problem solving and other forms of productivity. Moving these activities to online, web-, and cloud-based systems will lead the future.

Project RED Commentary

Each practice surveyed in this question has specific merits. Schools may use all to varying degrees.

Co-planning

Peer learning allows best practices to be shared, practiced, and debriefed.

Collaboration

When teachers collaborate, they discuss, practice, and assess elements of their craft. Research on adult learning shows that these are key attributes for professional growth. When teachers model collaboration, they experience the power of cooperative sharing and can begin to integrate it in instructional programs for students.

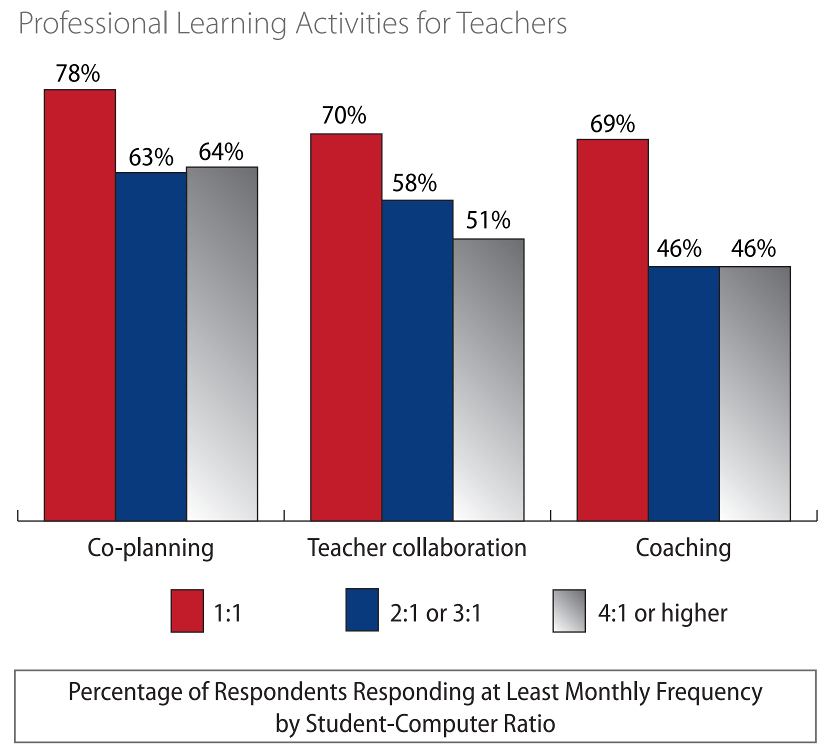
Coaching

Coaches model, observe, discuss, challenge, and assess for best practices. The coaching framework builds a safe professional learning community where adult learners can share, collaborate, experiment, and grow.

Debriefing on mentoring

Debriefing provides an opportunity for reflection and allows areas of success and improvement to be identified. Continuous improvement of the teaching process improves academic achievement.

Chart 4.10. In support of your tech program, how frequently does the typical teacher experience the following professional learning activities? (Q21)



Read As

- On the whole, a larger percentage of respondents from 1:1 environments report that teachers are experiencing at least monthly professional learning activities.
- Across all student-computer ratio environments, the highest percentage response rate is for teacher monthly co-planning. The second highest is for teacher collaboration.

- The highest rate (78%) of respondents in 1:1 environments say that teachers are co-planning, and the second highest response rate (70%) say that teachers are collaborating on at least a monthly basis.
- 69% of 1:1 respondents say that teachers are engaged in monthly coaching. 56% report that they are debriefing their coaching experiences.
- *Significance of 1:1 technology:* The lower the student-computer ratio, the higher the rate of professional collaboration, co-planning, and coaching.

Project RED Commentary

Professional learning (also called professional development) has been the most frequently overlooked component of technology integration since schools began using technology. As long ago as 2000, the U.S. Department of Education tried to set a model expectation by requiring that 25% of all EETT (Enhancing Education Through Technology) funds be set aside for professional development.

To make professional learning an essential part of technology in instruction, more time must be spent on the activities identified here. For example, while schools with 1:1 student-computer ratios report higher frequency than schools with higher ratios, less than half of 1:1 schools report use of in-class mentoring at least weekly. Since in-class mentoring is one of the most effective kinds of professional learning, frequency as well as appropriate planning is critical.

Research Basis

Chesbro, Patricia & Boxler, Nancy, "Weaving the fabric of professional development in the 21st century through technology," *Journal of Staff Development*, 2010, v31, n1, 48-53.

Clifford, Matthew, *Hiring Quality School Leaders: Challenges and Emerging Practices*, Learning Point Associates, 2010.

Eck, James & Goodwin, Bryan, "Autonomy for school leaders," *The School Administrator*, 2010, v67, n1, 24-27.

Kaasila, Raimo & Lauriala, Anneli, "Towards a collaborative, interactionist model of teacher change," *Teaching and Teacher Education: An International Journal of Research and Studies*, 2010, v26, n4, 854-862.

Klimek, Karl J.; Ritzenhein, Elsie; & Sullivan, Kathryn D., *Generative Leadership: Shaping New Futures for Today's Schools*, Corwin Press, 2008.

Kurland, Hanna; Peretz, Hilla; & Hertz-Lazarowitz, Rachel, "Leadership style and organizational learning: The mediate effect of school vision," *Journal of Educational Administration*, 2010, v48, n1, 7-30.

Marzano, R. J.; Waters, T.; & McNulty, B. A., *School Leadership That Works: From Research to Results*, Association for Supervision and Curriculum Development, 2005.

Mouza, Chrystalla & Wong, Wilkey, "Studying classroom practice: Case development for professional learning in technology integration," *Journal of Technology and Teacher Education*, 2009, v17, n2, 175-202.

Musanti, Sandra I. & Pence, Lucretia, "Collaboration and teacher development: Unpacking resistance, constructing knowledge, and navigating identities," *Teacher Education Quarterly*, 2010.

Reeves, Douglas, *The Learning Leader: How to Focus School Improvement for Better Results*, Association for Supervision and Curriculum Development, 2006.

Rhodes, Christopher & Brundrett, Mark, "Leadership development and school improvement," *Educational Review*, 2009, v61, n4, 361-374.

Ramaswami, Rama, "Best of both worlds," *Campus Technology*, 2009, v23, n1, 24-31.

Strom, Paris; Strom, Robert; Wing, Charlotte; & Beckert, Troy, "Adolescent learning and the Internet: Implications for school leadership and student engagement in learning," *Education Digest: Essential Readings Condensed for Quick Review*, 2010, v75, n6, 10-16.

U.S. Department of Education, Office of Planning, Evaluation and Policy Development, Policy and Program Studies Service, *Evaluation of Evidence-Based Practices in Online Learning: A Meta-Analysis and Review of Online Learning Studies*, 2010.

Wallace, Scott A.; McCartney, Robert; & Russell, Ingrid, "Games and machine learning: A powerful combination in an artificial intelligence course," *Computer Science Education*, 2010, v20, n1, 17-36.

Waters, Tim & Kingston, Sally, "The standards we need: A comparative analysis of performance standards shows us what is essential for principals to know and be able to do to improve achievement," *Leadership*, 2005, v35, n1, 14.


iStockphoto/Thinkstock

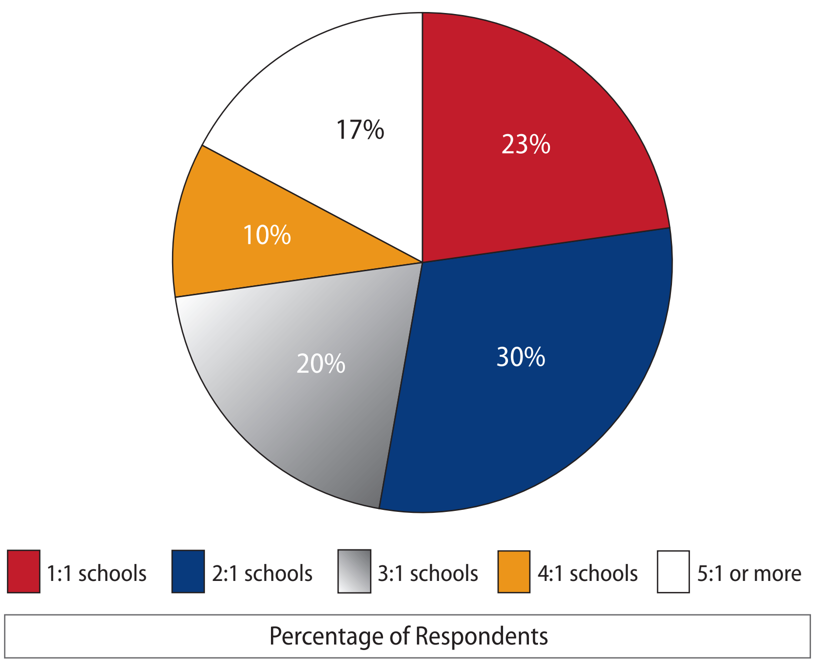
Chapter 5

School Environment

This chapter examines how the environments of the surveyed schools vary based on student-computer ratio and other factors, as well as the representativeness of the sample compared with all U.S. schools.

Chart 5.1. What is the student enrollment in your school? What is the total number of computing devices (desktops, laptops, netbooks, tablets, smartphones, thin clients, etc.) being used in your classrooms? (Q3, Q4)

Schools by Students Per Computer Ratio



Read As

- 20% of Project RED respondent schools have a student-computer ratio of 3:1 (3 students per 1 computer).
- 30% of Project RED respondent schools have a student-computer ratio of 2:1 (2 students per 1 computer).

Table 5.1. Respondent base by students per computer

Category	Number	% of Total
1:1 Students per computer (.1 to 1.3)	227	23
2:1 Students per computer (1.4 to 2.3)	295	30
3:1 Students per computer (2.4 to 3.3)	199	20
4:1 Students per computer (3.4 to 4.3)	104	10
5:1 Or more students per computer (4.4 or more)	172	17
Total	997	100

The Project RED respondent base contains a higher percentage of 1:1 schools (23%) than the general population (approximately 2%). To offset this imbalance, every effort has been made to report results separately for 1:1 learning environments.

In order to examine all respondent questions in light of the student-computer ratio, a compressed set of categories was created to exemplify the differing nature of the responses. These three categories are used throughout the report to compare student-computer ratios.

Table 5.2. Aggregated categories for students per computer

Category	No. of Respondents	% of Respondents
1:1 Students per computer	227	23
2:1 or 3:1 Students per computer	494	50
4:1 Or more students per computer	276	27
Note: 2:1 schools perform more like 3:1 schools than 1:1 schools.		

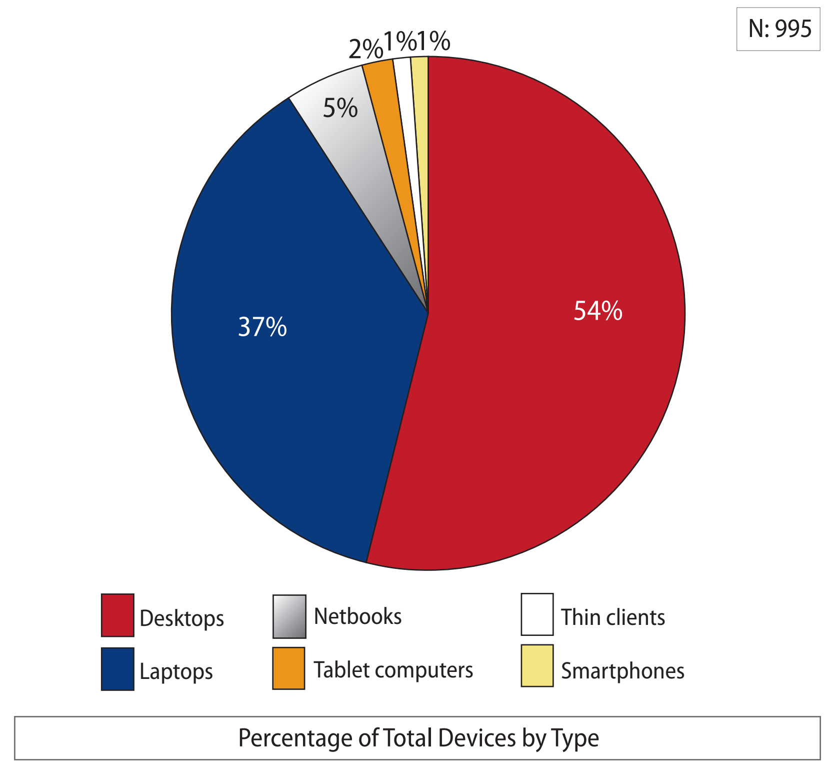
Demographic Highlights

- Respondents with 1:1 student-computer ratios are significantly more likely to be in the West than in other regions. Similarly, schools with 2:1 or 3:1 student-computer ratios are significantly more likely to be in the other three regions than in the West.

- Project RED 1:1 respondent schools do not reflect the popular belief that 1:1 schools are smaller and more affluent than typical schools.
  - **Lifestyle.** 1:1 respondent schools are significantly more likely to be in urban areas than in small towns, suburban or rural areas, while schools with 4:1 or higher student-computer ratios are significantly more likely to be in rural areas.
  - **Student enrollment.** 1:1 respondent schools are significantly less likely to be very low enrollment schools, while schools with 3:1 and 4.1 or higher student-computer ratios are significantly more likely to be very low enrollment schools. (Schools with 4.1 or higher ratios are also significantly more likely to be very high or high enrollment schools.)
  - **Instructional materials expenditures.** 1:1 respondent schools are significantly more likely to have low instructional materials expenditures than medium or high expenditures.
  - **Household income.** 1:1 respondent schools are significantly more likely to have medium household incomes than high or low household incomes.
  - **Poverty.** There are no significant differences for 1:1 respondent schools in poverty, but schools with a 4.1 student-computer ratio or higher are significantly more likely to be low poverty (not very low) or very high poverty.
  - **Minority percentage.** 1:1 respondent schools are significantly more likely to have a medium minority percentage than a low or high minority percentage.

Chart 5.2. Please enter an approximate number for each computing device used in your classroom. (Q5)

Computing Devices by Device



Read As

- At 54% of total, desktops are the most prevalent device. 95% of respondents report that they have desktops in their environment. The highest percentage was found in elementary schools, with penetration of almost 98%, followed by high schools at 92% and middle schools at 90%—a different mix from laptops.

- At 37% of total, laptops are a fast-growing category in the schools of the Project RED respondents. 91% of respondents report that they have laptops in their environment. The distribution is more weighted to secondary schools—94% of middle schools, 92% of high schools, and 88% of elementary schools.
- Only 5% of total devices reported are netbooks, with 13% of schools reporting some number of netbooks in their environment. The breakdown across grade levels is approximately 10% elementary schools, 10% middle schools, and 16% high schools.
- Just over 2% of total devices reported are tablets, but the percentage of schools with some number of tablets is equal to that of netbooks at 13%. The breakdown across grade levels is approximately 8% elementary schools, 13% middle schools, and 15% high schools. All but two respondents completed the survey before iPads were shipped, thus understating tablet share.
- Only 1% of total devices reported are smartphones, and 33 of the 144 schools that report having smartphones have only one device. When subtracting respondents with only one or two smartphones, the implementation percentage remains in the low single digits across all grade levels.
- Only 1% of total devices reported are thin clients. The breakdown across grade levels is evenly distributed—approximately 3% of elementary and middle schools and 4% of high schools.

Demographic Highlights

- Schools in the Southeast are significantly more likely than schools in the West or Central regions to report a 1:1 student-laptop ratio.
- Schools with elementary grades are significantly less likely than middle or high schools to report a 1:1 student-laptop ratio.

Implications

Instruction

Mobile devices now constitute 45% of the computing devices used in schools (laptops, netbooks, tablets and smartphones). However, different implementation levels may limit the benefits of mobile computing. The Michigan Freedom to Learn program, for example, saw high levels of usage in English language arts, social studies, and science and low levels of usage in math.

The tablet PC seems to hold promise for increasing student usage in math. According to Petty and Gunawardena (2007), "The computer [tablet PC] becomes 'intelligent paper,' capturing the benefits of the digital environment and traditional paper." The benefits seem to be equally shared by teachers and students, with the tablet PC providing a new level of freedom and interactive learning in the classroom (Olivier, 2005).

Since the survey was conducted, the iPad, and soon many other competitors, have found strong acceptance in schools among early adopters. Given inevitable advances in technology, iPad-type devices will only grow in popularity.

Ubiquitous technology programs face difficult financial and philosophical challenges in today's economic climate, in which superintendents and school boards must often cut programs and lay off teachers. In an era of high-stakes test scores and teacher accountability, it can be difficult to motivate teachers and administrators to move to more student-centered learning. And because the benefits of a ubiquitous educational technology program are realized over several years, many schools opt for short-term fixes and stopgap measures.

Although traditional computer labs cannot provide continuous access for all students, they can enhance learning opportunities by providing access to online information, assessments, and daily classes scheduled by teachers. Computer labs are also being used effectively to provide advanced placement opportunities and other online courses.

Cell phones remain controversial in the educational setting. Very few schools are supplying smartphones to students. Schools often require students to shut off their phones during the school day and punish those who are seen using them. However, this technology is being used in several instructionally appropriate ways. For example, cell phones are being adapted for use as response clickers, students are using the stopwatch function in science labs and physical education, and students are using the camera function to take pictures for media presentations.

Finance

As laptops continue to replace desktops, the potential for cost savings will increase, for example, by replacing textbooks with digital content. However, this cost benefit can only be realized when all students have continuous access to a computing device connected to the Internet. Paper and copying costs will also decline, and efficiencies in testing, grading, and reporting will increase (see Chapter 9).

Policy

Schools are moving to mobile computing at a breakneck pace, affecting many aspects of the school environment. Policymakers must address the issues of safety, privacy, and cyber-bullying before individual schools become too restrictive.

Industry

The move to mobile computing affects all segments of the educational technology industry. It is important to be aware that computers in schools are aging at an alarming rate, and funding for replacements is dwindling just as fast. Unfortunately, schools are not thinking in terms of refresh cycles in the current environment of strong budget constraints.

Project RED Commentary

Hardware

Although hardware manufacturers are well aware of the shift from desktop to mobile computing, too little R&D is going into this segment. Most devices were developed for the consumer or business markets and are not optimized for schools. Since school volumes are not huge, the argument can be made that there is no need for a custom product, but schools might argue that they would buy more if a product truly met their needs.

America's Digital Schools 2008 identified the requirement for eight-hour battery life in schools, with everything running. Very few devices meet these criteria. The consequences are messy, with extension cords and power strips littering the classroom. And the cost of external batteries and gang battery chargers is substantial.

The widespread assumption that netbooks are more appropriate for younger students may be erroneous, as seen in the Project RED survey data. *America's Digital Schools 2008* reported that "purpose-built student machines like the Intel Classmate have been announced but have yet to appear in significant numbers in U.S. classrooms." With 10% to 16% of schools now reporting the use of netbooks, it is clear that these smaller, less expensive devices are penetrating the education market. This is due in part to netbook improvements, such as larger screens, larger keyboards, and more powerful processors. The lines between a netbook and a low-end laptop are blurring.

It is clear that smartphones and thin clients are not currently playing a major role in schools. It is not feasible for schools to pay the hefty monthly service plan fees for phones, and innovative thinking will be needed to address this issue. In 2008, thin clients were rebranded as the "green" solution. Although their energy savings may be significant for large corporations with tens of thousands of devices, this strategy did not seem to move the education sector.

The move to virtualize the desktop was also seen as a potential driver for the adoption of thin clients. As more applications become web-based, virtualization will play an ever-increasing role, as indicated by the emergence of netbook solutions deployed in a cloud environment.[2] Netbooks seem to be a hybrid of a traditional laptop computer and a thin client, and the Project RED survey results indicate that the netbook solution seems to be winning out over the thin client.

[2] "Most IT departments will need to implement some degree of browser-based thin computing over the next few years but will retain a majority user base of fat clients," from Trends in Thin Client Computing: Mixing Thin Clients, Browsers, and Traditional Apps, Scott Alan Miller, *Datamation.com*, February 18, 2010, http://itmanagement.earthweb.com/features/article.php/3865726/Trends+in+Thin+Client+Computing.htm.

Software

Many software publishers appear to be unaware of the switch from desktop to mobile computing. Of the several thousand software programs on the market, very few require or fully exploit the capabilities of ubiquitous computing environments. Most software is written to run well in a wired LAN environment. Almost no software is written to run well in less robust, higher latency, 3G or 4G environments.

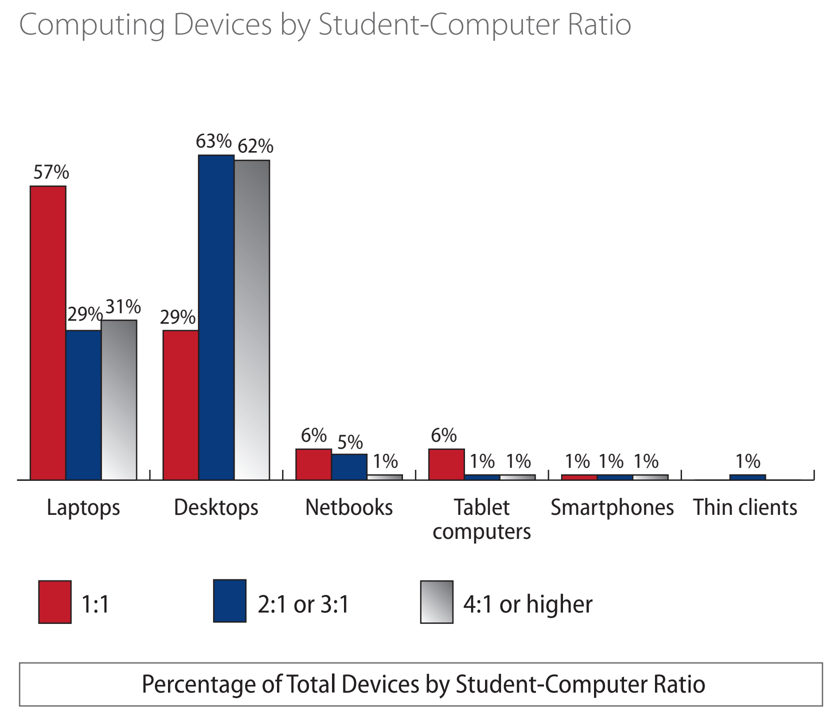
Infrastructure

The continued transition to mobile computing will coincide with the shift in the role of servers from data centers to a cloud environment in both the public and private sectors. Cloud computing will drive many district policy discussions around cost, data security, functionality, and other important topics.

As ubiquitous computing drives increased Internet bandwidth, the largest single barrier to the adoption of online assessment solutions will be eliminated.

Infrastructure providers should find education a strong growth market. Over the next five to ten years, three million classrooms will need new or upgraded WiFi or WiGig, driving the need for new switches, routers, and access points. Solutions that support student devices, such as smartphones, will be popular, as will systems management software and many other enterprise software packages.

Chart 5.3. Please enter an approximate number for each computing device used in your classrooms. (Q5)



Read As

- 70% of devices in schools with a 1:1 student-computer ratio are some type of mobile device.
- 57% of devices in 1:1 schools are laptops, while only 29% are desktops.
- Conversely, 29% of devices in 2:1 or 3:1 schools are laptops, while 63% are desktops.
- 62% of devices in schools with a 4:1 or higher student-computer ratio are desktops.

- *Significance of ubiquitous technology:* More than two-thirds of computing devices in 1:1 schools are mobile, while less than one-third of devices in schools with higher student-computer ratios are mobile. These suggest two very different environments for teaching and learning existing in U.S. schools today.

Project RED Commentary

The move to mobile computing is likely to support the transition from teacher-centered to student-centered learning. In both environments the teacher is essential, but in the latter, the teacher has more time for one-on-one student interaction. Mobile computing also provides freedom of location. Students can work in small groups, individually, or in large groups, inside or outside of the classroom.

The potential for personalized learning also increases in a digital learning environment. And to be effective, digital materials need to be portable and available wherever a book would be available—which is only possible with mobile devices.

Learning spaces

Since schools are built to last 40 years or more, school design and the need for in-classroom desktop computers must be revisited in light of the transition to mobile ubiquitous computing. Mobile computing offers a substantial increase in flexibility. In the 1980s and 1990s, architects began to add roughly 225 square feet per classroom to accommodate machines in the back of each classroom, along with additional electrical capacity and air conditioning. Each added square foot costs roughly $100, for an additional $22,500 per classroom. The added electrical service costs around $1,200 per classroom, with ongoing costs for maintenance, janitorial service, and air conditioning. It is likely that schools will look quite different, and most of these costs will be reduced when ubiquitous technology is more prevalent.

Computer labs

The need for labs must be revisited. Ubiquitous computing or COWs (carts on wheels) can replace most labs except for high-end Computer-Aided Design and Computer-Aided Manufacturing (CAD/CAM) or graphic art labs. The cost of a fully equipped computer lab has been estimated at $400,000—equivalent to the purchase price of 13 COWs. These economics explain in part the rapid growth of COWs, from near 0% ten years ago to 30% of school computing in 2008.

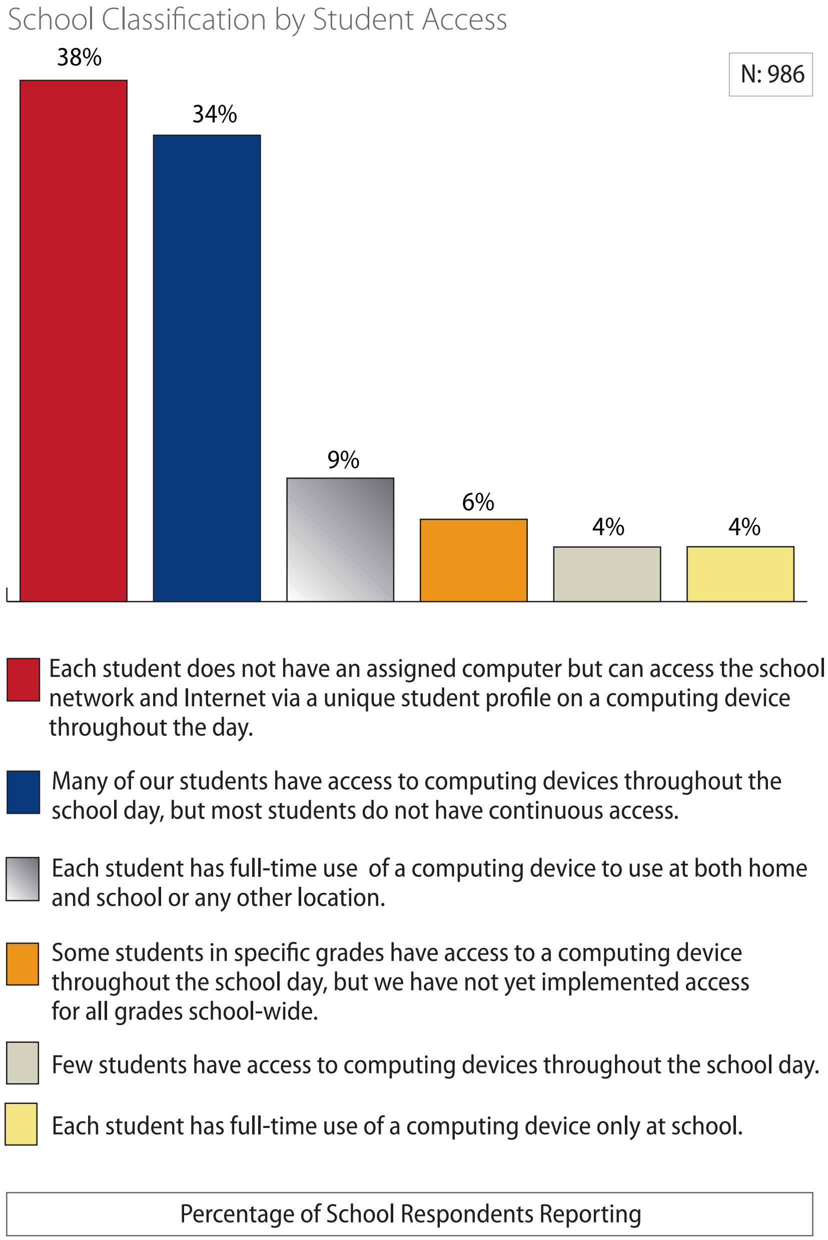
Student-owned devices

Growth is highly likely in this area, driving the need for policies regarding acceptable use, network security, heterogeneous versus homogeneous solutions, school funding of 3G/4G data plans, teacher training, software purchases, and more.

Technology roadmaps

Schools will need reliable roadmaps to keep up with rapid transitions in the market and avoid wasting money or sub-optimizing results. For example, many schools regret purchasing 802.11bg WiFi now that 802.11n is standard. Schools are now rushing to 802.11n, but WiGig or gigabit WiFi is on the planning horizon. No Chief Technical Officers (CTOs) interviewed by Project RED were aware of this important development.

Chart 5.4. Categorize your school to help us understand your school environment. (Q6)



Read As

- 38% of respondents report that each student does not have an assigned computing device but does have access to the student network through a unique student profile.
- 34% of respondents report that many students have access to computing devices but most do not have continuous access.
- At the other end of the spectrum, 4% of respondents report that each student has full-time use of a computing device only at school.

Demographic Highlights

Each student has full-time use of a computing device at school.

- Schools in urban and second city areas are more likely than schools in suburban areas to report this.

Students do not have assigned computers, but they each have a unique profile on the network.

- Schools in the Central region are more likely than schools in the Northeast or West to report this.
- Schools with very low minority percentages are more likely than schools with higher minority percentages to report this.

Each student has full-time use of a computing device at both home and school.

- Schools in the Southeast region are more likely than schools in the Northeast to report this.
- Schools with secondary grades are more likely than schools with elementary grades to report this.
- Schools with higher household incomes are more likely than schools with lower household incomes to report this.

Some students have access at school but not yet school-wide.

- Schools in the West are more likely than schools in the Southeast to report this.
- Schools with moderate household incomes are more likely than schools with very low or very high household incomes to report this.

Many students have access but not continuous access throughout the school day.

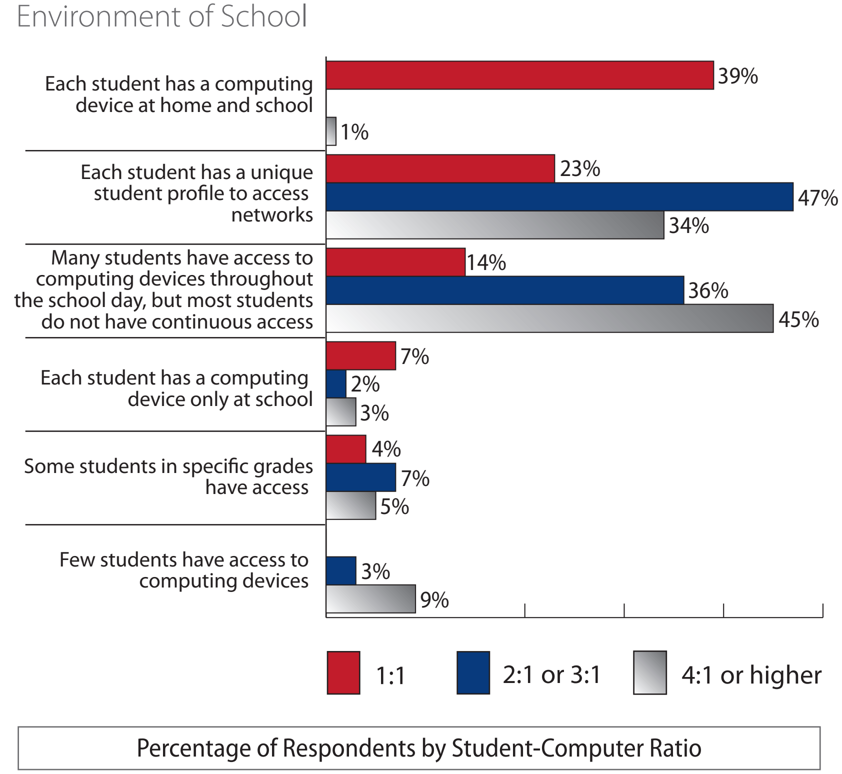
- Schools with elementary grades are more likely than schools with secondary grades to report this.
- Schools with very low household incomes are more likely than schools with moderate to higher household incomes to report this.

Implications

Instruction

Continuous personal access to a computing device and the Internet dramatically expands the intellectual resources available to students and ensures a dynamic, rather than static, education setting. It is encouraging that many of the schools who reported a higher than 1:1 student-computer ratio are still finding ways to provide their students with high levels of access.

Chart 5.5. Categorize your school to help us understand your school environment. (Q6)

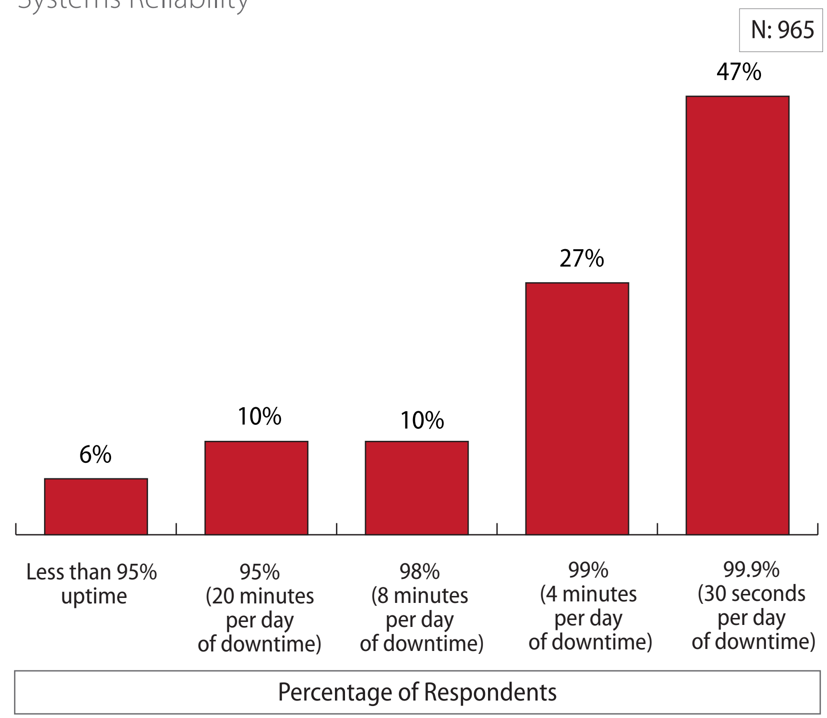


Read As

- **Full-time use of a device.** 46% of respondents who report that they have a 1:1 student-computer ratio also report that the students have full-time use of a computing device at school or home. In contrast, less than 4% of respondents with a higher than 1:1 student-computer ratio report similar usage for students at school or home.
- **Continuous access through a unique student profile.** Respondents from schools with a 2:1 student-computer ratio or higher also report higher rates of usage in environments that do not have a computer for every student. 48% of schools with a 2:1 student-computer ratio report that each student does not have an assigned computer but can access the school network and Internet via a unique student profile on a computing device throughout the day. Similarly, 45% of schools with a 3:1 student-computer ratio report that their students have this type of access.
- **Access throughout the day.** Respondents with a student-computer ratio of 4:1 or higher report the highest rate (45%) of students who have access to a computing device throughout the day, but the access is not continuous.

Chart 5.6. On average over the past year, what percentage of the school day is your instructional network up for student and teacher use? (Q23)

Systems Reliability



Read As

- Almost half (47%) of the respondents, whether from 1:1 schools or schools with higher student-computer ratios, report that their network functions 99.9% of the time.

Demographic Highlights

- Middle schools are significantly less likely than elementary and high schools to report less than 95% uptime.
- Schools in suburban areas are significantly more likely than schools in town and country areas to report 99.9% uptime.
- Schools with high instructional materials expenditures are significantly more likely to report less than 95% uptime, while schools with low instructional materials expenditures are significantly more likely to report 99.9% uptime than are schools with medium or high instructional materials expenditures.
- School with high and very high minority percentages are significantly more likely than schools with lower minority percentages to report 95% or less uptime.

Implications

Instruction

A reliable network is essential in any digital environment. If students and teachers—especially teachers who are new to technology—become frustrated by unreliable access, they will soon stop using the network. It is important that the network is never down for more than a few seconds and that long periods of downtime are rare.

Finance

Stable and robust networks are costly. However, the opportunity cost of idle equipment and an under-utilized network is even greater. It is important that school leaders understand the financial and physical network requirements to handle the amount and types of usage needed.

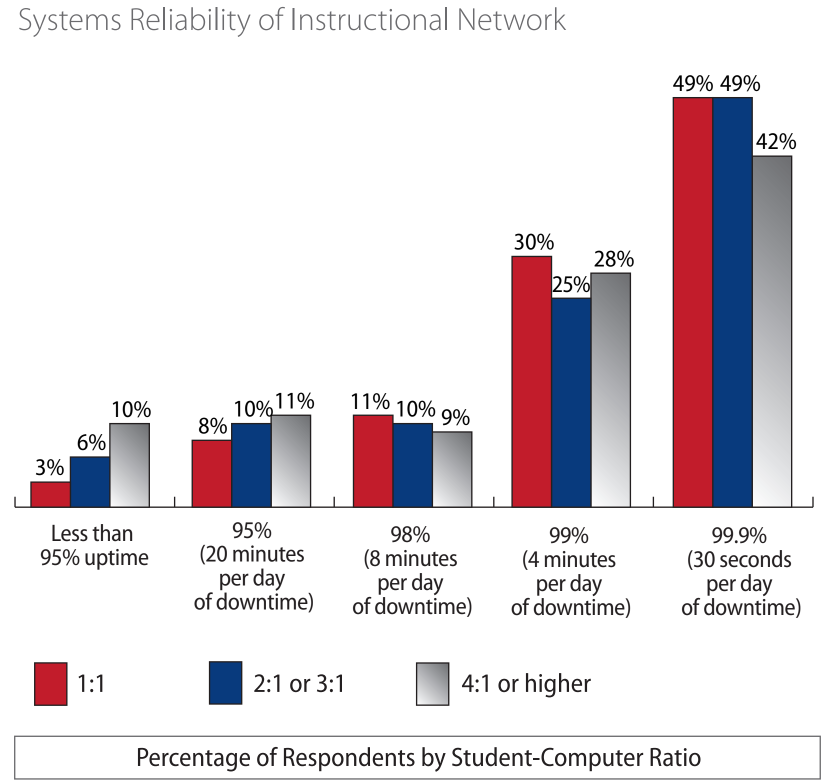
Policy

A lack of appropriate network infrastructure inhibits the usefulness of the devices. Policymakers might want to require that local education authorities provide appropriate infrastructure and support plans for devices purchased with public funding.

Industry

Device manufacturers could provide network specifications and implementation guidance that will lead to networks with higher availability.

Chart 5.7. On average over the past year, what percentage of the school day is your instructional network up for student and teacher use? (Q23)



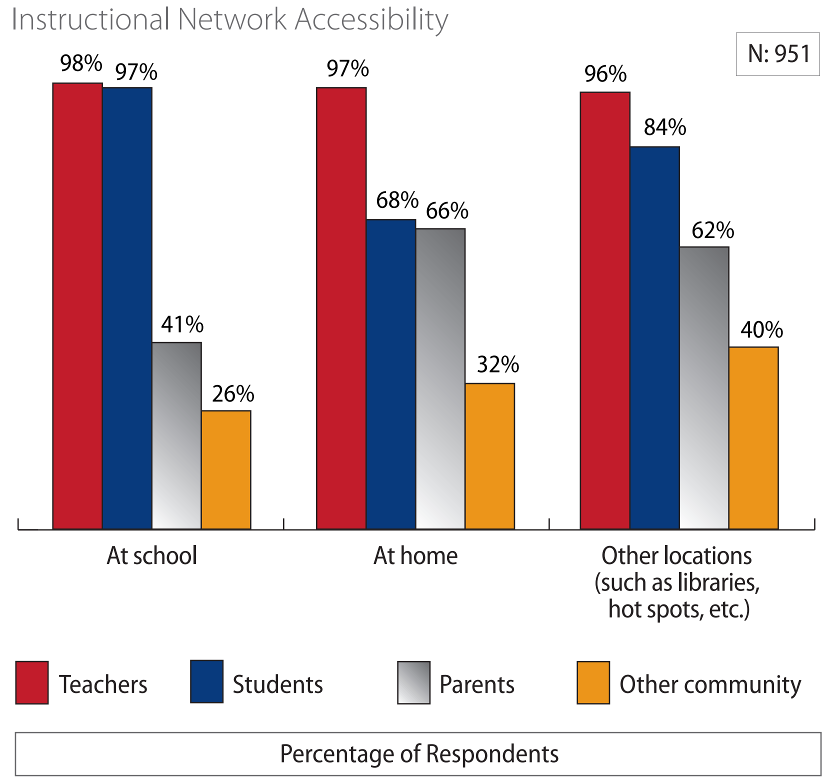
Read As

- 3% of respondents in 1:1 schools report that their network is up less than 95% of the time.
- High rates of network downtime seem to be associated with high student-computer ratios. 10% of schools with a 4:1 or higher ratio report their network is down more than 5% of the time, just over three times the rate of 1:1 schools.

Project RED Commentary

If technology does not work reliably, teachers and students will not use it. And if technology is not being used, it cannot contribute to student improvement. Informal technical support is estimated at 10% of teacher time, which is taken out of instructional time. More teacher time on task equals better results. School administrators interviewed by the Project RED team believe that a reliability of 99.9% is required before schools can move from print to digital.

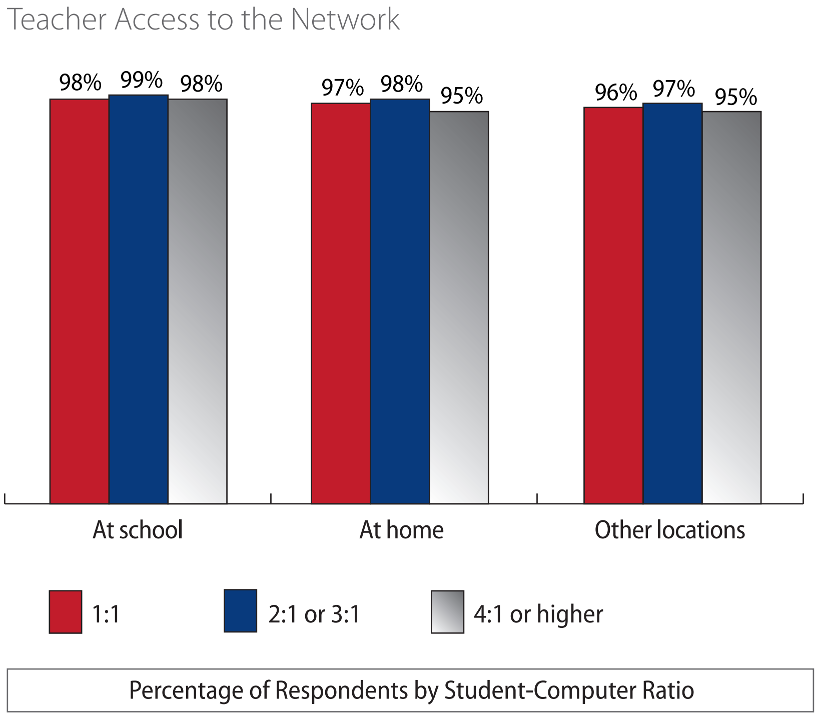
Chart 5.8. Is your instructional network accessible to teachers, students, and parents? (Q24)



Read As

- 98% of teachers have access to the instructional network at school, and 97% have access at home, according to Project RED respondents.
- The level of access to the instructional network is lower in all categories for students than for teachers.
- 97% of students have access at school, but only 68% have access at home. Surprisingly, more students have access in other locations, such as libraries, than at home.

Chart 5.9. Is your instructional network accessible to teachers? (Q24)



Read As

- 98% of 1:1 school respondents report that teachers have access at school. 99% of 2:1 or 3:1 respondents report access at school.
- Respondents from schools with 4:1 or higher ratios report the lowest level of access for teachers, although the level is still reasonably high. 98% of respondents from these schools report that teachers have access at school, while 95% report that teachers also have access at home and in other locations.

Demographic Highlights

- Schools in suburban areas are significantly more likely than schools in other areas to have access at home for teachers.
- Schools with higher household incomes are significantly more likely than schools with lower household incomes to have access at home for teachers. There were no significant differences in demographics between schools supplying access at school for teachers.

Implications

Instruction

When teachers, students, and parents can access the instructional network anytime/anywhere, communication and information sharing are simplified. With a couple of mouse clicks, teachers can send messages to all parents or private communications to individual parents and students. Teachers can also post their lessons and resources on the network so that students and parents can access them from any Internet connection. Once lessons are in a digital format, they can be easily adjusted or updated by teachers for future use.

Finance

Most schools will find it relatively easy to connect all teachers at home as well as at school. Leading-edge schools will provide 3G-4G coverage for teachers at a cost of $25 per teacher per month.

Policy

Key policy decisions include when and how to connect all teachers and whether or not to provide 3G-4G wireless connectivity off campus.

Industry

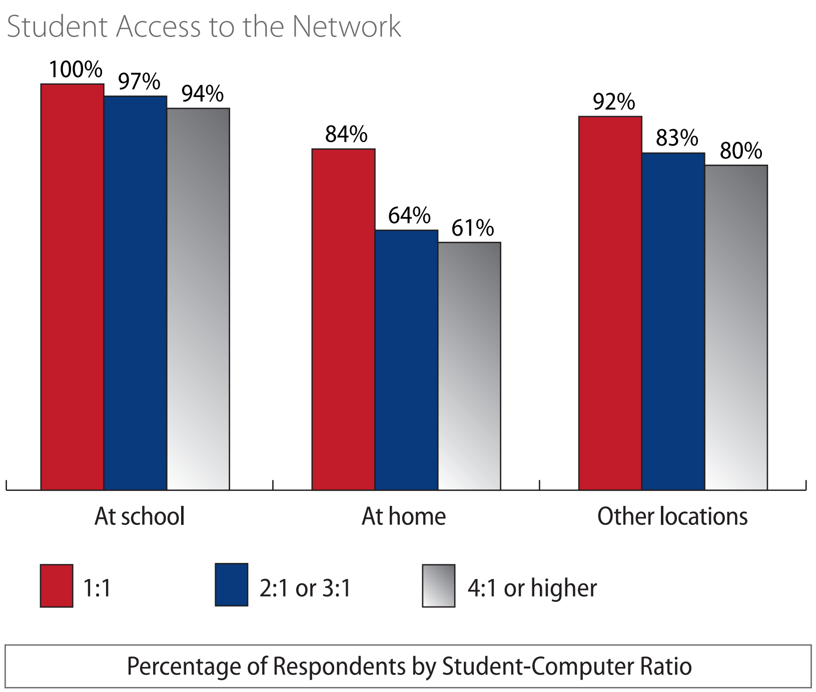
It is essential that the student platform within the instructional network is secure and easy to navigate. Students must be able to work through lessons easily and post completed assignments back to the network for teacher review. There will be a major sales opportunity based on the forecasted improvements in connectivity. In several areas, including support of 3G-4G to students, some invention will be required to reach desired price/functionality targets.

Project RED Commentary

To be most useful, digital materials and resources must be available wherever print materials are currently being used—at school, at home, at grandma's house, at the park, at the orthodontist's office, etc. Full access to digital resources can lengthen the school day, and more time leads to better results.

Hot spots are a nice step along the way toward universal access. But full, continuous access provided by a combination of WiFi and 4G wireless networks will indicate major progress.

Chart 5.10. Is your instructional network accessible to students? (Q24)



Please note: We have highlighted surprising findings in bold, blue type.

Read As

- Almost all the 1:1 school respondents report that they provide network access for their students, with 100% reporting that students have access at school.
- Survey respondents say the highest level of network access for students is at school, regardless of the student-computer ratio.
- The lowest level of access for students at school is 94%, reported by respondents from schools with a 4:1 or higher student-computer ratio.
- **The next highest level of network access for students is not at home but in locations such as libraries and coffee shops, with 92% of 1:1 schools reporting this kind of access, and respondents with student-computer ratios higher than 1:1 reporting this kind of access, ranging from 80% to 83%.**
- Access to the network across all categories is reported to be lowest in the home. 1:1 schools report fairly high access (84%). In schools with higher than 1:1 student-computer ratios, survey respondents say network access at home is dramatically lower, with ranges from 61% to 64%.

Demographic Highlights

- Schools in areas with high household incomes are significantly more likely than schools in areas with lower household incomes to provide network access for students at school.
- Schools in urban areas are significantly more likely not to provide the network for student access at school.
- Schools in suburban areas are significantly more likely than schools in urban or second city areas to provide network access for students at home.

- Schools in areas with very high household incomes are significantly more likely than schools in areas with lower household incomes to provide network access for students at home. Similarly, schools with very low poverty are significantly more likely than schools with higher poverty to provide network access. Surprisingly, schools with low instructional materials expenditures are significantly more likely than schools with higher expenditures to report student access to the network at home.
- Schools in urban areas are significantly more likely not to provide the network for student access at school.

Implications

Instruction

Students who have anytime/anywhere access to the instructional network enjoy several advantages. Parents or students no longer have to trek back to school in the hope of finding a custodian who will let them retrieve a forgotten textbook. When students are sick, they can avoid falling behind by accessing lessons and resources from home. Students can also communicate with teachers as needed, helping to build the personal relationships that are known to be an important factor in student achievement.

Finance

While most schools have networks, an estimated 90% of schools will need to update their networks in the future to accommodate increased usage. The most common upgrades and their financial impact are as follows:

- Wireless networks. Currently schools are predominantly 802.11b or 802.11g. And the wireless networks are not designed for 1:1 use. State-of-the-art networks are 802.11n and designed to support multiple megabits/second/student. They also offer more advanced Quality of Service (QOS) and security than today's wireless networks. *Estimated financial impact:* $80 per student, one-time capital equipment investment.
- Internet connections/bandwidth. The current Internet capacity is roughly 10 kilobits/second/student. In a future 1:1 environment, this will need to grow tenfold. *Estimated financial impact:* $20 per student per year, ongoing expense.
- Support of student-owned devices. Today, most schools ban student-owned devices as security risks. In the future, schools will need to support student-owned devices extensively. This will require upgrades to hardware and software in many cases. *Estimated financial impact:* $10 per student hardware, $3 per student in annual software fees.
- 24/7 3G-4G student connectivity. Today this is very rare. As 4G arrives, the cost per megabit is dropping, and as of the publication of this report, the FCC has announced a competitive pilot program for student 3G-4G wireless support. Ubiquitous connectivity is an integral part of the high-performance school of the future. *Estimated financial impact:* $20 to $75 per student per year, depending on the amount of bandwidth per student.
- Connectivity for financially disadvantaged students. Every district has students whose parents cannot afford home Internet access, ranging from 1% to 30% of students. To support the learning platforms of the future, every student will need to be connected at home. *Estimated financial impact:* $15 per student per month for those in need.

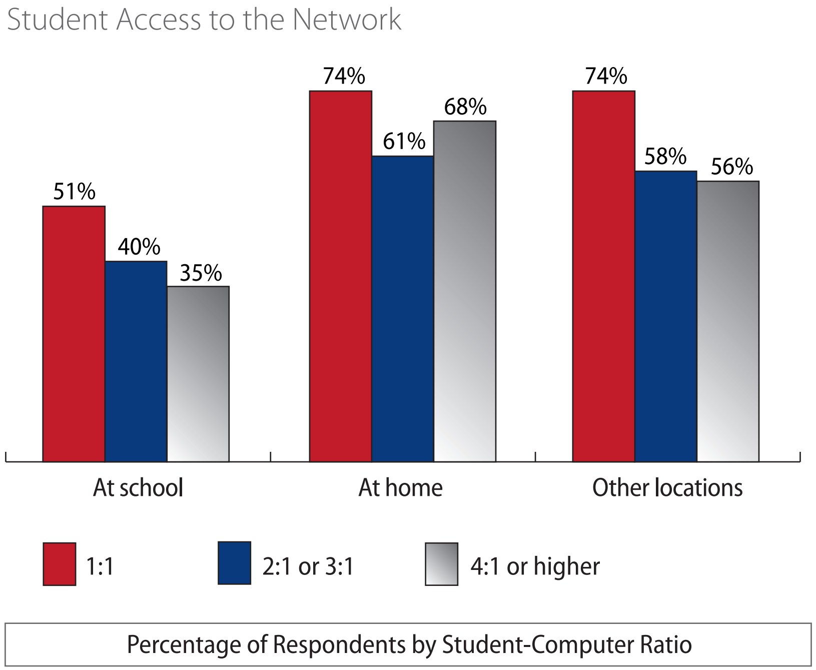
Policy

Most districts and states will need to overhaul their connectivity plans in light of the many upcoming changes. Key policy decisions will include when and how to support student-owned devices, including cell phones, and provide wireless Internet access off school premises (3G-4G); what level of support to provide to the economically disadvantaged; and what new funding sources might be required, including new taxes to support a state-level E-rate-like program.

Industry

It is essential that the student platform within the instructional network is secure and easy to navigate. Students must be able to work through lessons easily and post completed assignments back to the network for teacher review. There will be a major sales opportunity based on the forecasted improvements in connectivity. In several areas, including support of 3G-4G to students, some invention is required to reach desired price/functionality targets.

Chart 5.11. Is your instructional network accessible to parents? (Q24)



Read As

- Survey respondents report parents have less access to the instructional network than students or teachers.
- Respondents in 1:1 schools continue to report superior access to the instructional network. 51% report that parents have access to the network at school, and 74% report that parents have access from other locations.
- Only 35% of respondents in schools with 4:1 or higher student-computer ratios report that parents have access to the network at school, and only 56% provide network access to parents in other locations.

Demographic Highlights

- Schools in the Central region are significantly more likely than schools in the Northeast to offer parents access to the network at home.
- Schools with high school grades are significantly more likely than elementary schools to offer parents access to the network at home.
- Schools with low instructional materials expenditures are significantly more likely than schools with higher expenditures to offer parents access to the network at home.
- Schools in the Northeast are significantly less likely than schools in other regions to provide parents with network access at school.
- Schools with high poverty percentages are significantly more likely than schools with lower poverty percentages to provide parents with network access at school.

Implications

Instruction

Anytime/anywhere network access allows parents to see their child's lessons, assignments, and progress instantly and allows teachers and schools to easily update parents about school events and activities. Unfortunately, not all parents have Internet access or a device with which to access the Internet. In 1:1 programs where families do not have a computer at home, parents and siblings often use the school device. Public access in places such as community labs or public libraries can also provide valuable access.

Finance

Secure access for parents can help build communication between home and school. However, schools must recognize the challenges some parents face in accessing the network. Schools may need to budget for parent training or computer lab access for parents at school. Until all parents have reasonably simple access to the network, it will be impossible to abandon the traditional, less efficient, and more expensive forms of communication.

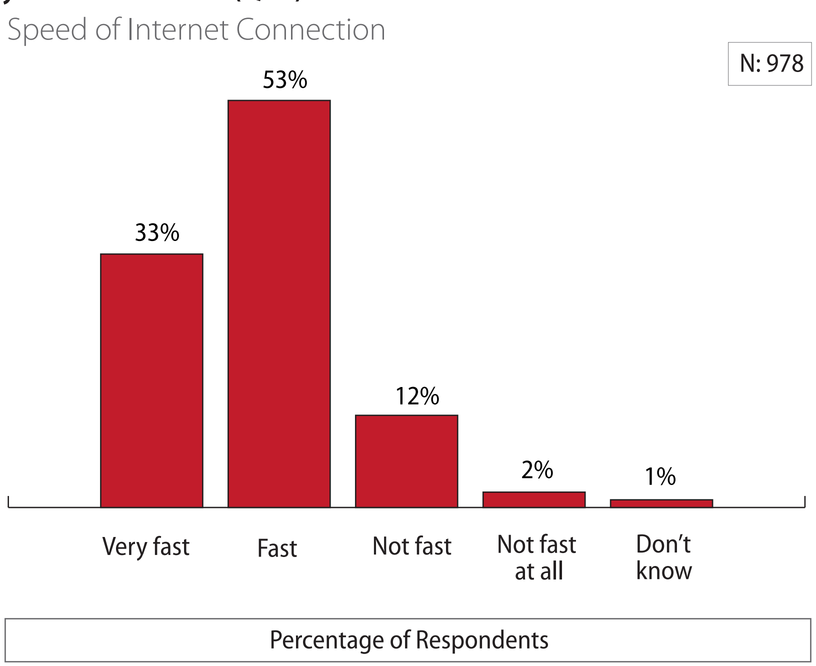
Policy

The digital divide exists not only between one student group and another but also between students and parents. As devices and networks become more widespread, free public access to computing devices and the Internet will become increasingly important to ensure that students and parents are connected and some groups are not left out.

Industry

Parents need a platform within the instructional network that is secure and easy to navigate. If these conditions are not met, it is highly unlikely that parents will access the network on a daily, or even frequent, basis. Because there may be limited opportunities for training, parents must be able to easily find and understand their child's records and any other pertinent information.

Chart 5.12. How fast is the speed of your Internet connection to your classrooms? (Q25)



Read As

- Most respondents report that the speed of their Internet connection is either fast (53%) or very fast (33%).

Demographic Highlights

- Schools in suburban and town and country areas are significantly more likely than schools in second city areas to report that connections are very fast.
- Schools with very low or low poverty percentages are significantly more likely than schools with very high poverty percentages to report that connections are very fast.

Implications

Instruction

The speed of the Internet connection is similar to the reliability of the instructional network in terms of its impact on the classroom environment. In any school computing environment, teachers and students will quickly stop using the Internet if they become frustrated with the speed.

Finance

Appropriate bandwidth available throughout the school community can be expensive and complicated. Bandwidth issues may reside in locations that the school does not control, and the district may have to pay for bandwidth both inside and outside of the district. It is essential that districts understand the entire bandwidth pipeline and the expenses associated with providing bandwidth to meet the needs of the implementation.

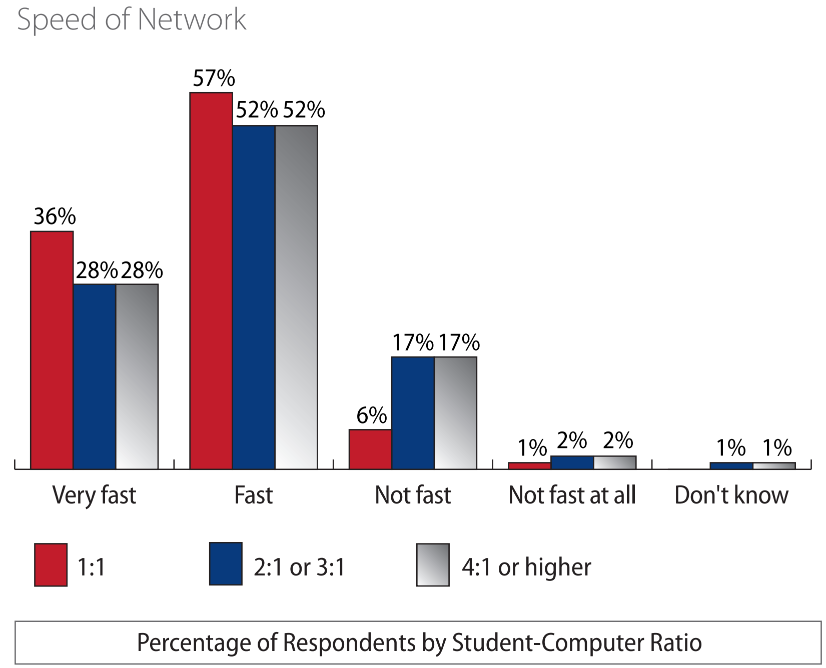
Policy

Despite extensive national discussions about the lack of bandwidth in the U.S., the Project RED survey seems to indicate that bandwidth is not an issue for most schools. But keep in mind that 68% of schools are already extensively limiting high bandwidth applications.[3] However, it would be prudent to closely examine the bandwidth issue at the state and national levels and to work toward completing a national wired and wireless grid to expand usage. The Project RED data do suggest that connectivity is correlated with affluence and that students in poor schools are more likely to have slower connections.

Industry

As in the case of the system reliability implications, it would be helpful if vendors could provide bandwidth specifications per user, for each software package, that would take into account individual district requirements, such as the number of devices and the levels and types of usage the Local Education Agency (LEA) is planning.

Chart 5.13. How fast is the speed of your Internet connection to the classroom? (Q25)



Read As

- 36% of respondents in 1:1 schools view their connection as very fast, compared with 28% of respondents in higher student-computer ratio schools.
- There appears to be a small difference in connection speed based on the richness of the technology. 93% of respondents say that connection speed is fast or very fast in 1:1 schools, compared with 80% of respondents for all other schools.
- 20% of respondents from schools with a student-computer ratio of 4:1 or higher report that their Internet connection is not fast. In 2:1 schools, the percentage drops to 15%, and in 3:1 schools, it drops to 13%.

[3] Greaves, T. & Hayes, J., *America's Digital Schools*, MDR, 2008.

Project RED Commentary

As schools make the switch from print to digital, the speed of the Internet connection takes center stage. Many factors drive bandwidth needs, including the number of computers, usage patterns in the classroom, the types of materials accessed (e.g., email or video), and the intensity of access (e.g., a course or a Google search).

Schools today are by and large under-provisioned, and the educational impact of insufficient bandwidth can be significant. If a student spends an hour a day on the Internet, the unproductive wait time could be reduced as much as 50%. Ten minutes saved during the school day are equivalent to 5 extra school days a year, and 30 minutes saved are equivalent to15 days. Doubling the bandwidth costs roughly $12 per student per year. Providing five more instructional days would cost roughly $222 per student per year.

Research Basis

Gray, L.; Thomas, N.; & Lewis, L., *Educational Technology in U.S. Public Schools: Fall 2008 (NCES 2010-034)*, U.S. Department of Education, National Center for Education Statistics, 2010.

Greaves, T. & Hayes, J., *America's Digital Schools*, MDR, 2008.

Olivier, W., "Teaching mathematics: Tablet PC technology adds a new dimension," *Proceedings of the Mathematics Education into the 21st Century Project*, 2005, Johor Bahru, Malaysia, 176-181.

Petty, D. & Gunawardena, A., The Use of Tablet PCs in Early Mathematics Education, in Prey, J.C.; Reed, R.H.; & Berque, D.A. (eds), *The Impact of Tablet PCs and Pen-based Technology on Education: Beyond the Tipping Point*, Purdue University Press, 2007, 89-96.

Teachers find more ways to connect with their students with modern technology. With many more creative ways to teach and learn, teachers want to share and spend more time investing in themselves and their classroom.

~ Kip Keckler
Instructional Technology Teacher
Washington Middle School
Kenosha, Wisconsin


iStockphoto/Thinkstock

Chapter 6

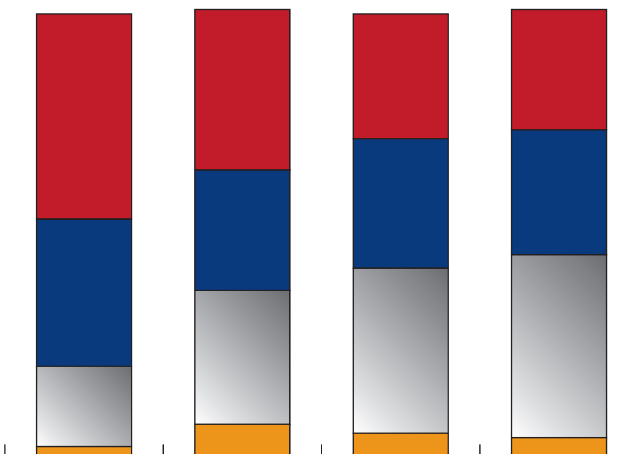
Technology Implementation in Schools

This set of questions examines how schools are using classroom technologies; in which subject areas; and with what levels of curriculum integration, training, funding, effectiveness, and sustainability.

Chart 6.1. How do teachers and students in your school use technology in instruction? (Q16)

Learning Activities: Frequency of Use

N: 988



Teachers spend more time on small-group instruction than on lectures	Students use a wide range of electronic materials	Students use problem-based learning	Students take control of their learning, including choosing research topics	
46%	36%	28%	27%	Daily use
33%	27%	29%	28%	Weekly use
18%	30%	37%	41%	Monthly/ semester use
2%	7%	5%	4%	Not at all

Percentage of Respondents

Read As

- 46% of respondents report that teachers spend more time at least daily on individualized and small-group instruction than on teacher-centered lecturing; 33% report weekly.
- 63% of respondents say that students are using a wide range of digital resources for learning, courseware, and collaboration daily or weekly.
- 57% of respondents report that students are engaged in problem-based real-world learning activities daily or weekly.
- 55% of respondents report that students are directing their own learning daily or weekly by identifying research topics, resources, and presentation of findings.

Demographic Highlights

Time spent on small-group and individual instruction rather than lectures

- Elementary schools are more likely than high schools to report this.
- Schools with very high household incomes or high instructional materials expenditures are more likely than schools with lower household incomes or materials expenditures to report this.

Range of electronic materials

- Schools with high instructional materials expenditures are more likely than schools with low or medium instructional materials expenditures to report use at least daily.
- Schools in the Southeast are more likely than schools in other regions to report use at least daily.

Problem-based learning

- Students in medium- and large-enrollment schools are more likely than schools with very large or small enrollments to report use at least daily.

- Schools with medium or very high household incomes are more likely than schools with high household incomes to report use many times a day.

Self-directed learning

- Schools with high instructional materials expenditures are more likely than schools with low or medium instructional materials expenditures to report use at least daily.
- Schools with very high or medium household incomes are more likely than schools with low or very low household incomes to report use at least daily.

Implications

Instruction

Personalized instruction is one of the strongest benefits of technology and one of the most critical factors in 21st century education. To help students achieve, it is essential to address their unique learning needs, generally in small-group and one-on-one situations, and to move from a teacher-centered to a learner-centered environment. Schools with good technology implementations follow these practices. They also provide students with consistent access to digital resources, ensuring a dynamic rather than a static educational setting.

Critical thinking and information literacy based on real-world activities are skills that students have needed for generations. However, the need is greater than ever today because learning offers a strategic advantage in our competitive global environment. Educators have generally under-estimated the challenge of teaching these skills in the context of real-world content, but in technology-rich schools, they are making a realistic assessment of the needs and moving ahead with the major changes in curriculum, teaching, and learning

Finance

Personalized instruction that meets each student's needs offers a greater chance of on-time or early college matriculation, thus reducing the cost of remedial coursework at the college level (see Chapter 9). In addition, learners with 21st century skills will be competitively positioned in the global marketplace and more likely to achieve success, leading to a skilled workforce and an increased tax base.

Policy

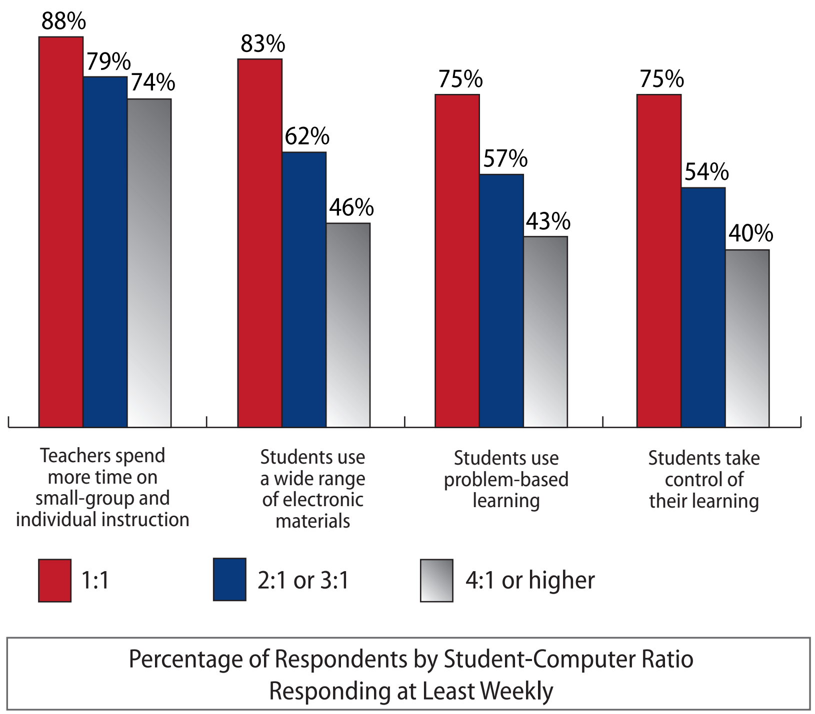
The survey shows that well-implemented technology programs have enabled personalized instruction and the development of 21st century skills, pointing to the need for policies that foster uninterrupted access to technology and related professional learning. The policies that need to be re-examined include those that require Carnegie Units (or seat time) for course credit and those that require a teacher to be present at all times (inappropriate for blended online and offline learning).

Industry

The new paradigm of student-centered learning and individualized instruction creates a need for new materials and classroom designs.

Chart 6.2. How do teachers and students in your school use technology in instruction? (Q16)

Learning Activities: Students and Teachers



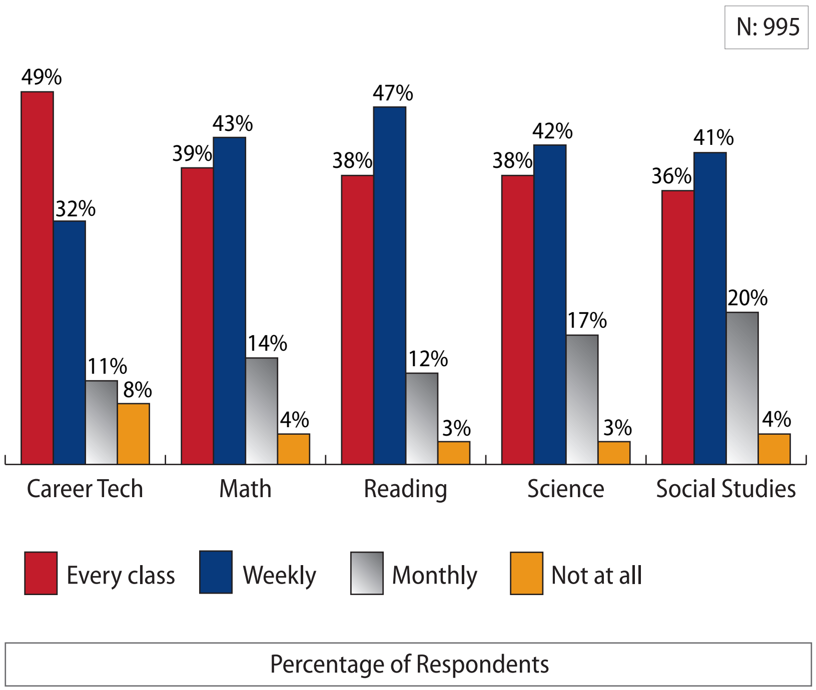
Read As

- 88% of respondents in 1:1 schools report frequent use of individualized and small-group instruction, compared with 79% of 2:1 or 3:1 schools and 74% of 4:1 or higher-ratio schools.
- *Significance of 1:1 technology:* There is a considerable difference between the behavior of teachers and students in 1:1 schools and that of teachers and students in schools with higher student-computer ratios. Students who have continuous access to a computing device can clearly take more control of their own learning than students with infrequent access to a variety of different devices, where links and materials cannot be stored and exploration is limited.
- Using a wide range of electronic materials: 1:1 schools report 37 points higher frequency (83% vs. 46%) than schools with 4:1 or higher ratios.
- Using problem-based learning: 1:1 schools report 32 points higher frequency (75% vs. 43%) than schools with 4:1 or higher ratios.
- Taking control of their own learning: 1:1 schools report 35 points higher frequency (75% vs. 40%) than schools with 4:1 or higher ratios.

Project RED Commentary

- The behaviors surveyed here describe the key activities in student-centered environments where students can take control of their learning, the major desire of students as indicated in the *Project Tomorrow 2009* survey.
- Individualized instruction is perhaps the most important use of technology in education—students can move at their own pace. Whether advanced or remedial, they can engage at exactly the right entry point.
- Technology-based solutions provide almost limitless opportunities for personalization. If one approach is not working, other approaches can easily be tried.
- In the technology-transformed classroom, the teacher is no longer the sage on the stage. Teachers have more time for one-on-one instruction to address more difficult educational challenges.
- Personalization provides more time on task.
- Students in control of their learning are more productive than passive learners.
- The effect of a technology transformation is similar to that of a class size reduction from 30 to 10 students, when measured by student-teacher face time.
- The wide range of materials available electronically means that students can easily find alternative materials more suited to their learning style or previous experiences.

Chart 6.3. How frequently do your students use technology as an integral part of instruction? (Q9)



Read As

- 49% of respondents report that students use technology as an integral part of instruction in every career tech class.
- 32% report that technology is used in career tech at last weekly, while 11% report at least monthly and 8% report not at all.
- Among the five most frequent subject areas, at least one-third of the respondents are using technology in every class. 39% report using technology in every math class, 38% in every reading and science class, and 36% in every social studies class.
- At the other end of the spectrum, only 9% of respondents report they are using technology in every health/PE class, and 38% of respondents say their health/PE classes do not use technology at all.

In addition to the most frequently cited categories shown in Chart 6.3, other categories and their respective use levels are shown in Table 6.1 below.

Table 6.1. Frequency of technology use as an integral part of instruction (in rank order)

Subject	Every Class (%)	Weekly (%)	Monthly (%)	Not at All (%)
English/Language Arts	37	49	12	2
Title I Intervention	34	47	12	7
Special Education Intervention	33	51	12	4
Reading Intervention	33	47	13	7
World Languages	29	36	22	13
ELL Intervention	27	45	15	12
Art	13	35	28	24
Music	11	32	31	27
Health/PE	9	22	31	38

Demographic Highlights

Art

- Schools in the Central region are more likely than schools in the West to report daily use of technology with the textbook as the core curriculum.
- Schools with higher household incomes and low minority percentages are more likely than less affluent schools to report daily use of technology with digital content as the core curriculum.

Career tech

- Schools in the Southeast are more likely than schools in other regions to report daily use of technology with digital content as the core curriculum.

- Schools in the Central region are more likely than schools in other regions to report daily use of technology with the textbook as the core curriculum.
- Schools with very low to medium household incomes are more likely than schools with very high household incomes to report weekly use of technology.

English/language arts

- Schools in second city, suburban, and town and country areas are more likely than schools in urban areas to use digital content as the core curriculum daily.
- Schools with high instructional materials expenditures are more likely than schools with medium instructional materials expenditures to not use technology at all in English/language arts.

Health/physical education

- Schools with small- to medium-size enrollments are more likely than schools with very large enrollments to report not using technology at all.
- Schools with very high household incomes are more likely than schools with very low and low household incomes to report using digital content as the core curriculum.

Math

- Schools with a high minority percentage are more likely than schools with a lower minority percentage to report using digital content in every math class as the core curriculum.
- On the other hand, schools with a low minority percentage are more likely than schools with a high minority percentage to use technology daily with a textbook as the core curriculum.
- Schools in the Southeast are more likely than schools in the Northeast or West to use technology in every class with a textbook as the core curriculum.

Please note: Throughout this chapter we have highlighted surprising findings in bold, blue type.

Music

- Schools in the West are less likely than schools in the Northeast and Southeast to use technology in every class with a textbook as the core curriculum.
- Schools in suburban areas (and to a less degree, town and country) are more likely than schools in second city areas to use technology in every class with a textbook as the core curriculum.
- Schools in areas with very high household incomes are more likely than schools in areas with lower household incomes to report using technology in every class with digital content as the core curriculum.

Reading

- Schools in the Southeast are more likely than schools in other regions to use technology in every class with a textbook as the core curriculum.
- **Elementary schools are more likely than high schools to use technology in every class with digital content as the core curriculum.**
- **Schools with high or very high minority percentages are more likely than schools with lower minority percentages to use technology in every class with digital content as the core curriculum.**

Science

- Schools in the Southeast are more likely than schools in the West to use technology in every class with a textbook as the core curriculum.
- **High schools are more likely than elementary schools to use technology in every class with a textbook as the core curriculum.**
- Schools with very high poverty are more likely than schools with lower poverty to report not using technology at all.

Social studies

- Schools with very large enrollments are more likely than schools with small or medium enrollments to use technology in every class with a textbook as the core curriculum.
- Similarly, high schools, which tend to be larger, are more likely than elementary schools to use technology in every class with a textbook as the core curriculum.
- Schools with very high poverty are more likely than schools with very low poverty to not use technology at all in social studies classes.

World languages

- Schools with very large enrollments are more likely than all other schools to use technology in every class with the textbook as the core curriculum.

Technology-augmented intervention classes

- English Language Learners (ELL)
  - Middle schools and high schools are more likely than elementary schools to use technology daily with either textbooks or digital content as the core curriculum.
  - Schools with very low minority percentages are less likely than other schools to use technology daily with textbooks as the core curriculum.
- Reading Intervention
  - Schools in the Northeast are less likely than schools in other regions to use technology daily with digital core curriculum for reading intervention classes.
  - Schools in areas with low-medium household incomes are more likely than schools in areas with higher household incomes to use technology daily with a digital core curriculum.
  - Schools in areas with very high minority percentages are more likely than less diverse schools to use technology daily with a textbook as the core curriculum.
- Special Education Intervention
  - Schools in the West region are less likely than schools in other regions to use technology with the textbook as the core curriculum.
  - Schools with very low minority percentages are more likely than schools with higher minority percentages to use technology in every class with a textbook as the core curriculum.
- Title I Intervention
  - Schools in the Northeast are more likely than schools in the West to use technology daily with a digital core curriculum.
  - **Schools in urban areas are more likely than schools in suburban or town and country areas to use technology daily with either a digital core curriculum or textbooks as the core curriculum.**
  - Schools in areas with low to medium household incomes are more likely than schools in more affluent areas to use technology on a daily basis.

Implications

Instruction

Since one of the core strengths of technology is its ability to personalize instruction, it is interesting to note the frequency with which intervention classes use technology. At least 80% of respondents report weekly use of technology for Title I, reading intervention, and special education.

Clearly, a well-qualified teacher remains the single most important component in reading intervention, but technology can help students quickly make progress in areas of de-coding, in which they are deficient. Technology is used less frequently for English Language Learners (ELL) but still at least weekly in 72% of respondent schools.

The frequent use of technology in social studies (at least weekly in 79% of respondent schools) indicates the important attributes of digital content—currency, accessibility, and modularity. Original documents, often available online through search engines, lend authenticity and reality, while viewing opposing positions on current events, online supports, lively discussion, and debate.

Project RED respondent comments:

> *"The students needing math for credit recovery are the ones using the digital core curriculum. The others just use their textbook as core curriculum."*

> *"Because of state-mandated tests and the fact that a large percentage of teachers teach to the test, computer use is much lower than it could be. Many of the classroom workstations are not much more than dust catchers."*

> *"The computer lab is used almost exclusively for reading and math intervention."*

Technology Use in STEM Subjects

"Every 1:1 program I have seen has trouble getting math teachers to integrate technology in meaningful ways. Teachers may use graphing calculators and other tools but generally in very traditional ways. But math is just a tool to help explain the world. From a STEM perspective, math should be meaningfully integrated into science in order to help students explain natural phenomena instead of being taught as a discrete subject with no connection to the real world. Technology can and should be used as a powerful tool to facilitate the dynamic integration of math and science."

~ Michael Gielniak, Ph.D., Director of Programs and Development, One-to-One Institute

Finance

Under the Obama Administration, technology funding is now part of regular instructional programs rather than a separate funding stream in EETT. In subjects such as math, where technology can help bridge the gap between the U.S. and other countries, funding is available from more sources than ever before. School finance officials should check with the Association of School Business Officials (ASBO) and the National Council of Teachers of Mathematics (NCTM) for the most current information about funding streams from both public and private sources.

Policy

Intervention programs for struggling students have used technology more frequently than traditional subject areas—possibly the result of the higher funding per student for remediation. The strong desire of U.S. schools to improve Science, Technology, Engineering, and Mathematics (STEM) learning may drive the next wave of integrated use of technology for collaborative learning. To increase our nation's competitiveness, policymakers should make more funding available for intervention and STEM subjects, including technology-augmented programs.

Strong Title I funding is needed for the purchase of software in technology-augmented intervention classes. These curriculum purchases for daily use are more likely to be in urban areas with higher minority percentages and lower household incomes than the average.

School districts should integrate teacher use of technology into their overall assessment of teachers, to speed up the adoption of technology as an integral part of the learning process by those teachers who might be reluctant to change. It is clear from our respondents that technology use is not expected or mandated in many environments.

Industry

Although the concept of authentic learning has been discussed for some time, it remains a major growth area for developers of high-quality real-world math and science content and providers of authentic learning teacher training.

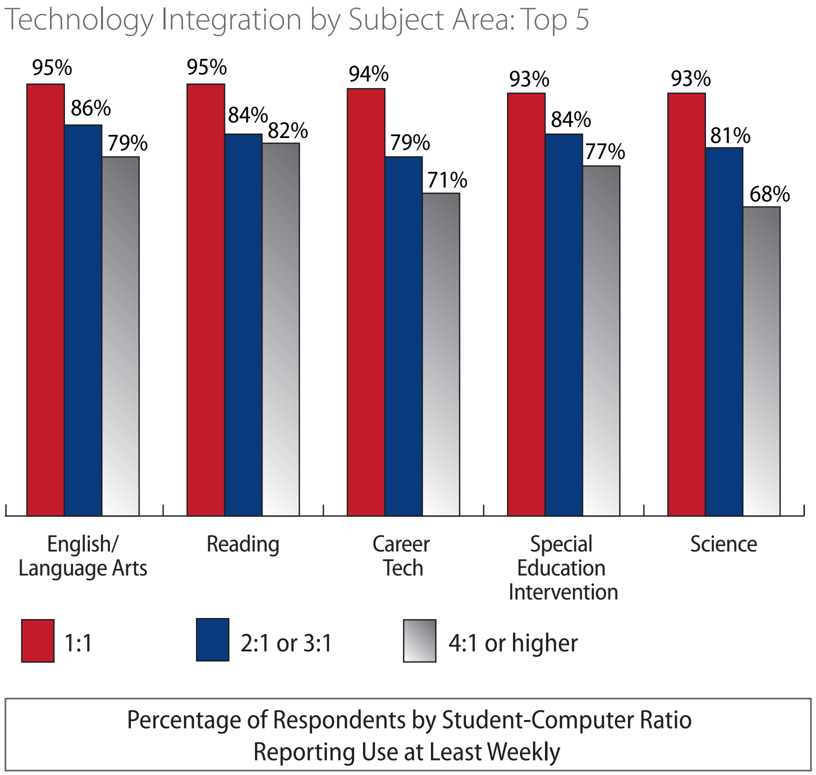
Project RED respondent comments:

> *"Usage varies from classroom to classroom and teacher comfort level with technology."*

> *"If children have difficulty learning the way we teach, we teach the way they can learn, especially using technology."*

> *"Our students are behind academically, so the district has allowed extra digital core curriculum to help enhance our students' learning and achievement as well as to improve our AYP, and it has worked on both initiatives."*

Chart 6.4. How frequently do your students use technology as an integral part of instruction? (Q9)



Read As

- 1:1 schools are far more likely than other schools to report at least weekly use of technology. 95% of 1:1 schools report weekly use in English/language arts, compared with 86% of 2:1 or 3:1 schools and 79% of 4:1 or higher-ratio schools.
- English/language arts is ranked only sixth in overall usage (see Table 6.1 on page 67) but is the most frequently cited when daily and weekly usage are combined.
- The same large usage discrepancies based on student-computer ratio are found in the other subject areas.

Table 6.2. Findings for lower-ranked weekly use of technology by subject and student-computer ratio (in rank order)

Subject	1:1 (%)	2:1 or 3:1 (%)	4:1 or Higher Ratio (%)
Math	91	80	77
Social Studies	91	76	67
Title I Intervention	90	81	75
ELL Intervention	88	73	63
Reading Intervention	87	81	73
World Languages	81	63	51
Art	66	46	37
Music	56	40	35
Health/PE	54	26	8

Project RED Commentary

Schools with 1:1 implementations are using technology frequently, across the entire range of subject areas, an indication that they may be experimenting with second-order change strategies enabled by the 1:1 student-computer ratio.

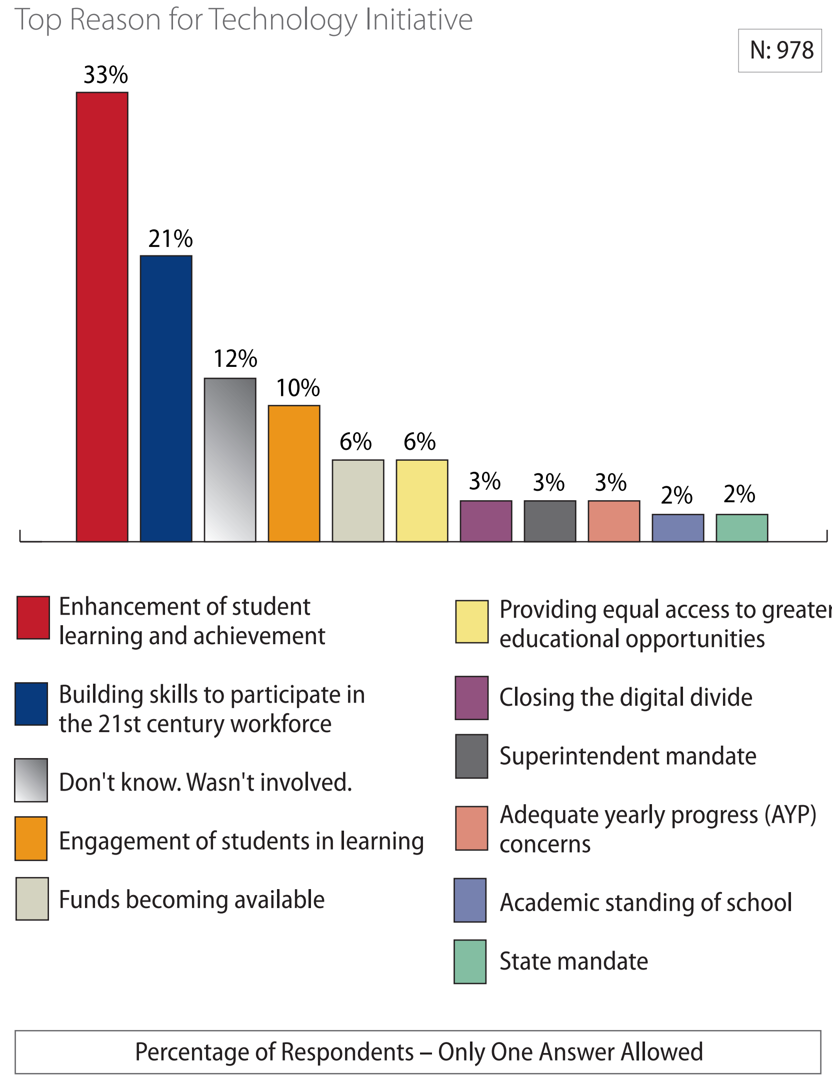
By showing greater daily and weekly use of technology, the data suggest that the amount of time per subject per week is far greater in 1:1 schools than in others, which correlates to educational benefits.

Table 6.3 shows some of the courses that suffer from a lack of technology. The lower usage levels in health/PE and art are understandable, but the lower usage in world languages indicates that offsetting cost savings may be possible, since these classes might be using expensive single-purpose language labs. The lower usage levels in science, ELL, social studies, and career tech for 4:1 and higher-ratio schools indicate that these students are not enjoying the benefits of technology. Science and social studies, in particular, are changing on a daily basis, and the amount of information available online far surpasses in quantity and quality that is available in traditional textbooks.

Table 6.3. Frequency of use—1:1 schools vs. 4:1 or higher-ratio schools (rank order of difference)

Subject	1:1 Schools (%)	4:1 Ratio or Higher (%)	Difference
Health/PE	54	8	46
World Languages	81	51	30
Art	66	37	29
Science	93	68	25
English Language Learners	88	63	25
Social Studies	91	67	24
Career Tech	94	71	23
Music	56	35	21
English	99	79	20
Special Education	93	77	16
Title I	90	75	15
Math	91	77	14
Reading Intervention	87	73	14
Reading	95	82	13

Chart 6.5. What was the original impetus for your technology initiative? (Q10)



Read As

- 33% of respondents report that the original impetus for their technology initiative was to enhance student learning and achievement.
- 21% report that the original impetus was to build the skills needed in the 21st century workforce.

Demographic Highlights

- Schools in the Central region are more likely than schools in the Northeast or Southeast to cite student engagement.
- Schools in the West are more likely than schools in other regions to cite the availability of funding.
- Schools with elementary and middle school grades are more likely to cite AYP (adequate yearly progress).
- High schools are more likely to cite building skills for the 21st century workforce, as are schools in areas of higher household incomes or lower poverty.
- Schools in urban areas are more likely than schools in second city and town and country areas to report that a superintendent mandate is the primary driver of their initiative.

Implications

Instruction

School districts increasingly view technology as supporting the teaching and learning mission rather than as a goal in itself. One-third of survey respondents cite the enhancement of student learning as the rationale for their technology initiative.

Finance

Because instructional technology is no longer a line item in federal grants, school finance officers should look to business operations and infrastructure as a place to fund productivity investments. Technology advocates in schools should continue to focus on funding instructional solutions that meet the needs of high risk, special education, and English Language Learners.

Policy

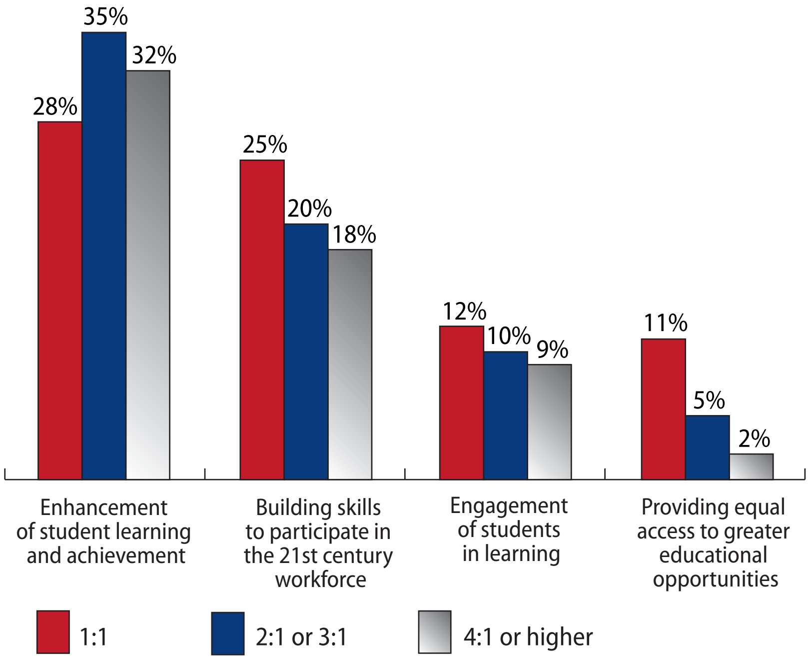
The lack of a clear education goal is one of the main reasons technology initiatives fail. Creators of grants and special initiatives should build in clear objectives and measurements throughout the life of the grant. Many grant applications lack a clear objective and, even more frequently, a clear process for assessing progress toward the goal after the grant is awarded.

Industry

Educators are not looking for gadgets but for ways to engage students in education and help them learn. Technical details are not appealing to educators unless a technical advantage is linked to learning outcomes.

Chart 6.6. What was the original impetus for your technology initiative? (Q10)

Impetus for Technology Initiative: Top 4 Reasons



Percentage of Respondents by Student-Computer Ratio
Only One Answer Allowed

Read As

- Only 28% of 1:1 schools report that enhancement of student learning and achievement was their original impetus, compared with 35% of 2:1 or 3:1 respondents and 32% of 4:1 or higher-ratio respondents. Overall, there are few differences in the reasons for funding a technology initiative across the different student-computer ratios.

In addition to the most frequently cited categories shown in Chart 6.6, other categories and their respective use levels are shown in Table 6.4 below.

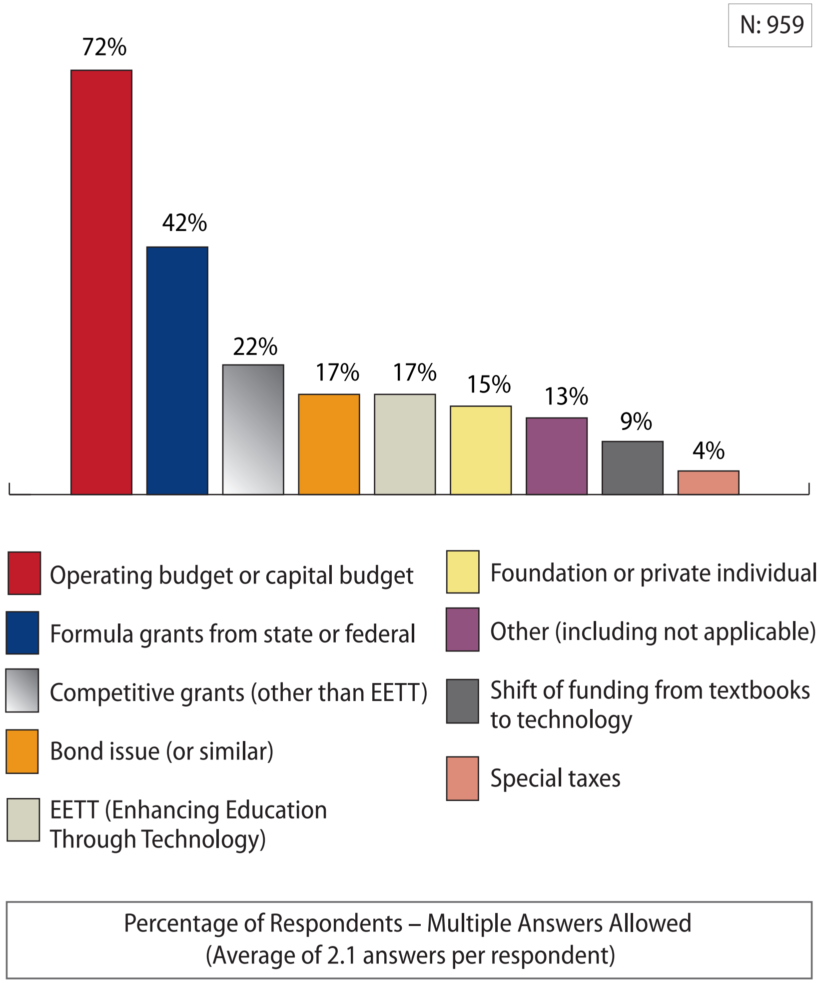
Table 6.4. Primary driver for adoption of technology initiative – other results (in rank order)

Category	1:1 (%)	2:1 or 3:1 (%)	4:1 or Higher (%)
Closing the digital divide	4	2	3
Superintendent mandate	4	3	4
AYP concerns	4	2	3
State mandate	3	2	2
Availability of funds	2	7	9
Academic standing of school	1	3	2

Interestingly, only 6% of respondents in 1:1 schools report "don't know, wasn't involved," regarding the reason for their technology initiative, while 12% give that answer in 2:1 or 3:1 schools and almost 16% in 4:1 or higher-ratio schools. Schools with a lower student-computer ratio appear to give more thought to the objectives driving their technology purchase.

Chart 6.7. How was your technology initiative funded? Check all that apply. (Q11)

Funding Sources for Technology Initiative



Read As

- 72% of respondents report that one of the funding sources for their technology initiative was their operating budget or capital budget.
- 42% of respondents report using formula grants from state or federal sources, reflecting the frequent use of Title I (NCLB) funding for technology purchases as well as various innovative program-funding sources. Many also point to E-rate funding.
- Surprisingly, only 17% of respondents cite EETT funds as a source for funding their technology initiative.

Demographic Highlights

- Schools in the Central and Northeast regions are more likely than schools in the West or Southeast to report using funds from the operating budget.
- Schools in suburban areas are more likely than schools in urban, second city, or town and country areas to report using funds from the operating budget. As expected, schools with higher household incomes and lower poverty are also more likely to report using operating budget funds as a source of funding.
- Schools in very high poverty areas are more likely than schools in lower poverty areas to report using formula grant funds from state or federal sources as a source of funding.
- Schools in the West are more likely than schools in the Central, Northeast, or Southeast regions to report bond issues as a source of funding. Also, schools with low or medium instructional materials expenditures are more likely than schools with high instructional materials expenditures to report bond issues as a source of funding.
- Schools with larger enrollments are more likely than schools with smaller enrollments to report that they use EETT funds as a funding source. And schools with lower household incomes (from very low to high) are more likely than schools with very high household incomes to report that they use EETT funds as a funding source.

Implications

Instruction

Funding technology from the regular operating budget allows technology to be integrated into the curricular budget, paralleling the integration of technology into the curriculum. This follows the federal government lead in reducing the dependence on technology-specific funding sources, such as EETT. Many respondents note that they started with a grant but continued to fund through operating expenses. Others were unable to continue funding technology when grant money ceased.

Project RED respondent comment:

> *"We have used our dwindling categorical funds. We are at the point where we cannot replace or expand our program. The majority of our classroom, library, and lab computers are over five years old."*

Finance

School operating budgets provide stable financing for ongoing purchases and support, a major shift from the 1990s when bond issues provided most funding. However, given the current state of school budgets, schools may cut back on technology programs and tech support staff if they are part of the regular operating budget.

Policy

Policymakers can consider some new alternatives to the funding conundrum. Other industrialized societies are considering widely available alternative technologies, such as cell phones as a new choice. Schools can consider using the technologies that students already own or adapt their systems to accept any laptop within certain standards. Some districts are moving in this direction. For example, Plano Independent School District in Texas is leveraging student-owned devices by providing robust wireless access at all sites. Students can connect any device they bring.

Project RED respondent comment:

> *"Our school is implementing a Bring Your Own Laptop program. Students can bring their own laptops from home and join our network through a student-specific login. Our plans are to purchase netbooks and provide them to those students who do not have the funds or their laptop is below the netbook standard."*

Industry

A more stable funding base has both advantages and disadvantages. Major project initiatives will still require substantial funding sources, but day-to-day purchases and support will benefit from funding through the regular budget. While bond issues and special taxes are cited by less than 25% of respondents, they may still be the fuel for major initiatives and upgrades.

Chart 6.8. How was your technology initiative funded? Check all that apply. (Q11)

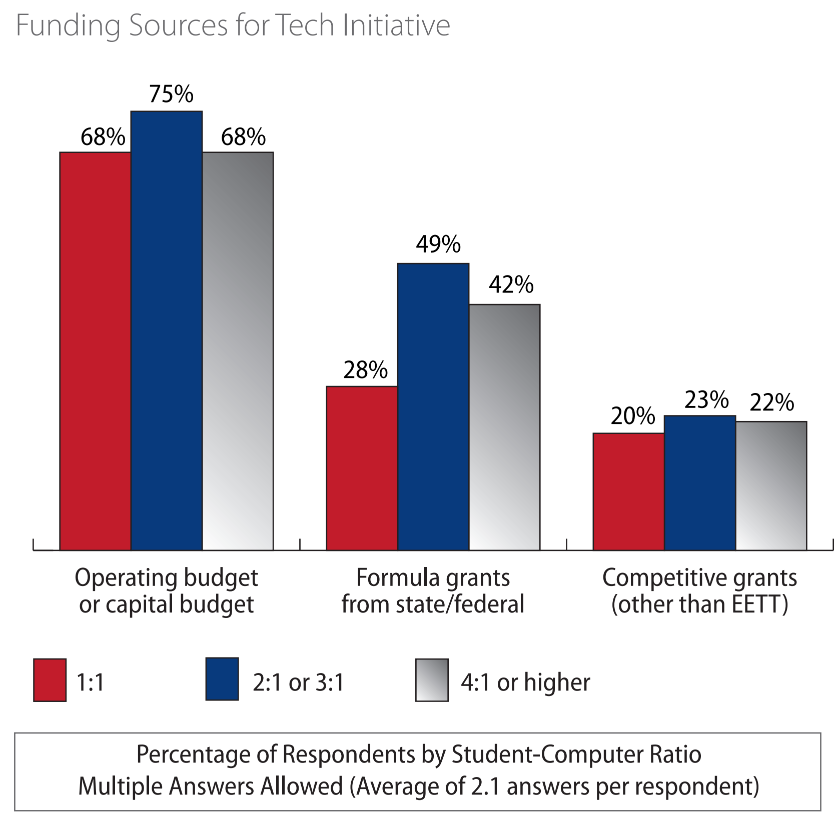


Table 6.5. Funding sources for tech initiative

Funding Source	1:1 (%)	2:1 or 3:1 (%)	4:1 or Higher (%)
Operating budget or capital budget	68	75	68
Formula grants from state/federal	28	49	42
Competitive grants (other than EETT)	20	23	22
Bond issue (or similar)	14	17	19
Shift of funding from textbooks	13	9	6
EETT	11	20	15
Foundation or private individual	10	16	16
Special taxes	4	5	3

Read As

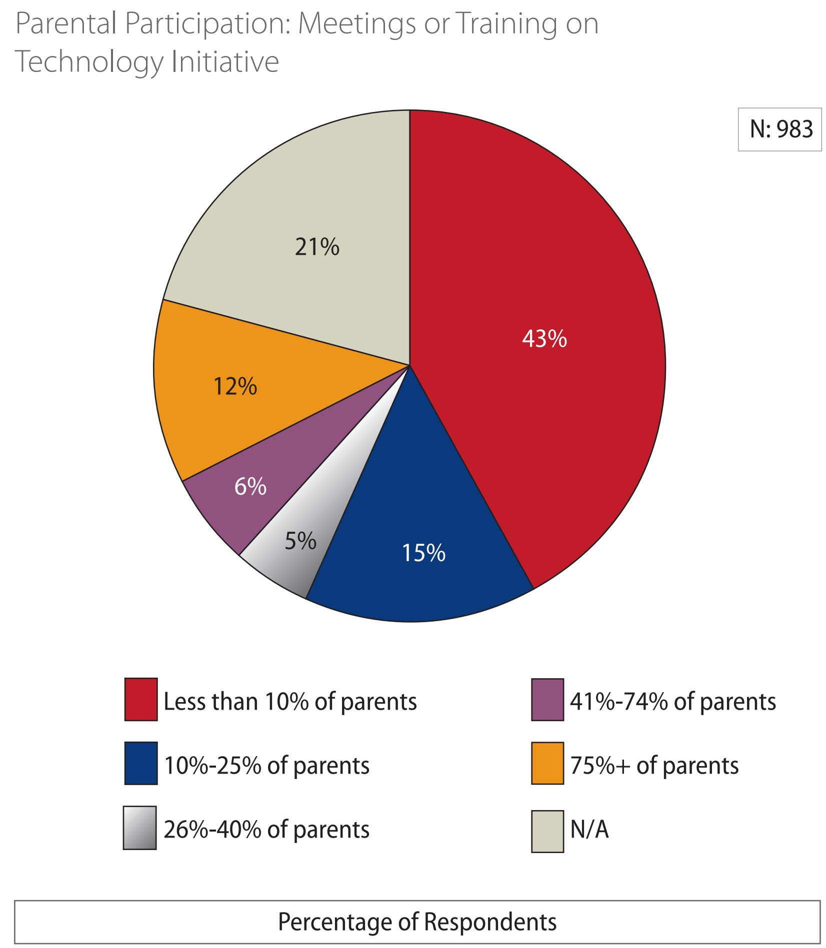
- 68% of 1:1 schools report using funding from their operating budget or capital budget, compared with 75% of 2:1 or 3:1 respondents and 68% of respondents in 4:1 or higher-ratio schools.
- 13% of 1:1 schools have shifted textbook funds to technology in order to pay for technology. This funding source is more frequent in 1:1 schools than in schools with higher ratios and may reflect a growing confidence in the use of digital curriculum to deliver core content.

A District-Level Example

"After Vail School District in Arizona completely replaced its instructional materials with digital content, all 14 of its regular elementary, middle, and high schools—along with its charter high school—earned 'excelling' labels from the state. Less than 15% of schools in the state receive an excelling label. Eighteen other districts and charter schools have now joined Vail's Beyond Textbooks model of sharing teacher-developed content."

~ Calvin Baker, Superintendent, Vail School District, Vail, Arizona, http://www.vail.k12.az.us/

Chart 6.9. Indicate what percentage of parents participated in face-to-face meetings or training on their role in helping the technology initiative. (Q12)



Read As

- Almost half (43%) of respondents report that less than 10% of parents attended any face-to-face meetings or training sessions.
- Only 12% of respondents report that 75%+ of parents attend face-to-face meetings and training sessions.

Demographic Highlights

- Schools in urban areas are more likely than schools in second city areas to report that less than 10% of parents participate in face-to-face meetings or training.
- Similarly, schools with low instructional materials expenditures and schools with medium to very high poverty are more likely than more affluent schools to report that less than 10% of parents participate in face-to-face meetings or training.

Implications

Instruction

One of the biggest challenges for any instructional initiative is parental buy-in, which affects sustainability. To increase ownership and encourage parents to review homework, grades, and other information, many districts are looking into opening up their instructional networks to families. Business practices, such as webinars and other web-based solutions, can help involve busy families and build support to some extent. However, schools must continue to seek essential face-to-face time with parents. Some schools and districts are proactively seeking out parents in locations away from school, such as local churches.

Finance

Parents are a primary influencer of bond issues and other funding measures, so schools need to develop parents as both information sources and spokespersons. An outreach public relations program that uses materials from the Association of School Business Officials International (ASBO), the National School Boards Association (NSBA), and other organizations can provide valuable content for busy school officials.

Policy

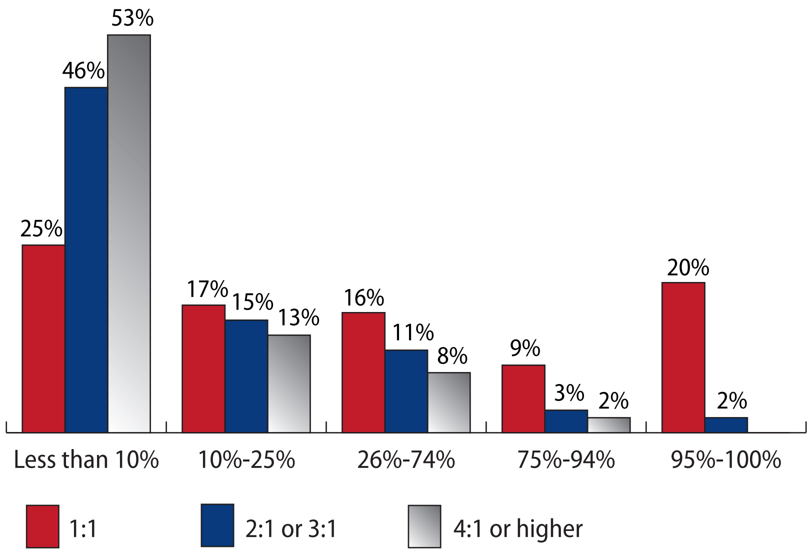
Numerous surveys, such as National Association of Colleges and Employers 2007, have indicated that parents have high education aspirations for their children. Policymakers should view technology as one way to advance this agenda. The Project RED finding that parents in less affluent areas are more likely to have less involvement suggests a strong need for programs that engage parents and perhaps enable access to instructional networks for parents.

Industry

Opportunities exist to help schools communicate with parents, engage them in school activities, and train them on major technology initiatives, all of which are good investments on the part of schools.

Chart 6.10. Indicate what percentage of parents participated in face-to-face meetings or training on their role in helping the technology initiative. (Q12)

Parental Participation in Training



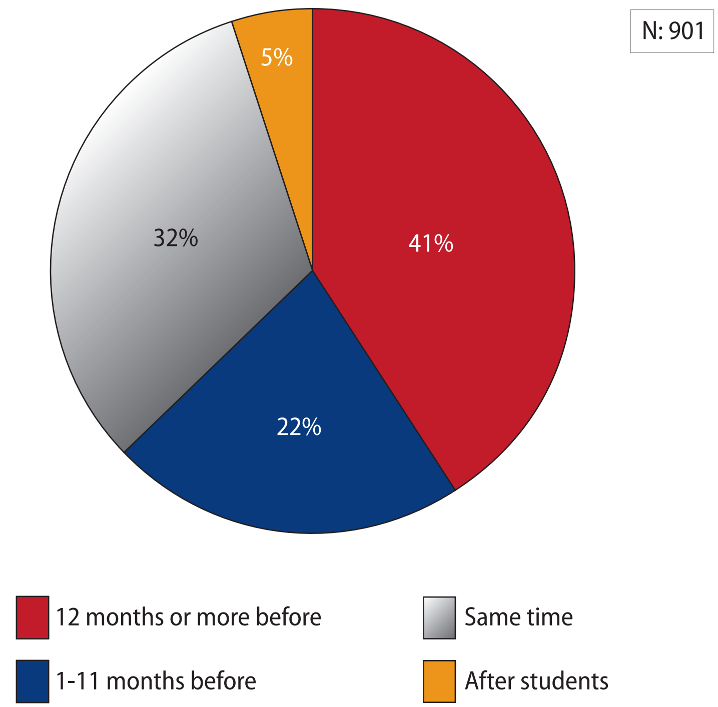
Percentage of Respondents by Student-Computer Ratio

Read As

- A quarter of 1:1 schools report that less than 10% of parents attend training. In schools with higher student-computer ratios, about one-half of respondents report 10% of parents attending.
- At the opposite extreme, 20% of respondents in 1:1 schools report that 95% to 100% of parents attend training, compared with 2% of 2:1 or 3:1 schools and 0% of 4:1 or higher-ratio schools.
- *Significance of 1:1 technology:* 1:1 schools are only half as likely to report that less than 10% of parents participate in parent training. On the other hand, 20% of 1:1 schools report that 95% or more parents participate, in sharp contrast to 2% of 2:1 or 3:1 schools and 0% of 4:1 or higher-ratio schools. Perhaps the very climate of a 1:1 school encourages greater parental involvement, a key factor in student engagement.

Chart 6.11. Indicate when teachers were issued a computing device as compared with students. (Q13)

Teacher Access to Computers Compared With Student Access



Percentage of Respondents

Read As

- 41% of respondents report teachers receive computing devices at least 12 months before students.
- 63% of respondents report teachers receive computing devices before students.

Demographic Highlights

- Schools in the Northeast are more likely than schools in all other regions to report that teachers are issued computing devices at the same time as students.
- Schools in urban areas are more likely than schools in suburban, second city, and town and country areas to report that teachers are issued computing devices at the same time as students.
- Schools in the Central region are more likely than schools in the Northeast or Southeast to report that teachers are given computing devices 12 months or more before students.
- Schools in areas with very low household incomes are more likely than schools in areas with higher household incomes to report that teachers are issued computing devices at the same time as students. Similarly, schools in areas with very high poverty are more likely than schools with lower poverty to report that teachers are issued computing devices at the same time as students.

Implications

Instruction

One of the challenges of technology in schools is that students are digital natives and many teachers are not, and students' comfort level with technology can impact the leadership of teachers unless they receive high-quality training. Many teachers enlist the support of students, and some schools give teachers an edge by equipping them with devices well ahead of students, which allows teachers to become proficient in using technology in their subject areas and locating relevant digital resources and content.

Finance

Schools can save money by phasing in computing devices and refining deployment procedures on an ongoing basis. Equipping teachers ahead of students can reduce technical support costs as well as ensure better classroom management.

Policy

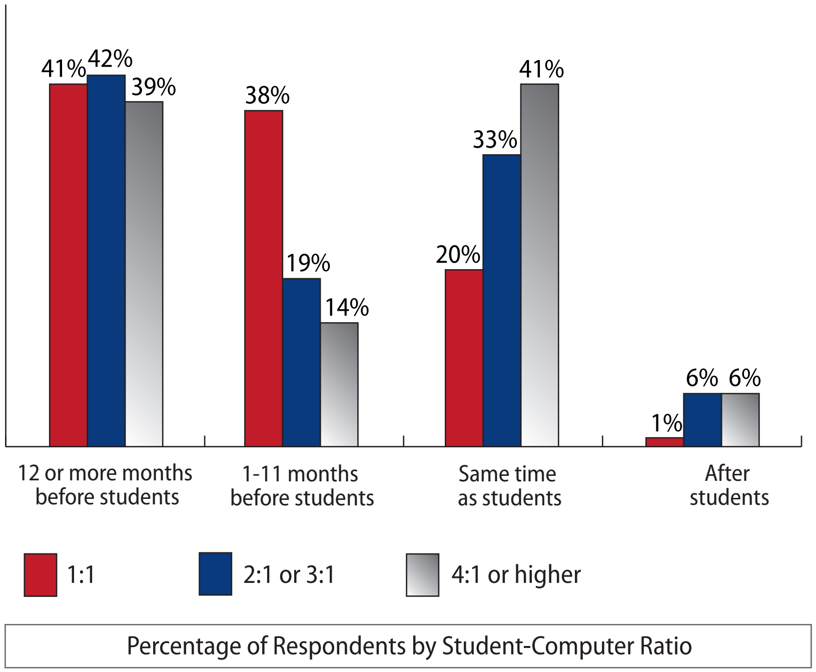
Policymakers should consider that giving teachers devices and training before students provides advantages in terms of classroom control and their new role as guide on the side. Grants and competitive initiatives should state these requirements clearly as prerequisites for funding.

Industry

Opportunities exist to create faculty training services or workshops on classroom implementation and integration strategies.

Chart 6.12. Indicate when teachers were issued a computing device as compared with students. (Q13)

Timing of Teachers Receiving Computing Device



Read As

- 41% of respondents in 1:1 schools report that teachers receive devices 12 or more months before students, compared with 42% in 2:1 or 3:1 schools.
- *Significance of 1:1 technology:* Only 20% of respondents in 1:1 schools report that teachers receive devices at the same time as students, compared with 33% of schools with 2:1 or 3:1 and 41% of schools with 4:1 or higher ratios. Schools with 1:1 programs appear to be following better instructional practices.

Project RED Commentary

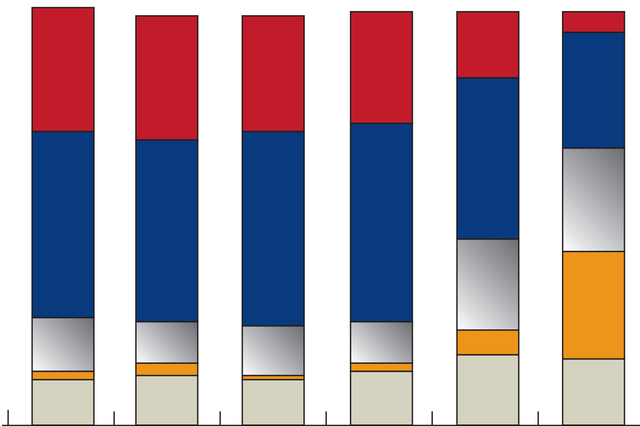
It is generally accepted that teachers should receive technology and training before students. Many experts suggest an interval of three to six months, with six or more months preferred. Teachers need time to become familiar with the equipment, operating systems, and tools and review the various resources that work with their lessons and state standards.

A majority of survey respondents (63%) report that teachers receive devices before students. A surprising 32% receive devices at the same time as students, possibly because the teachers had previous computer experience. However, this would not allow teachers to gather instructional resources for their lesson plans before using the device for classroom instruction.

Chart 6.13. How well did your technology implementation plan address each of the following? (Q14)

Assessing the Technology Plan's Effectiveness

N: 984



Teacher training	Teacher buy-in	Service and support	Instructional network	Long-term funding	Parent training	
30%	30%	28%	27%	16%	5%	Very well
45%	44%	47%	48%	39%	28%	Adequately
13%	10%	12%	10%	22%	25%	Not well
2%	3%	1%	2%	6%	26%	Not addressed
11%	12%	11%	13%	17%	16%	Don't know: I wasn't part of the plan

Percentage of Respondents

Read As

- Three-quarters of respondents report that teacher training, teacher buy-in, service and support, and the instructional network were addressed well or adequately in the technology implementation plan.
- 55% report that long-term funding was addressed very well or adequately.
- Only 33% report that parent training was addressed very well or adequately.

Demographic Highlights

Long-term funding

- Schools in the Central or Southeast regions are more likely than schools in the West to report that long-term funding was addressed well.
- Schools with low or medium instructional materials expenditures are more likely than schools with high instructional materials expenditures to report that long-term funding was not addressed well.
- Schools in second city and urban areas are more likely than schools in suburban or rural areas to report that long-term funding was not addressed well.

Parent training

- Schools in the Southeast are more likely than schools in the West or Central regions to report that parent training was handled well. Schools in the Central region are more likely than others to report that parent training was not addressed at all.
- Schools with high instructional materials expenditures are more likely than schools with lower expenditures to report that parent training was handled well. Schools with medium instructional expenditures are more likely than schools with low or high expenditures to report that parent training was not addressed at all.

- **Schools with very low to medium poverty percentages are more likely than schools with very high poverty percentages to report that parent training was not addressed at all.[1] Similarly, schools in areas with very high household incomes are more likely than schools with very low household incomes to report that parent training was not addressed at all.**

Instructional network

- Schools in the Southeast region are more likely than schools in the West or Central regions to report that instructional network installation was handled well. Schools in the West region are more likely to report that instructional networks were not addressed at all as part of the planning for the technology initiative.
- Schools with large or very large enrollments are more likely than schools with small or very small enrollments to report that instructional networks were handled well.

Service and support

- Schools in town and country areas are more likely than other areas to report that service and support were not handled well.[2]
- Schools with middle school grades are more likely than schools with elementary grades to report that service and support were handled well.
- Schools with high instructional materials expenditures are more likely than schools with low to medium instructional materials expenditures to report that service and support were handled well.

Teacher buy-in

- Schools in the Southeast are more likely than schools in the Northeast or Central regions to report that teacher buy-in was handled well. Schools in the West are more likely to report that teacher buy-in was not handled well.
- Schools with a high minority percentage are more likely than schools with a very low minority percentage to report that teacher buy-in was handled well.

Teacher training

- Schools in the Southeast are more likely than schools in the Northeast or Central regions to report that teacher training was handled well. Schools in the West are more likely than schools in the other regions to report that teacher training was not handled well.
- Schools with middle school grades are more likely than elementary or high schools to report that teacher training was handled well.
- Schools with medium poverty percentages are more likely than either lower or higher poverty percentages to report that teacher training was not handled well.

Implications

Instruction

As superintendents report,[3] the single most important factor for success in a technology implementation is leadership. Implementations driven by the vision and goals of leaders are much more likely to be successful than implementations driven by the sudden availability of funds.

However, leadership is not the only success factor. It is telling that only 33% of respondents feel that parent training was addressed even adequately. While this is a long-standing challenge for education, schools need a marketing plan focused on parental involvement in order to be successful in implementing technology.

Finance

The school finance environment tends to focus on the short term, with single-year rather than five-year plans. However, creative long-term financing, such as the leasing of equipment, can help smooth out costs and allow for more timely maintenance and continuity of instruction.

[1] Perhaps the result of more stringent grants requirements for high-poverty schools.

[2] Perhaps due to a paucity of resources.

[3] *America's Digital Schools*, 2006.

Policy

Parent training must be included as part of any technology initiative. It appears that some grants are already doing this, as evidenced by the high percentage of schools with high poverty percentages reporting that parent training was handled well, in contrast to schools with lower poverty.[4]

Three-quarters of respondents gave C-to-failing grades to all phases of the technology implementation. Clearly the days of "we got the funding, let's go" must be replaced with cabinet-level and system-wide planning. The Project RED Roadmap for Large-Scale Technology Implementations (see Appendix A) can function as an integral part of the management plan so that no district has to start from ground zero.

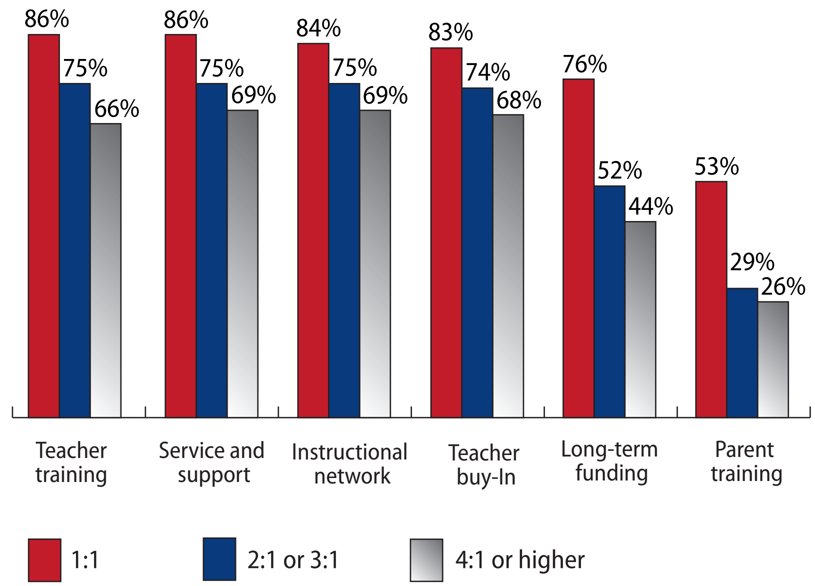
Industry

Suppliers can provide added value by helping schools up front with the planning process. Many vendors do an excellent job with advice regarding the mechanical parts of a technology initiative, but information on plans made by other districts of similar size and demographics could help the process as well as cement customer loyalty.

[4] Schools with high poverty percentages are far more likely than schools with lower poverty percentages to receive Title I and E-rate federal funding.

Chart 6.14. How well did your technology implementation plan address each of the following? (Q14)

Implementation of Tech Initiative



Percentage of Respondents by Student-Computer Ratio Reporting Very Well or Adequately

Read As

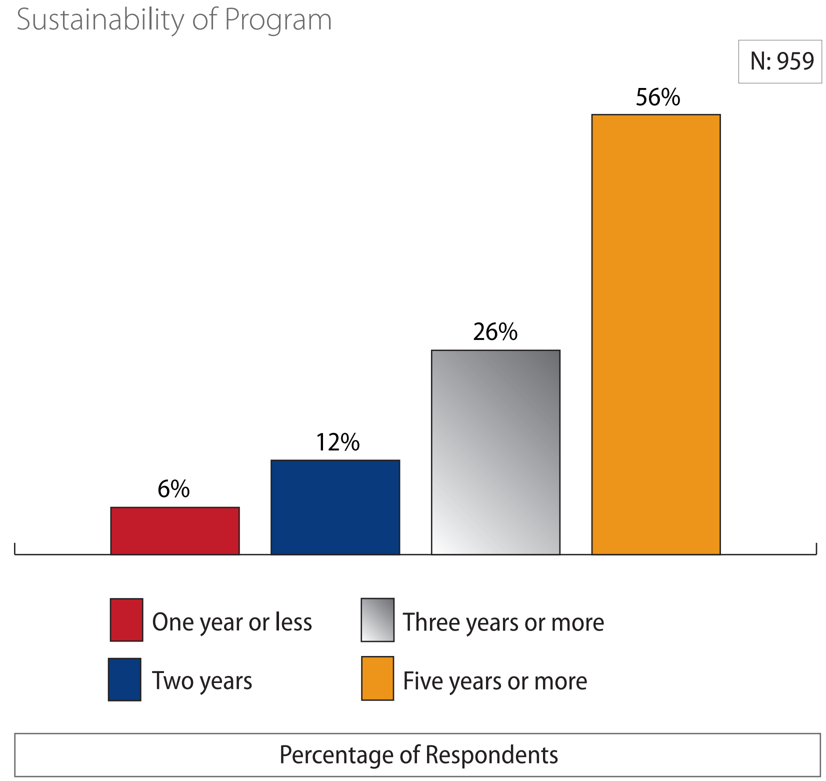
- 76% of schools with 1:1 programs report adequate planning for long-term funding, far more than other schools.
- Teacher training is reported more frequently in 1:1 schools than in other schools.
- The biggest difference between 1:1 schools and other schools is in parent training. Almost twice as many 1:1 schools report successful parent training than other schools—53%, compared with all other schools with higher student-computer ratios. Interestingly, most respondents report successful teacher buy-in, training, and support.

Project RED Commentary

This question was designed to investigate the quality of the implementation, with the technology plan quality being a proxy for implementation quality. There are several components to success:

- **Service and support.** Student and teacher laptops must be available 100% of the time. If it takes more than 30 minutes to repair or replace a device, the teacher's ability to deliver instruction is impacted.
- **Instructional network.** The network must be robust. It must support log-on and activity by every student at the same time.
- **Teacher buy-in and training.** If teachers are not engaged, they generally do not buy in. If they do not buy in, they generally do not take advantage of professional development opportunities or modify their teaching behavior to accommodate and exploit technology.
- **Long-term funding.** Adequate funding is required to sustain a technology initiative. When funding is in jeopardy, teachers and administrators tend to withdraw from the program and start planning for life after technology. A large number of 1:1 implementations have failed when the hardware aged and the money ran out.
- **Parent training.** Parent training drives parental involvement and expectations, which lead to more time on task and impact student achievement. Also, parent training can reduce the number of lost, stolen, and damaged devices.

Chart 6.15. For how long do you think your program is sustainable? (Q15)



Read As

- 6% of respondents feel their program is sustainable for one year or less.
- 56% of respondents feel their program is sustainable for five years or more.
- 38 respondents did not answer this question, suggesting a lack of knowledge or communication.

Demographic Highlights

- Schools in the West are more likely than schools in the Northeast or Southeast to report that their program is sustainable for one year or less. On the other hand, schools in suburban or town and country areas are more likely than schools in urban areas to report that their program is sustainable for five years or more.
- Schools in areas with high or very high household incomes are more likely than schools with lower household incomes to report that their program is sustainable for five years or more.

Implications

Instruction

The belief that a technology program is sustainable for two, three, or five years allows the program to become imbedded in curriculum standards. When programs are viewed as a test, long-term plans cannot be made.

Finance

One of the early problems with technology purchases in schools was the lack of long-term funding, driven by the nature of school finance. Leasing programs and other creative financing options can smooth out the costs over time and work better in school budgets than one major investment.

Policy

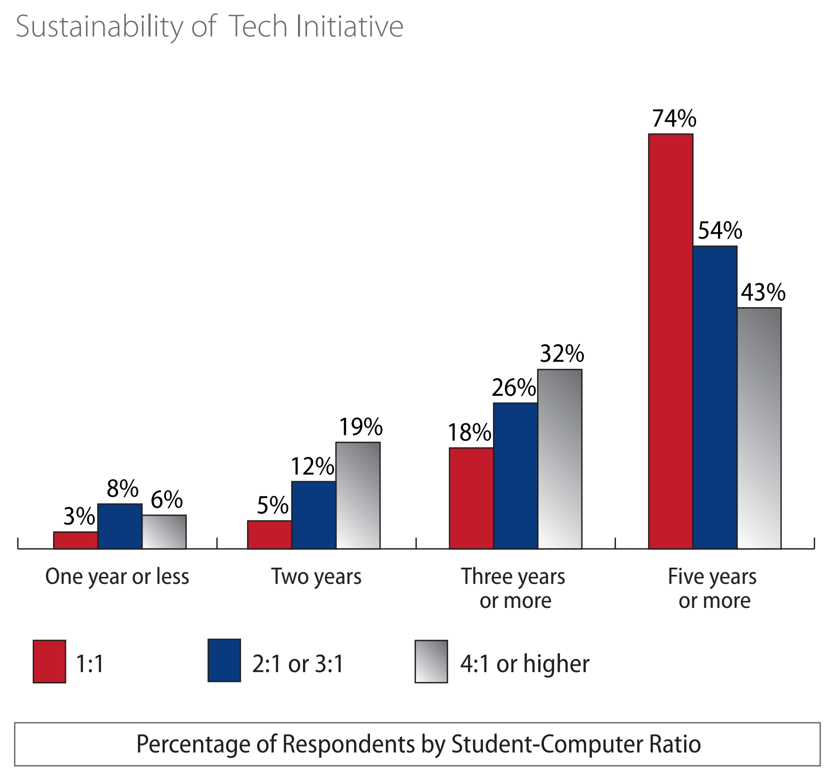
School budgets are growing at twice the rate of inflation, yet long-term planning is still not a consistent practice. Education is one of the most service-intensive industries in the country, yet it lags far behind in using technology to reduce costs and improve processes. Indeed, school district budgets are often set up to "hide" or "save" cost reductions with little or no reward for economic measures.

The Project RED Roadmap for Large-Scale Technology Implementations (see Appendix A) suggests information data management practices that punish the continual use of old processes and reward the kinds of cost savings that industry has long experienced from the use of technology. States and other stakeholders should examine the negative financial implications of many state practices and work toward improvement in processes and cost reductions as part of its mandates, with part of the savings going back to the schools and districts.

Industry

Devices with lower initial costs and education-appropriate features are becoming more common. Many districts are looking at netbooks and similar devices as a way to make ubiquitous technology sustainable.

Chart 6.16. For how long do you think your program is sustainable? (Q15)



Read As

- Few respondents report that their program is sustainable for only one year—3% of schools with 1:1 student-computer ratios and 8% of schools with 2:1 or 3:1 ratios.
- Three out of four schools with 1:1 programs believe their program is sustainable for five years or more.

Project RED Commentary

Sustainability is an important factor in effective change management. If stakeholders believe that the program is not sustainable, they are reluctant to make the extra effort required for success. However, in many districts, building-level administrators may not know the district-level budget plans that affect future funding.

Research Basis

Bebell, Damian & Kay, Rachel, "One to One Computing: A Summary of the Quantitative Results from the Berkshire Wireless Learning Initiative," *The Journal of Technology, Learning and Assessment*, 2010, v9, n 2.

Greaves, Thomas & Hayes, Jeanne, *America's Digital Schools*, MDR, 2006.

Hanson, Katherine & Carlson, Bethany, "Effective Access: Teachers' Use of Digital Resources in STEM Teaching," *Education Development Center*, 2005.

Keefe, James W. & Jenkins, John M., *Personalized Instruction: The Key to Student Achievement, Second Edition*, Rowman & Littlefield Education, 2008.

Kinney, Patti, "Transforming Teacher Leadership: A Conversation with Douglas Reeves," *Principal Leadership*, 2008, v9, n2.

Lesisko, Lee J.; Wright Robert J.; & O'Hern, Brenda, *Technology Integration: A Best Practice Perspective*, Online submission, paper presented at the Annual Meeting of the Eastern Educational Research Association, 2010.

Palak, Deniz & Walls, Richard T., "Teachers' Beliefs and Technology Practices: A Mixed-Methods Approach," *Journal of Research on Technology in Education*, 2009, v41, n4.

Project Tomorrow, 2009, www.tomorrow.org.

We've needed a metastudy of 1:1 programs and ubiquitous technologies for years, but none existed till now. Project RED's research is rich, deep, practical, and meaningful, with the kind of specifics educators require to carry forward 1:1 programs for fundamental improvement.

~ Pamela Livingston
Author
1-to-1 Learning: Laptop Programs That Work
International Society for Technology in Education, 2006

Hemera/Thinkstock

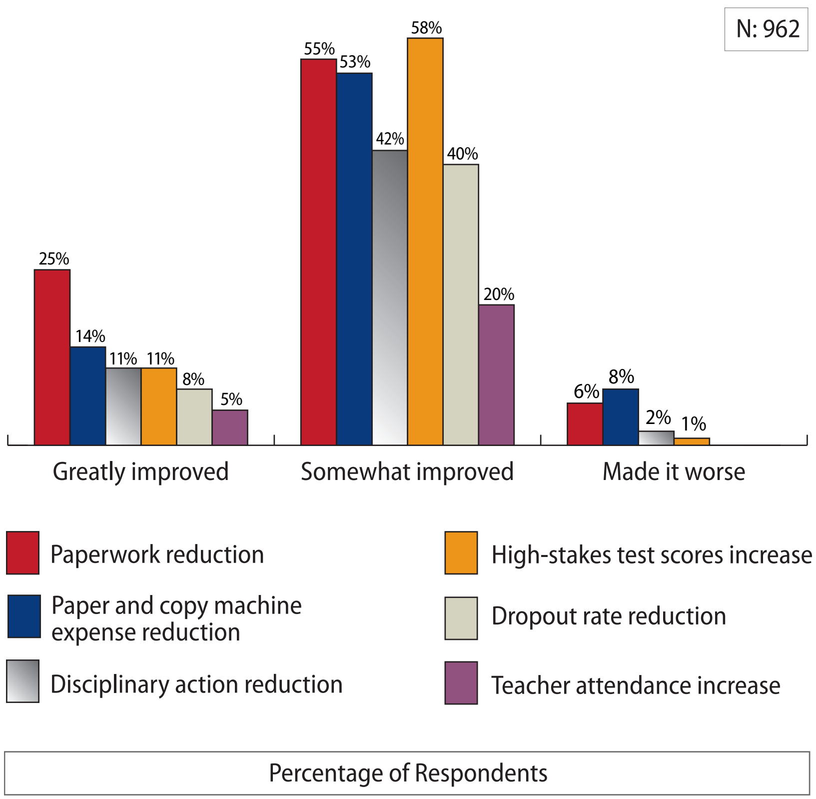
Chapter 7

Student and Teacher Outcomes

This chapter reports outcomes as defined by the 11 education success measures identified in the Project RED pre-survey literature review (see Chapter 1). The survey results indicate that nine key implementation factors positively impact the education success measures (see Chapter 3).

Chart 7.1. How has ubiquitous technology changed the following? (Q26)

Financial Impact of Technology in Schools



Read As

- 80% of respondents report that paperwork has been greatly or somewhat reduced.
- 67% of respondents report that paper and copy machine expenses have been greatly or somewhat reduced.
- 53% of respondents report that the number of disciplinary actions has been greatly or somewhat reduced.
- 69% of respondents report that high-stakes test scores have greatly or somewhat improved.
- 48% of respondents report that dropout rates have greatly or somewhat improved.
- 25% of respondents report that teacher attendance has greatly or somewhat improved.

Demographic Highlights

Paperwork reduction

- Schools in rural areas and in the Central and Northeast regions are more likely to report that paperwork has been somewhat reduced.
- Schools with low instructional materials expenditures are more likely to report that paperwork has been somewhat reduced.

Paper and copy machine expenses

- Schools in the Central and Northeast regions are more likely than schools in the West to report a reduction in paper and copy machine expenses.
- Schools in rural areas are more likely than schools in urban and suburban areas to report greater reductions in paper and copy machine expenses.

Disciplinary action reduction

- Schools with very low household incomes and schools with very high minority percentages are more likely than schools with higher incomes or less diverse populations to report that disciplinary actions are somewhat reduced.

- Schools with students of low to moderate household income levels are more likely than schools with very high household incomes to report that disciplinary actions are greatly reduced.
- Schools with medium-size enrollments are more likely than smaller schools to report that disciplinary actions are reduced. Also, combined schools are more likely than traditional elementary or secondary schools to report a reduction.
- Schools in the Central and Southeast regions are more likely than schools in the Northeast to report that disciplinary actions are somewhat reduced.

High-stakes test scores

- Schools in the Central, Southeast, and West regions are more likely than schools in the Northeast to report great improvements in high-stakes test scores.
- Schools with low enrollments are more likely than schools with very large enrollments to report great improvements in high-stakes test scores.
- Schools with elementary or combined grades are more likely than high schools to report some improvement in high-stakes test scores.
- Schools with very high household incomes are less likely than schools with lower household incomes to report improved high-stakes test scores.
- Schools with high and very high poverty are more likely to report some or great improvement in high-stakes test scores.
- Schools with high or very high minority percentages are more likely than less diverse schools to report great improvement in high-stakes test scores.

Dropout rates

- Schools with very high household incomes are less likely than schools of other income levels to report some improvement in dropout rates.
- Schools in the Central and Southeast regions are more likely than schools in the Northeast to report some improvement in dropout rates.
- Schools with very large enrollments are more likely than lower-enrollment schools to report some improvement in dropout rates.

Teacher attendance

- Schools with small enrollments are more likely than schools with very large enrollments to report greatly improved teacher attendance.
- Schools with high or very high poverty and schools with very high minority percentages are more likely to report improvement in teacher attendance.

Implications

Instruction

Reduced paperwork increases across-the-board productivity and frees up time for teachers and administrators to focus on improving job performance and enhancing instruction. Increased dual enrollment in high school and college courses provides more personalized education and expedites pathways to matriculation. Increased course completion rates mean that fewer students drop out and need remediation after high school. Finally, when students develop a roadmap of the courses and skills they need to reach their academic and career goals, they make more plans for higher education.

Finance

Teachers report that a reduction in paperwork can lead to five extra instructional minutes per class period, translating to 15 days per year or $4,123 per teacher per year based on a $50,000 salary.[1] A reduction in paper and copy machine expenses can free up funds for student-focused areas or ameliorate cost increases and revenue reductions.

[1] Based on author's estimated averages using data from Waterford, Holly, Walled Lake, and Hillsdale Public Schools in Michigan and Irving ISD in Irving, Texas.

In terms of the financial impact on society as a whole, studies show that students who attend college or who are jointly enrolled in high school and college enjoy significantly higher annual earnings, leading to increased tax revenue that benefits the economy and legislative priorities, such as education.

Policy

School and district policies must be in place to fully realize the savings and increased productivity that result from reduced paperwork, for example, through "workflow re-engineering" that adjusts roles and responsibilities. The expectation that schools will acquire technology and use it well must be embedded in policy. When technology is well integrated, policymakers can begin shifting some of the resources allocated for staffing and legacy expenses to contemporary processes that provide greater return on investment.

District, state, and national policies can further require that data be used to drive decisions regarding staffing, course offerings, student education plans, and more, so that districts and schools make expenditures that have been shown to make a difference in schools.

Industry

As schools migrate to complete digitization, technology tools for classroom, clerical, and administrative purposes will be increasingly in demand. A whole system approach will be the order of the day, with just-in-time data retrieval that drives best practices and one point of registration from which information is accessible as students move through the grades.

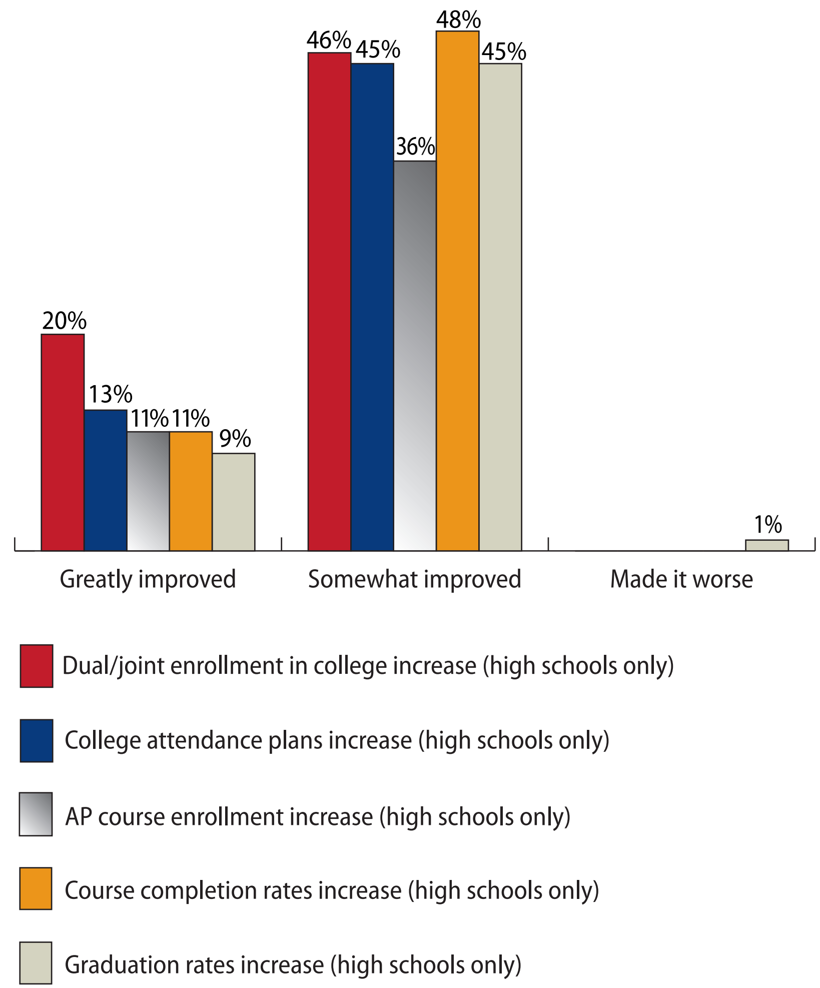
Looking beyond the educational technology industry, the implications for the service, construction, and manufacturing sectors are substantial, since working-age adults who are better educated exhibit improved time on task, attendance, critical thinking, problem solving, personal growth, and organizational and individual earnings potential.

Project RED Commentary

The implementation of technology has a broad-based positive impact on schools across grade levels, affecting academic achievement, financial savings, and efficiency for teachers and the educational system as a whole.

Chart 7.2. How has ubiquitous technology changed the following? (Q26)

Impact of Technology in Schools: High Schools Only



Read As

- 66% of respondents report that dual or joint enrollment in college has greatly or somewhat increased.
- 58% of respondents report that the number of students who have established college attendance plans has greatly or somewhat increased.
- 47% of respondents report that AP course enrollment has greatly or somewhat increased.
- 59% of respondents report that course completion rates have greatly or somewhat increased.
- 54% of respondents report that graduation rates have greatly or somewhat increased.

Demographic Highlights

Dual or joint college enrollment increase

- Schools in the West are more likely than schools in the Central region to report increased dual/joint college enrollment.
- Schools with low-medium poverty are more likely than schools with very high poverty to report somewhat increased dual/joint enrollment.

College attendance plans

- Schools in the West and Central regions are more likely than schools in the Northeast to report that college attendance plans have increased.
- Schools with very small and very large enrollments are more likely than schools with small, medium, and large enrollments to report that college attendance plans have increased somewhat.
- Schools with very high household incomes are less likely than schools in less affluent areas to report some increase in college attendance plans.

AP course enrollment

- Schools in the Central region are more likely than schools in the Northeast to report greatly or somewhat improved AP course enrollments.
- Schools in town and country areas are more likely than schools in second city or urban areas to report greatly or somewhat improved AP course enrollment.
- Schools with very large enrollments are more likely than schools with smaller enrollments to report some improvement in AP course enrollment.

Course completion rates

- Schools in the Northeast are less likely than schools in other regions to report some improvement in course completion rates.
- Schools in rural and town and country lifestyles are more likely to report some improvement in course completion rates.
- Schools with low instructional materials expenditures are more likely than schools with high instructional materials expenditures to report some improvement in course completion rates.
- Schools in very high household income areas are less likely than schools in lower household income areas to report some improvement in course completion rates.
- Schools with very high poverty are less likely than schools in more affluent areas to report some improvement in course completion rates.

Graduation rates

- Schools in the Northeast are less likely than schools in other regions to report some improvement in graduation rates.
- Schools in very high household income areas are less likely than schools in lower household income areas to report some improvement in graduation rates.
- Schools with very high poverty rates are less likely than schools with lower poverty to report some improvement in graduation rates.

Implications

Instruction

When students attain some college objectives while still in high school, states and families save money, student engagement in the workforce is expedited, and contributions to state revenue increase.

Dual and joint enrollment allows students to personalize and pursue instructional goals that are generally available only in the post-secondary environment, thus reducing college costs for families and states.

Increased AP course enrollment allows the learning experience to be individualized, so that students can achieve at the highest levels, reduce the number of courses taken at the post-high school level, and matriculate earlier from college.

Course completion, graduation rates, and college attendance affect the efficiency of instructional delivery and prepare students for college. These three factors come together to lay the bedrock for effective, efficient, and cost-conscious school programming.

Finance

For districts and institutions of higher education, an increase in AP course enrollment—combined with increased high-stakes test scores, increased graduation rates, and decreased discipline referrals—can result in less student remediation and thus reduced expenses. When more students are enrolled in AP courses and more students complete college courses in high school, post-secondary costs are reduced, moderating overall taxation rates.

When teacher attendance improves, substitute teacher costs are reduced, including the operational costs associated with finding and hiring substitutes. When high-stakes test scores improve, remediation time is reduced, and student outcomes improve within a constant metric of dollars and time invested. When the need for disciplinary action is reduced, administrators and teachers expend less time on behavior issues and more time on student learning, while remaining within existing budgets.

There is also a financial impact on society as a whole. When students pursue AP and dual enrollment in high school, families benefit from reduced higher education tuition expense. When graduation rates increase, annual and lifetime income also increases, which increases the overall consumption of goods and services, thereby increasing tax revenue without raising taxes (see Chapter 9).

Policy

Policymakers must provide incentives that encourage schools to adopt cost-saving measures along with mechanisms to capture the savings, rather than having them disappear into the system.

State, national, and district policies can require that schools provide access to Advanced Placement (AP) and dual enrollment opportunities, as well as the preliminary scaffolding through a standards-based curriculum. Technology tools provide efficient ways to reach these goals. With efficient technology integration throughout the instructional program, systems will become more effective and student achievement will flourish.

Industry

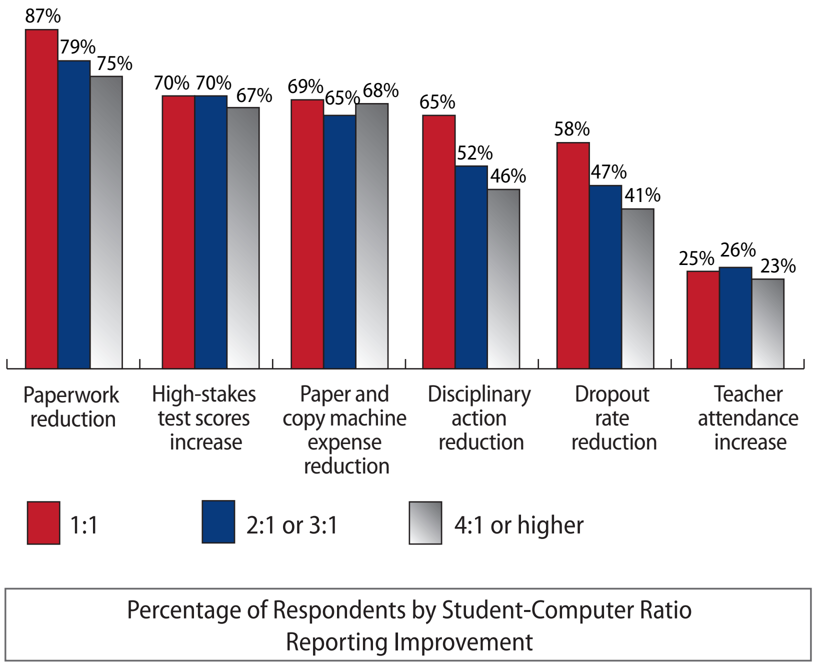
Schools and districts need resources that support individualized learning and tools that provide immediate personal feedback to students and teachers. Data systems that allow for just-in-time student progress data will give districts and schools the ability to make decisions and plan based on pre- and post-high school coursework.

Project RED Commentary

Administrators, teachers, staff, and others benefit from time savings due to paperwork reduction. The actual savings are dependent on many factors, but in a NextSchools (see Chapter 2), the savings estimate is about a 2% reduction in the teacher's time. When aggregated, this can translate to large savings. Additional commentary on the financial implications of well-implemented technology can be found in Chapter 9.

Chart 7.3. How has ubiquitous technology changed the following? (Q26)

Improvements Due to Technology Deployment:
All Schools by Student-Computer Ratio

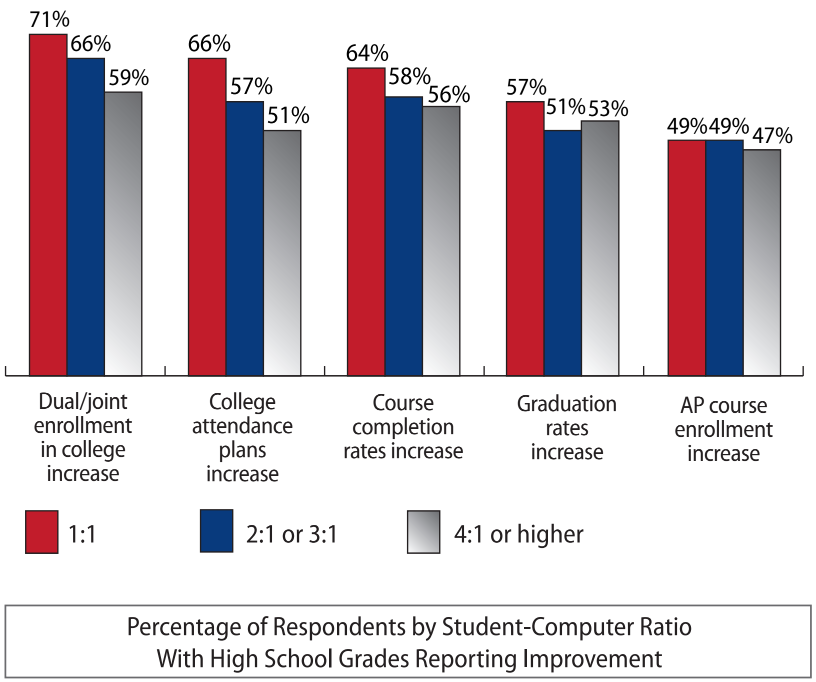


Read As

- 87% of 1:1 schools report a paperwork reduction, while 79% of 2:1 or 3:1 schools and 75% of 4:1 or higher-ratio schools report a reduction.
- 70% of 1:1, 2:1, and 3:1 schools report an improvement in high-stakes test scores, while 67% of 4:1 or higher-ratio schools report an increase.
- 69% of 1:1 schools report reductions in paper and copy machine expenses, while 65% of 2:1 or 3:1 schools and 68% of 4:1 or higher-ratio schools report a reduction.
- 65% of 1:1 schools report reductions in disciplinary actions, while 52% of 2:1 or 3:1 schools and 46% of 4:1 or higher-ratio schools report a reduction.
- 58% of 1:1 schools report a dropout rate reduction, while 47% of 2:1 or 3:1 schools and 41% of 4:1 or higher-ratio schools report a reduction.
- 25% of 1:1 schools report a teacher attendance increase, while 26% of 2:1 or 3:1 schools and 23% of 4:1 or higher-ratio schools report an increase.
- *Significance of 1:1 technology:*
  - 1:1 schools report greater increases than schools with higher student-computer ratios in paperwork reduction and dual/joint enrollment in college. These improvements can be attributed to the following:
    - A low student-computer ratio allows for greater access to students and the electronic aggregation of data.
    - Dual/joint enrollment may increase when each student can take control of the learning environment through a dedicated learning device.
  - Test scores do not appear to be improving at a greater rate in 1:1 schools than in schools with higher ratios. As noted in Chapter 6, proper implementation appears to be more important than student-computer ratio. A school with a 4:1 ratio that enjoys good leadership, teacher collaboration, and frequent online communication in a mentoring environment may have better outcomes than a 1:1 school that implements none of the key implementation factors (KIFs).

Chart 7.4. How has ubiquitous technology changed the following? (Q26)

Improvements Due to Technology Deployment:
High Schools by Student-Computer Ratio



Read As

- 71% of 1:1 schools report increases in dual/joint college enrollment, while 66% of 2:1 or 3:1 schools and 59% of 4:1 or higher-ratio schools report an increase.
- 66% of 1:1 schools report increases in college attendance plans, while 57% of 2:1 or 3:1 schools and 51% of 4:1 or higher-ratio schools report an increase.
- 64% of 1:1 schools report an increase in course completion, while 58% of 2:1 or 3:1 schools and 56% of 4:1 or higher-ratio schools report an increase.
- 57% of 1:1 schools report a graduation rate increase, while 51% of 2:1 or 3:1 schools and 53% of 4:1 or higher-ratio schools report an increase.
- 49% of 1:1 schools report an AP course enrollment increase, while 49% of 2:1 or 3:1 schools and 47% of 4:1 or higher-ratio schools report an increase.
- *Significance of 1:1 technology:* More respondents from 1:1 schools than from schools with higher student-computer ratios report improvements in paperwork reduction, college attendance plans, and rate of course completion.

Project RED Commentary

Unlike other industries, education is late to integrate technology to enhance system-wide efficiency. The time has come. When technology is effectively implemented, schools become dynamic, flexible, responsive, and nimble organizations. They experience significant cost and resource savings while helping students achieve and matriculate at higher levels.

Research Basis

Bebell, Damian & Kay, Rachel, "One to one computing: A summary of the quantitative results from the Berkshire Wireless Learning Initiative," *The Journal of Technology, Learning, and Assessment*, January 2010, v9, n2.

Franceschini, Louis; Allen, Lee E.; Lowther, Deborah L; & Strahl, J. Daniel, "Freedom to Learn Program Michigan 2007-2008 Evaluation Report," *Center for Research in Educational Policy*, The University of Memphis, September 2008.

Gomez, Elizabeth Avery; Wu, Dezhi; & Passerini, Katia, "Computer-supported team-based learning: The impact on motivation, enjoyment and team contributions on learning outcomes," *Computers and Education*, August 2010, v55, n1, 378-390.


Comstock Images/Thinkstock

Chapter 8

The Instructional Impact of Technology-Transformed Schools

The first Project RED hypothesis is that education technology, when properly implemented, can substantially improve student achievement (see Chapter 1). This hypothesis is difficult to prove because learning environments are human systems and numerous variables are in play at all times.

However, the links between certain education success measures and technology best practices, or key implementation factors, can be investigated and established. The Project RED contribution is to show which factors are key to success and should be deployed more frequently (see Chapters 1 and 3).

This chapter will review the research surrounding this subject and provide a theoretical basis for the findings of the Project RED survey.

Personalized, Self-Directed Learning

Project RED points to the emergence of a learner-centric school environment built around personalized teaching and learning. The advent of computer technology in the 1980s fueled a new interest in personalized learning—long advocated by influential figures, such as F.H. Hayward, Dewey, and Piaget—and offered new opportunities for teachers to function as "guide on the side" rather than "sage on the stage."

A major impetus in education reform today is the movement from a teacher-centered to a learner-centered environment, in which students take on increased responsibility, unique student needs drive more personalized teaching and learning, teachers move about the classroom providing just-in-time support to individuals and groups, and academic success improves.[1]

When students are pursuing their own learning experiences, teachers are able to work directly with individuals and small groups, providing just-in-time response and dramatically enhancing the personalization process that leads to increased achievement. The end result is that teachers are able to engage more individuals and small groups to enhance the learning process.

The transition is not always easy. A new environment in which teachers no longer provide all the questions and answers can be a shock for students used to being passive recipients of information. Trusting students to become self-directed learners can be challenging for teachers used to being totally in charge. To help students make the shift, the school environment must understand and respond to second-order change (see Chapter 2). To ensure a successful transition, it is essential that schools implement the concepts of second-order change in a systemic fashion.

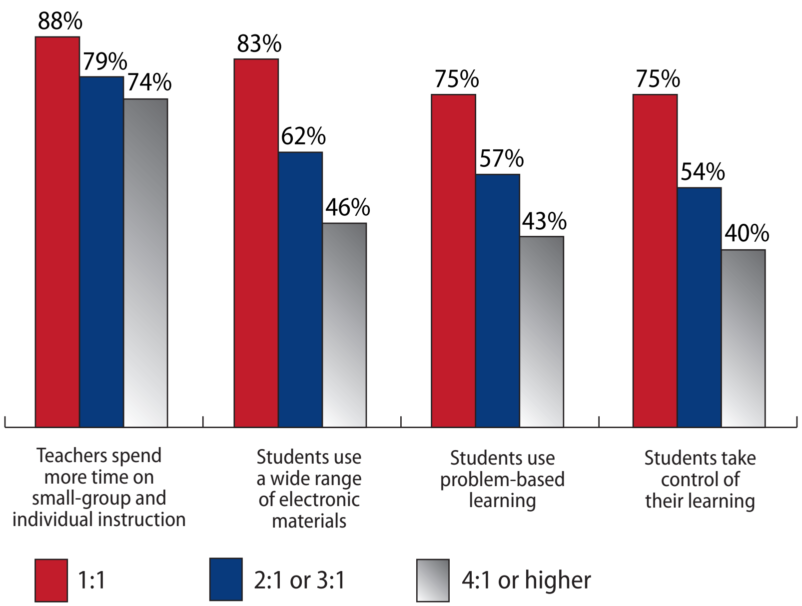
Project RED Findings

Project RED shows that the lower the student-computer ratio, the greater the individualization of instruction and the more students take responsibility for their learning. Eighty-eight percent of respondents say that teachers in 1:1 classrooms spend more time on individual and small-group instruction. Seventy-five percent say that students in 1:1 environments take control of their own learning.

[1] Evidence continues to mount about the benefits of student-centered learning. A six-year study in Helsinki (Lonka & Ahola, 1995) compared direct instruction to student-centered learning and found that the student-centered group developed a better understanding of content. Hall and Saunders (1997) showed that learners in a student-centered program demonstrated increased participation, motivation, and higher grades. In a study by O'Neill & McMahon (2005), 94% of students said that they would recommend the student-centered approach over direct instruction.

Chart 8.1. How do teachers and students in your school use technology in instruction? (Q16)

Learning Activities: Students and Teachers



Percentage of Respondents by Student-Computer Ratio Responding at Least Weekly

Project RED examined the ability of technology to personalize student learning. Predictive modeling shows that the key drivers and implementation factors for increased high-stakes test scores are technology-transformed intervention classes (ELL, Title I, special education, and reading) and the daily availability of the network and an LMS at home and at school.

Both target the individual student. The technology-transformed classes are individualized to provide immediate feedback and resources for remediation. Consistent access to the Internet and the LMS anywhere/anytime lets each student pursue learning at his or her own pace. The next two tables show that a key predictor of improved high-stakes test performance is student involvement in technology-transformed intervention classes.

Table 8.1. Drivers of improving high-stakes test scores

High-Stakes Test Improvement by Predicted Model Quintile

Description	Relative Importance
Technology in Intervention Classes	24.6
Instructional Network Available at Home and LMS Daily	19.8
Principal Training Exists	14.1
Daily Games, Social Media	13.1
Principal's Role in Technology	11.6
Online Assesments	8.7

Relative Importance Scale

Table 8.2. Drivers of improving discipline

Discipline Improvement by Predicted Model Quintile

Description	Relative Importance
Technology in Intervention Classes	24.4
Collaboration Between Students	22.1
Daily Use of Technology in Core Classes	15.4
Principal Training Exists	11.7
Virtual Field Trips	6.3
Tech Implementation Effectiveness	5.3

Relative Importance Scale

Collaboration also seems to play an important role in improving discipline and preventing students from dropping out. Collaboration with peers ranks second-highest in reducing discipline referrals, with the continuous integration of technology in intervention classes and core classes ranking first and third, respectively.

As shown in Table 8.3, collaboration plays a slightly different role in improving dropout rates. External collaboration outside the school is an important driver, but again, along with the continuous integration of technology in intervention classes and core classes.

Table 8.3. Drivers of improving dropout rates

Dropout Rate Improvement by Predicted Model Quintile

Description	Relative Importance
Technology in Intervention Classes	32.6
Weekly External Collaboration	14.2
Daily Use in Technology Core Classes	13.1
Principal's Role in Technology	10.9
Daily Games, Social Media	9.6
Virtual Field Trips	9.2

Constructivist Classrooms and Quality Teaching

Consistent with the development of learner-centered classrooms, a key under-pinning of education reform is the constructivist classroom, where the focus shifts from teacher to student. Teachers become facilitators or coaches who support students in developing understanding through exploration, research, discovery, and collaboration. Students and teachers become producers of dynamic content rather than consumers of static, dated resources. A technology-rich learning environment, especially where there is a low student-computer ratio, facilitates the attributes of the constructivist classroom outlined in Table 8.4.

Table 8.4. Traditional versus constructivist classrooms

Traditional Classroom	Constructivist Classroom
Focus on basic skills. Content and curriculum look at the parts and then the whole.	Content addresses overarching concepts/ questions, looking at the whole and then the parts.
Strident attachment to a linguistic, linear approach to curriculum/content.	Curriculum/content is made relevant, meaningful, integrated with student interest, real-life experiences, problem solving, and questions.
Predominantly uses static resources—texts, workbooks, etc.	Resources include wide variety of dynamic, current options, projects, which may include projects researched or created by teachers/students.
Learning is rote, drill and kill, linguistic.	Learning is scaffolded, interactive, collaborative, project-based.
Teachers are sages on the stage; students are passive recipients.	Students are self-directed learners, responsible for research, exploration, problem solving, and the creation of learning artifacts.
Tests are administered to demonstrate achievement; correct answers are expected.	Assessments are formative, used for redirecting/adjusting instruction and rely on student demonstration of learning through variety of avenues.
Source: One-to-One Institute training materials.	

Project RED Findings

Looking again at Chart 8.1, seventy-five percent of the Project RED respondents say that students in 1:1 classrooms use problem-based learning activities, a constructivist learning approach. That same percentage says that students are taking responsibility for their own learning.

Eighty-three percent of 1:1 respondents note that students use a wide variety of electronic resources in their learning. Ninety-four percent say those students use Google and other search engines in their instruction. Eighty percent report that students are collaborating with peers in their schools.

Of all Project RED respondents:

- 56% say students engage in problem-based (real-world) learning activities daily or weekly.
- 53% note that students are self-directing their learning by identifying research topics and resources and presenting their findings daily or weekly.
- 60% report that students are using a wide range of digital resources for learning, courseware, and collaboration daily or weekly.

These findings underscore how personal portable technologies—particularly when the student-computer ratio is low—can transform the classroom according to education reform standards.

Collaboration and Creativity

Collaborative learning is an active, student-centered approach that requires students to engage with their peers in investigation, creative design, problem solving, decision making, as well as applying, analyzing, and synthesizing content. Project-based learning and problem-based learning are well-known approaches to collaborative learning.

Tools such as social media, Web 2.0 and 3.0, blogs, and wikis, integrated into project- and problem-based strategies, provide effective and seamless ways for students to collaborate throughout the learning process and develop team communication, higher-order thinking, and analytical skills.

Online collaboration tools provide engaging platforms for students to become co-creators of content, connect with peers via social media, and demonstrate creativity in multimedia presentations, websites, blogs, wikis, and webinars.[2]

Project RED Findings

The Project RED results show that a greater percentage of schools with low student-computer ratios use a wide range of electronic tools for collaboration.

Table 8.5. Use of electronic materials

Student-Computer Ratio	% of Respondents Reporting That Students Use a Wide Range of Electronic Materials[3]
1:1	83
2:1 or 3:1	62
4:1 or higher	46

Collaboration is one of the skills necessary for students to be successful in the contemporary world and is included in the three learning and innovation skills subgroups identified by the Partnership for 21st Century Skills (P21):

- Creativity and innovation
- Critical thinking and problem solving
- Communication and collaboration

Collaborative educational technology tools provide engaging platforms to learn these skills.

The need for collaboration as a social component of learning is well documented.[4] Project RED has found that the number one driver of increased graduation rates is digital collaboration with peers on at least a monthly basis, shown in Table 8.6.

[2] Yazzie-Mintz, Ethan, *Charting the Path from Engagement to Achievement, A Report on the 2009 High School Survey of Student Engagement*, University of Indiana, 2009.

[3] These include courseware, collaboration tools, and multimedia databases.

[4] Dr. Sugata Mitra performed a series of "hole in the wall" experiments demonstrating that groups of children can learn to use public computers and complex content in unsupervised, social groups. The first experiments were conducted with "hole in the wall" (minimally invasive education, or MIE) computers in 17 locations in rural India. Focus groups in each location were tested for computer literacy and complex content knowledge acquisition for nine months. www.ascilite.org.au/ajet/ajet21/mitra.html

Table 8.6. Drivers of improving graduation rates

Graduation Rate Improvement by Predicted Model Quintile

Description	Relative Importance
Monthly Collaboration With Students Outside School	17.4
Technology Intervention Classes	15.4
Daily Search Engines	13.4
Instructional Network Available at Home	9.9
Frequent Virtual Field Trips	9.5
Daily Communication Via Technology	9.4

Critical Thinking and Problem Solving

Students improve their critical thinking and problem solving skills when they use research, communication, publishing, and presentation tools individually and in collaborative groups. For example, a 1997 study by Coley et al. has shown that students who used the Internet to research topics, share information, and complete a final project within the context of a semi-structured lesson became more independent critical thinkers.[5]

Project RED Findings

Problem-based learning is one method teachers use to engage students in critical thinking and problem solving. The Project RED data shows that the lower the student-to-computer ratio, the more they are using problem-based learning.

Table 8.7. Use of problem-solving skills

Student-Computer Ratio	% of Respondents Reporting That Students Use Problem-Based Learning
1:1	75
2:1 or 3:1	57
4:1 or higher	43

Students in 1:1 environments appear to engage more frequently in problem-solving activities than those in schools with higher student-to-computer ratios. Seventy-five percent of Project RED survey respondents from 1:1 environments say that they use problem-based learning, compared with 57% of respondents from 2:1 or 3:1 environments and only 43% from 4:1 environments.

Communication

Collaborative software facilitates and manages effective communication among group members, while project management tools handle the logistics of planning and scheduling. The digital environment extends beyond the individual device by allowing members to access, contribute to, and edit content developed by the group.

Project RED Findings

Ongoing communications with students allow teachers to "know" their students as individuals, as well as monitor their progress and adjust instruction. Project RED findings show that 75% of respondents from 1:1 environments say that their teachers are using online communications, such as chat and email, to communicate with their students, compared with 42% in 2:1 or 3:1 environments and 33% in 4:1 environments.

[5] Coley, R.; Cradler, J.; & Engel, P., "Computers and Classrooms: The Status of Technology in U.S. Schools. Policy Information Report," *Educational Testing Service*, 1997.

Table 8.8. Email and chat with teachers

Student-Computer Ratio	% of Respondents Reporting Student Communication With Teachers Via Email and Chat
1:1	74
2:1 or 3:1	42
4:1 or higher	33

Technology Tools Used

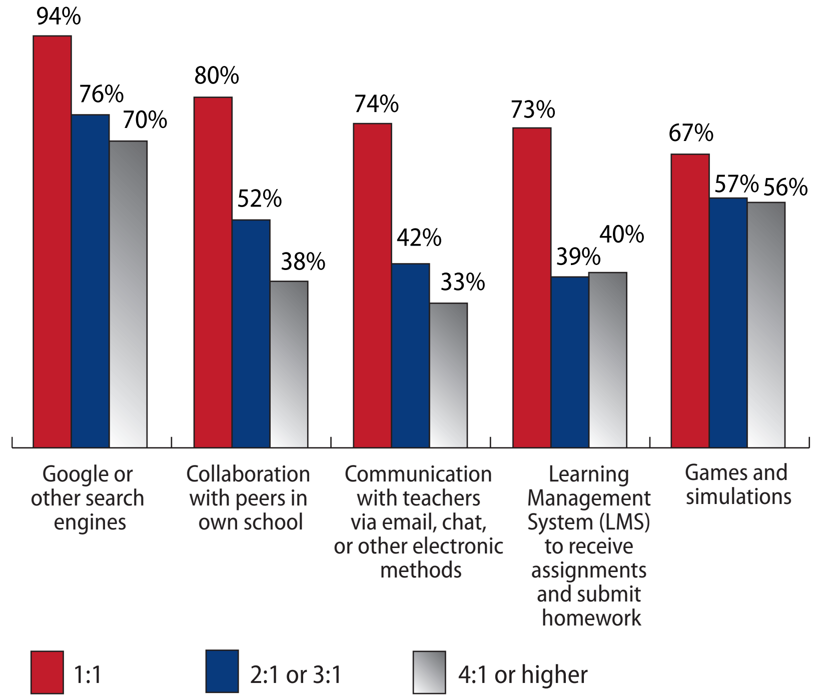
Digital collaboration and communications are two technology tools that have already been described above. There are other technology tools being used in schools that are driving higher levels of achievement on Project RED's educational success measures. These tools include search engines, Learning Management Systems, and games and simulations.

Project RED Findings

Project RED reveals that 1:1 environments use a variety of technology tools more frequently than schools with higher student-to-computer ratios.

Chart 8.2. How frequently do students actually use technology in the following activities? (Q18)

Technology Tools Used: Actual Use Estimated – Top Five



Percentage of Respondents by Student-Computer Ratio Responding at Least Weekly

The rate of usage of the key technology tools is at least 10% higher in 1:1 environments than in environments with higher than a 1:1 student-to-computer ratio. The difference in usage rates is greatest with digital collaboration, communication tools, and Learning Management Systems, with rates for 1:1 schools at least 25% higher than in environments with higher student-to-computer ratios.

Project RED also shows that the more frequently technology is used in the learning process, the greater the return on investment (see Chapter 9).

Student Engagement

Most high school students are bored and disconnected from school, according to a 2009 survey of 103 high schools in 27 states, "Charting the Path from Engagement to Achievement." This finding has been consistent since 2006. The survey also found that:

- 41% of students said they went to school because of what they learned.
- 23% said they went to school because they liked their teachers.
- 65% said they liked discussions in which there were no clear answers.
- 82% said they would welcome the chance to be creative in school.

Much current research (for example, Bates, et al 2007; Bebell 2009) shows the impact on student engagement of personalized learning, constructivist principles, and the integration of technology into teaching and learning.

Consistent access to technology provides a natural way for students to drive their own learning and work at their own pace, as demonstrated in the Michigan Freedom to Learn 1:1 program (Franceschini, Allen, Lowther, Strahl 2007). Teacher and student surveys showed a high rate of engagement, and observations showed high levels of on-task learning. The schools that included special education students were astounded by the results obtained through individualized instruction and engaging student devices.

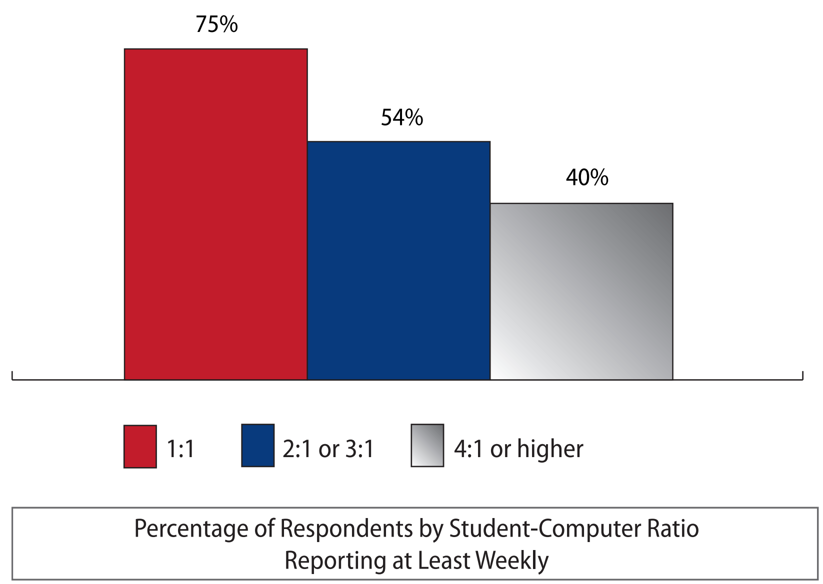
Project RED Findings

Project RED respondents indicate high levels of student engagement, especially in low student-computer ratio schools. Chart 8.3 shows that 75% of respondents in 1:1 schools note that students take responsibility for their own learning. Of all Project RED respondents, 53% say that students are self-directing their learning by identifying research topics and resources and presenting their findings daily or weekly.

[6] Walden University, Richard W. Riley College of Education and Leadership, 2010.

Chart 8.3. Indicate how teachers and students in your school use technology in instruction. (Q16)

Students Take Control of Their Learning



Frequency of Use

As teachers and students use education technology tools more frequently within instructional programs, their expertise and efficiency increase. New research from Walden University, Richard W. Riley College of Education and Leadership indicates that as teachers use technology more frequently, they become more aware of its potential to boost student learning, engagement, and 21st century skills.[6]

According to research conducted by Janet Kolodner (1983), two major factors distinguish novices from experts. Experts know more about their field and are better at applying what they know since they can evaluate and learn from past experience. The more novices apply new knowledge, the closer they come to expert status. The Dreyfus novice-to-expert skill acquisition scale (http://www.sld.demon.co.uk/dreyfus.pdf) underscores Kolodner's research.

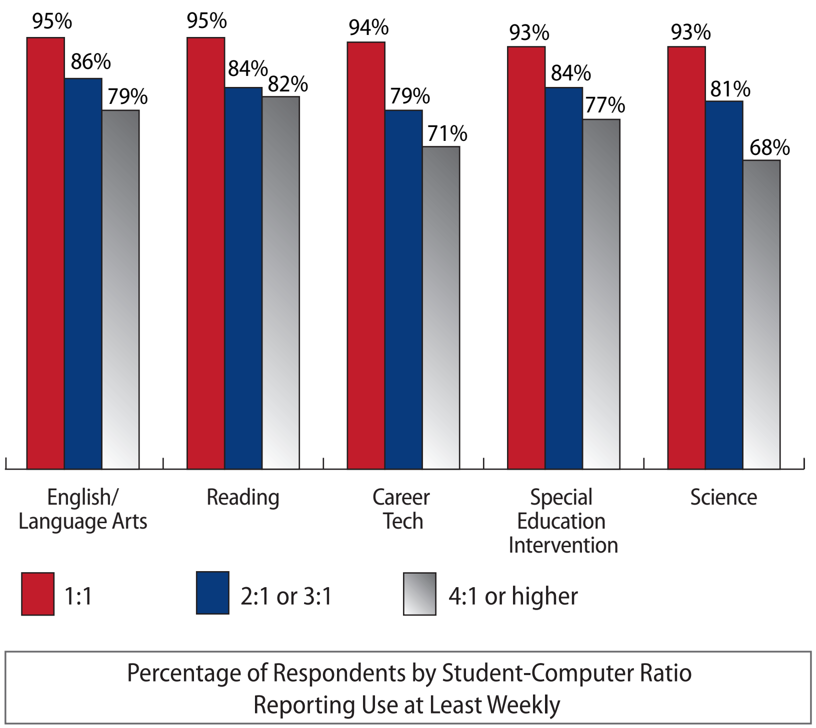
Project RED Findings

Project RED respondents indicate a greater frequency of technology tool use in the 1:1 environment than the higher-ratio environments. When students have uninterrupted access to personal technologies, they are able to use technology tools more often.

In 1:1 classrooms, technology is most highly integrated on a weekly basis in English language arts and reading intervention courses, closely followed by career tech. In 2:1 and 3:1 environments, the rate of integration is still high each week in these content areas (79%-86%). In 4:1 and higher-ratio environments, the rate of weekly technology tool use is less in these subject areas.

Chart 8.4. How frequently do your students use technology as an integral part of instruction? (Q9)

Technology Integration by Subject Area: Top 5



Digital Curricula

Digital curricula provide a dynamic, conceptual framework and a powerful transformative tool in the enhanced learning environment. Digital resources allow students and teachers to create just-in-time content that is relevant and meaningful, not static and outdated.

When educators and students use digital research, content, and resources, they become critical explorers, agile problem solvers, and communicators who use imagination and initiative to guide the teaching and learning processes.

An instructional shift takes place. Static information becomes dynamic, questioned, researched, and relevant to learning. Students manipulate and explore until the content provides meaning or provides answers to overarching questions.

Other school conventions are assimilated to conform to digital resources, which helps transform traditional practice. Where students would traditionally perform static research and write paper and pencil reports, digital resources allow them to explore topics online in a dynamic fashion and use multimedia tools to produce learning artifacts, such as podcasts, videos, or vodcasts. Where students would wait long periods of time for feedback, formative assessments via an LMS or other online tools allow for just-in-time demonstrations of learning and immediate feedback to inform next steps. Where student collaboration would consume large amounts of instructional time using static tools, online tools allow for simultaneous interaction and the development of collaborative products. Media literacy is a crucial skill that must be developed, monitored, and maintained.

Table 8.9. Digital curriculum versus analog curriculum

Digital Curriculum	Analog Curriculum
Dynamic	Static
Quick	Slow
Accessible	Insular
Mashable[7]	Stand-alone
Mobile	Rigid
Multi-layered	Single-layered

Evan Abbey, http://eabbey.blogspot.com.

Project RED Findings

The textbook has been the foundation of the 20th century classroom. Today it is beginning to take a back seat to digital alternatives. Higher education has led the charge away from static texts, driven by student concerns about the rising cost of books required for college classes.

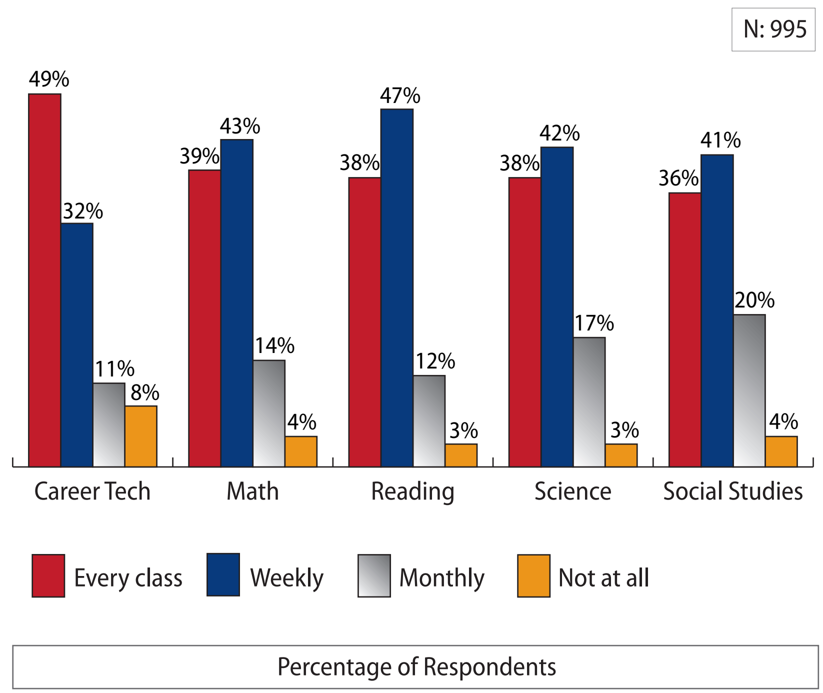
Aside from costs, digital content uses electronic images, text, video, and sounds. Use of digital media expands educators' ability to meet diverse learners' needs, providing avenues for differentiation. Combining digital content, the right software and online tools give students options for finding information and showing understanding. These opportunities help engage each student by providing the right level of challenge for each one.

Intervention courses (Title I, special education, reading, and English language learning) have high rates of technology integration in 1:1 environments. Project RED shows that high levels of technology integration in these intervention classes may be one predictor of increased student achievement, reduced dropout rates, and increased graduation rates.

[7] Mashable means that digital content can contain text, graphics, audio, video, and animation, blended from pre-existing sources to create a new resource.

Digital content, which can be personalized to the needs of each student, is more available to students who have seamless access to technology. As classrooms move to digital curricula, teachers must be prepared appropriately, and additional professional development must be provided. A best practice that has emerged around digital content is teachers' focused time seeking digital resources (web-based, open source, subscription) that align with curriculum, standards, and instructional goals. Those resources are then aggregated, chunked or used in whole as is appropriate.

Chart 8.5. Digital content: top 5 frequency of use



Project RED respondent schools are using digital content, though not at exceptionally high levels. 49% of schools report that they use career tech digital content in every class. 39% report that they use digital content in every math class, with 38% using it in every reading intervention class. Science digital content is reportedly used 38% in every class and social studies 36%.

Project RED Commentary

Technology has great potential to change teaching and learning. Simply adding technology doesn't change classrooms into superior learning environments. Meaningful change will only happen through thoughtful, systemic planning for integrating tools, aggregating resources, and creating and using digital content. Blended learning (face-to-face traditional methods combined with digital and online resources) is shown to be the preferred method for student learning.

The concept of blended learning, in which students spend part of their time in class face-to-face with the teacher and part of their time pursuing online courses or learning experiences, is relevant to the findings discussed in this chapter. Recent research from the U.S. Department of Education[8] shows that students prefer a blend of online and face-to-face instruction.

Blended learning works best when each student has a personal, portable technology device, and real transformation occurs when teachers base instructional practice on digital resources and digitally organized materials. For example, once a teacher has organized regular classroom instruction onto Moodle or other search engines—and students have adjusted to connecting with instruction in that manner—the transition to online or blended learning is comparatively easy.

Key Implementation Factors

The Project RED analysis revealed the nine key implementation factors (KIFs) that drive improved high-stakes test scores; college attendance; and graduation, dropout, and discipline rates (see Chapter 3). Many are directly related to instruction.

1. **Intervention classes:** Technology is integrated into every class period.
2. **Change management leadership by principal:** Leaders provide time for teacher professional learning and collaboration at least monthly.
3. **Online collaboration:** Students use technology daily for online collaboration (games/simulations and social media).
4. **Core subjects:** Technology is integrated into core curriculum weekly or more frequently.
5. **Online formative assessments:** Assessments are done at least weekly.
6. **Student-computer ratio:** Lower ratios improve outcomes.
7. **Virtual field trips:** With more frequent use, virtual trips are more powerful. The best schools do these at least monthly.
8. **Search engines:** Students use daily.
9. **Principal training:** Principals are trained in teacher buy-in, best practices, and technology-transformed learning.

These nine factors encompass several important aspects of instruction that contribute to improved achievement:

- **Personalized teaching and learning.** When every student has a personal portable computing device connected to the Internet, the opportunity for students to work independently and at their own pace dramatically increases, along with the opportunity for teachers to address individual needs.
- **Online formative and summative assessments.** Ongoing instant feedback provides the data to make important individualized adjustments to the instructional process.
- **Student engagement.** Social media, games, simulations, and virtual field trips engage students in the learning process.
- **Frequent use of technology.** When technology is integrated into every intervention class and into the daily core curriculum, students and teachers have the opportunity to practice and improve their skills on an ongoing basis.

[8] U.S. Department of Education, Office of Planning, Evaluation and Policy Development, "Evaluation of Evidence-Based Practices in Online Learning: A Meta-Analysis and Review of Online Learning Studies," Washington, D.C., 2010.

Conclusion

Education leaders have a wealth of research on which to draw for general learning best practices. The instructional impact of technology deserves the same support. We hope these findings help educators implement more frequently the practices that are linked to research and education success measures and avoid the practices with no strong grounding in research or learning outcomes.

Research Basis

Bebell, Damian & Kay, Rachel, "One to one computing: A summary of the quantitative results from the Berkshire Wireless Learning Initiative," *The Journal of Technology, Learning, and Assessment*, January 2010, v9, n2.

Coley, R.; Cradler, J.; & Engel, P., "Computers and Classrooms: The Status of Technology in U.S. Schools. Policy Information Report," *Educational Testing Service*, 1997.

Franceschini, Louis; Allen, Lee E.; Lowther, Deborah L.; & Strahl, J. Daniel, "Freedom to Learn Program Michigan 2007-2008 Evaluation Report," *Center for Research in Educational Policy*, The University of Memphis, September 2008.

Gomez, Elizabeth Avery; Wu, Dezhi; & Passerini, Katia, "Computer-supported team-based learning: The impact of motivation, enjoyment and team contributions on learning outcomes," *Computers and Education*, August 2010, v55, n1, 378-390.

Hall, J. & Saunders, P., "Adopting a student-centered approach to management of learning," in C. Bell, M. Bowden, & A. Trott (eds.), *Implementing Flexible Learning*, Kogan Page, 1997.

Kolodner, Janet L., "Towards an understanding of the role of experience in the evolution from novice to expert," *International Journal of Man-Machine Studies*, November 1983, v19, issue 5, 497-518.

Landrum, Timothy J. & McDuffie, Kimberly A., "Learning styles in the age of differentiated instruction," *Exceptionality*, 2010, v18, n1, 6-17.

Lee, Hee-Sun; Linn, Marcia C.; Varma, Keisha; & Liu, Ou Lydia, "How do technology-enhanced inquiry science units impact classroom learning?" *Journal of Research in Science Teaching*, January 2010, v47, n1, 71-90.

Lei, Jing, "Quantity versus Quality: A new approach to examine the relationship between technology use and student outcomes," *British Journal of Educational Technology*, May 2010, v 41, n3, 455-472.

Lonka, K. & Ahola, K., "Activating instruction: How to foster study and thinking skills in higher education," *European Journal of Psychology of Education*, 1995, v10, n4, 351-368.

Marzano, Robert J.; Pickering, Debra J.; & Pollock, Jane E., "Classroom Instruction That Works: Research-Based Strategies for Increasing Student Achievement," ASCD Books, McREL, 2009.

Marzano, R. J.; Waters, T.; & McNulty, B. A., "School Leadership That Works: From Research to Results," ASCD, 2005.

Mitra, Sugata; Dangwal, Ritu; Chatterjee, Shiffon; Jha, Swati; Bisht, Ravinder S.; & Kapur, Preeti, "Acquisition of computing literacy on shared public computers: Children and the 'hole in the wall,'" *Australasian Journal of Educational Technology*, 2005, v21, n3, 407-426.

O'Neill, G. & McMahon, T., "Student-centered learning: What does it mean for students and lecturers?" in G. O'Neill, S. Moore, and B. McMullin (eds.), *Emerging Issues in the Practice of University Learning and Teaching*, All Ireland Society for Higher Education, 2005.

Roschelle, Jeremy; Rafanan, Ken; Bhanot, Ruchi; Estrella, Gucci; Penuel, Bill; Nussbaum, Miguel; & Claro, Susana, "Scaffolding group explanation and feedback with handheld technology: Impact on students' mathematics learning," *Educational Technology Research and Development*, August 2010, v58, n4, 399-419.

U.S. Department of Education, Office of Planning, Evaluation and Policy Development, Policy and Program Studies Service (2010), "Evaluation of Evidence-Based Practices in Online Learning: A Meta-Analysis and Review of Online Learning Studies."

Walden University, Richard C. Riley College of Education and Leadership, "Educators, Technology and 21st Century Skills: Dispelling Five Myths – A Study on the Connection Between K-12 Technology Use and 21st Century Skills," Walden University, 2010.

Wilson, Christopher D.; Taylor, Joseph A.; Kowalski, Susan M.; & Carlson, Janet, "The relative effects and equity of inquiry-based and commonplace science teaching on students' knowledge, reasoning and argumentation," *Journal of Research in Science Teaching*, March 2010, v47, n3, 276-301.

Yazzie-Mintz, Ethan, *Charting the Path from Engagement to Achievement, A Report on the 2009 High School Survey of Student Engagement*, University of Indiana, 2009.

Yu, Wen-Feng; She, Hsiao-Ching; & Lee, Yu-Mei, "The effects of Web-based/non-Web-based problem-solving instruction and high/low achievement on students' problem-solving ability and biology achievement," *Innovations in Education and Teaching International*, May 2010, v47, n2, 187-199.

At a time when it is needed the most, Project RED brings together student achievement and cost-effectiveness. The concept of radical educational reform has been discussed for years. Now, Project RED provides the blueprint for Reform Success, providing a much greater return on our investments in education.

~ John Musso, CAE, RSBA
Executive Director
Association for School Business Officials
International (ASBO Intl.)

Jupiterimages, Creatas Images/Thinkstock

Chapter 9

The Financial Impact of Technology-Transformed Schools

Education has often failed to replicate the success of other industry sectors in automating and transforming through technology, in large part due to the challenge—real or perceived—of allocating the necessary initial capital budget to start such initiatives.

Very few substantial research efforts have examined the cost savings and revenue enhancements (increased tax revenues) that can be directly attributed to educational technology. Most deal with only one aspect of cost savings. Preliminary Project RED research, undertaken before the survey began, indicated that an understanding of the financial benefits of technology is surprisingly absent in schools. The prevailing wisdom is that educational technology is an expensive proposition.

However, the Project RED data support the business case that there is enough money in the system at a macro level to properly implement technology and positively impact many education success measures (ESMs), from high-stakes tests to disciplinary actions.

Although much remains to be done, this chapter points the way toward a better understanding of the cost-benefit picture of technology-transformed learning[1] by examining many categories of savings and providing examples from three innovative school districts and one educational association.

Implementation Costs

The cost of technology implementations can vary widely. For example, the reported cost for 1:1 implementations range from $250 per student per year to over $1,000 per student per year, measured on a four-year refresh cycle.[2] There are many cost drivers. A few of the larger items are:

- Type of hardware – The cost delta between a netbook or handheld versus full featured laptop can be significant.
- Refresh cycles – These range from three years to six years or longer.
- Professional development – Districts report a range of $1 to $100 per student per year.
- Amount of software – Annualized software costs range from $25 per student per year to over $100 per student per year.

On the following page we have included two cost scenarios. We have tried to be conservative, but these costs may be high. Many school districts have found ways to cut costs while maintaining program quality. An example is a district which self-insures and uses student technicians to do first-level tech support and to repair laptops as a for-credit course.

Examples

The first example is a school with one computer for every three students, made up of a combination of classroom and lab computers. The second is a 1:1 school able to fully exploit second-order change (see Chapter 2), providing extensive professional development and support. Both are presumed to be new schools, since in existing schools there would be a range of pre-existing hardware, software, and infrastructure.

In both schools, the Project RED analysis assumes the following:

- 500 students
- 25 teachers and staff
- 20 classrooms
- 10 common areas (library, cafeteria, etc.)
- Student and teacher hardware with a useful life of four years
- Infrastructure costs for wireless LANS, etc., amortized over seven years
- Hardware costs amortized over four years and full warranty with protection for accidental damage; there is a 5% loaner pool for the 1:1 laptop program
- Space savings and power savings are not included below but are covered later in this chapter
- Consumables, such as paper and toner, are not included

[1] The positive and negative financial implications of technology are complex, and a full treatment of this subject is beyond the scope of this survey. Opportunities exist for further investigation by Project RED and other researchers. We are the beneficiaries of several earlier studies, including *The Price We Pay: Economic and Social Consequences of Inadequate Education* by Belfield and Levin.

[2] *America's Digital Schools 2006* reported that the cost for a 1:1 implementation ranged from $250 to over $1,000 per student per year over four years.

Table 9.1. Sample implementation costs (most conservative)

Traditional 3:1 Student-Computer Ratio School		1:1 Technology-Transformed School	
Hardware		**Hardware**	
$1,000	Cost of student computer with 4-year warranty	$900	Cost of student computer with 4-year warranty
$1,100	Cost of teacher computer with 4-year warranty	$1,100	Cost of teacher computer with 4-year warranty
$7,600	Total cost of 1 printer per classroom plus 2 for common areas (20 b/w laser printers and 2 color laser printers)	$9,200	Total cost of 1 printer per classroom plus 4 for common areas (20 b/w laser printers and 4 color laser printers)
$202,100	Total cost over 4 years	$509,200	Total cost over 4 years
$101	**Cost per student per year**	**$255**	**Cost per student per year**
Servers, router, firewall, and related software		**Servers, router, firewall, and related software**	
$25,000	Cost of servers, router, firewall, and software	$50,000	Cost of servers, router, firewall, and software
$13	**Cost per student per year**	**$25**	**Cost per student per year**
Annualized software costs		**Annualized software costs**	
$50	Cost per student per year for instructional software	$50	Cost per student per year for instructional software
$13	Cost of productivity tools per student computer	$40	Cost of productivity tools per student computer
$25	Cost for LMS, assessment, etc.	$25	Cost for LMS, assessment, etc.
$8	Installation and customization costs per student	$13	Installation and customization costs per student
$96	**Cost per student per year**	**$128**	**Cost per student per year**
Wireless network		**Wireless network**	
$2,000	Cost per classroom/common area, includes POE	$3,000	Cost per classroom/common area, includes POE
$50,000	Total infrastructure	$75,000	Total infrastructure
$14	**Cost per student per year**	**$22**	**Cost per student per year**
Telecom (10 Kilobits/sec/student average)		**Telecom (50 Kilobits/sec/student average)**	
$75	Cost per megabit at 5 megabits/second rate	$50	Cost per megabit at 25 megabits/second rate
$225	Cost per month	$1,250	Cost per month
$2,250	Cost per year (10 months)	$12,500	Cost per year (10 months)
$5	**Cost per student per year**	**$25**	**Cost per student per year**
Tech support (0.25 dedicated tech support person, presumes 4-year hardware warranty)		**Tech support (0.5 dedicated tech support person, presumes 4-year hardware warranty)**	
$75,000	Cost of tech support person plus overhead	$75,000	Cost of tech support person plus overhead
$38	**Cost per student per year**	**$75**	**Cost per student per year**
Professional development (0.25 trainer year 1, 0.125 trainer years 2-4)		**Professional development (0.50 trainer year 1, 0.25 trainer years 2-4)**	
$100,000	Cost of PD person, fully burdened	$100,000	Cost of PD person, fully burdened
$62,500	Total cost	$125,000	Total cost
$31	**Cost per student per year**	**$63**	**Cost per student per year**
$298	**Total cost per student per year**	**$593**	**Total cost per student per year**

Today's cost differential between the two schools is roughly $295 per student per year. These costs will continue to decline in the coming years. Since it would take a state at least seven years to fully implement 1:1 computing from initial planning to last student device purchased, the 1:1 implementation cost at the end of that period could be the same as a 3:1 implementation today.

More importantly, as discussed below, the technology-transformed solution enables second-order changes and financial advantages that far outweigh the cost differential.

Impact on ESMs and Financial Variables

A technology-transformed environment affects numerous education success measures and financial variables,[3] which are examined below with regard to three types of impact:

- **Cost avoidance.** These savings result when a current practice ceases; for example, when free online primary source materials replace purchased materials.
- **Cost savings.** These savings result when technology provides a less expensive way to perform a function; for example, when parent newsletters are sent out electronically rather than on paper.
- **Revenue enhancements.** These savings are the additional tax revenues that result when students are better trained and enjoy higher incomes.

[3] This chapter does not discuss the variables that could result from truly significant second-order re-engineering. Also, the impact of each item is highly dependent on local issues. For example, some schools have a huge number of dropouts, while others do not.

[4] Public School Graduates and Dropouts, 2010.

[5] Project RED estimate.

[6] Belfield, Clive & Levin, Henry M., 2007.

Dropout and Graduation Rates

Dropouts undoubtedly have the highest financial impact of any of the variables discussed in this report. The primary reason is that students who avoid dropping out and who go on to college have substantially increased earning power and consequently pay more taxes. These increased tax payments continue throughout their careers.

Current Costs

- Nationally, 25% of all students drop out,[4] roughly a million students a year, and the average dropout fails at least six classes before dropping out.[5] Given an average cost per class of $1,333, the direct avoidable cost is approximately $8,000.
- The human cost is incalculable and can span generations.

Benefits/Savings

- The number of Project RED schools reporting a reduction in dropouts due to technology jumps to 89% when the key implementation factors (KIFs) are employed (see Chapter 3).
- A student who graduates from high school could generate $166,000 to $353,000 in increased tax revenues compared with a dropout.
- A dropout who would have gone on to college could have generated an additional $448,000 to $874,000 in tax revenue over a career of 40 years.[6]
- **National-level savings:** $3 trillion per year after 40 years of a higher taxpaying workforce or $56,273 per student per year.

Post-Secondary Remedial Education

Despite meeting graduation requirements, roughly a third of today's high school students require some level of remedial education in basic skills,[7] a percentage that climbs as the job or course rigor increases. For example, 75% of freshmen entering the University of California system require at least one remedial course, although they represent the cream of their high school graduating class. This places a financial burden on employers and post-secondary institutions.

Current Costs

- The cost of re-teaching basic skills at the college or university level[8]
- The increased expenses of re-teaching, resulting in lower tax revenues[9]
- The longer time needed to receive a post-secondary degree, resulting in loss of income and tax revenues
- The likelihood that students who require remediation will not complete college, resulting in long-term loss of tax revenue
- The total annual cost at a national level is estimated at $16.6 billion a year[10]

Benefits/Savings

- An additional 20% of Project RED schools report that high-stakes test scores increase when they use the top four key implementation factors.
- **National-level savings:** $1.6 billion a year or $30 per student per year, based on only a 10% reduction in remediation costs due to better-performing high schools.

[7] Mackinac Center for Public Policy, 2000.
[8] Ibid.
[9] Ibid
[10] Ibid.

Teacher Attendance

Project RED found that teacher attendance improves in 1:1 school environments.

Current Costs

- The cost of substitute teachers
- The cost of finding, qualifying, and scheduling substitute teachers
- The impact on learning of substitutes versus regular teachers

Benefits/Savings

- The number of Project RED schools reporting teacher attendance increases goes up 20% when the top four key implementation factors are employed.
- **National-level savings:** $718 million a year, based on a 1% increase in teacher attendance, leading to savings of $13 per student per year.

Copy Machine Costs

Copy machine costs are an easy-to-understand proxy for the savings potential of re-engineering.

Current Costs

- $100,000 in paper and copy machine costs for a 1,500 student high school
- 2 million copies a year or 1,333 copies per student per year or 7.4 copies per student per day at 4 cents per copy for the paper and the machine use
- An estimated labor cost of one penny per page, assuming the machine makes copies at 30 pages a minute, and another penny per page for distribution

Benefits/Savings

- In Project RED schools where students use an LMS many times a day, 20% more schools report reductions in copy machine expenses. As might be expected, if the LMS is used only daily versus many times a day, the number of schools reporting copy cost reductions drops from 20% to 6%.[11]
- **National-level savings:** $2.2 billion a year, based on annual savings of $40 per student per year, a 50% reduction in expenses.

Online Formative Assessments

Online formative assessments have financial advantages, but more importantly, they provide valuable real-time feedback to both teachers and students regarding student performance levels.

Current Costs

- Test printing costs 3 to 4 cents a page. Tests run from 1 to 10 pages, and students often take 1 test a month in each of five classes, or 50 tests a year. At nine pages a test and 3 cents a page, the cost is $13.50 per student per year.
- Manual scoring takes one to three minutes per multiple-choice test. If teacher time is worth 30 cents to 60 cents per minute, the cost is roughly 30 cents to $2 per test, including recording in the grade book, returning tests, etc. Assuming 50 tests a year and 50 cents a test, the cost is $25 per student per year.

Benefits/Savings[12]

- Reduced paper and printing costs for exam booklets.
- Reduced teacher time spent on scoring. If scanner scoring is used, the cost can be cut in half to $12.50 per student per year.
- Second-order changes:
  - Shorter test times
  - More time for instruction
  - Easier tailoring to class circumstances
  - More frequent tests for ongoing feedback
  - More teachable moments based on immediate feedback
  - Automatic essay grading
- **National-level savings:** Over $2.4 billion a year, based on $44 per student per year.

[11]Once-a-day LMS use indicates casual use to check calendars, etc. Multiple times a day use indicates more integral use, to upload and download assignments, take online courses, and collaborate with others.

[12]Online assessment uses a computing system to create, store, deliver, and score test items—on a local computer, a networked computer, or via cloud computing. These functions are frequently performed by a Learning Management System (LMS) or a more specialized testing system. Teachers can select high-quality test items based on a specific state standard and create a test. As the industry matures, standards such as QTI (IMS Question and Test Interoperability) are contributing to features such as the ability to reuse items and combine item banks from multiple suppliers.

Online Assessment: Irving Independent School District, Texas

An ambitious online formative assessment program is replacing traditional paper and pencil testing at Irving ISD. Teachers use the new system three to seven times per year in English language arts, math, science, and social studies in Grades 3-12. The licensing fee for the online package plus upgrades is $621,000 for three years or $207,000 per year.

Paper and Pencil Formative Assessment Printing Cost Estimate Per Year*	Total
Students taking assessments	26,000
Number of assessments (dependent on grade)	3-7
Number of assessments per date	4
Total pages per assessment	11
Total pages printed	8,211,000
Total printing cost per year	$328,000
*All data is a "good faith" estimate provided by the district.	

Paper and Pencil Versus Online Formative Assessment Cost Based on Nine Assessments Per Year	Total
Printing cost per year	$328,000
License fee per year	$207,000
Online formative assessment cost savings per year	$121,000
Online formative assessment cost savings per student per year	$5 (35% savings)

High-Stakes Test Scores and College Attendance Plans

Increases in high-stakes test scores imply that fewer students are failing. They also correlate to improved college attendance, increased long-term tax revenues, and reduced test-prep expenses. Most of these savings are discussed elsewhere and are not repeated here.

AP/Dual/Joint Enrollment

Advanced high school students can take AP courses or college-level courses via dual/joint enrollment, allowing them to graduate from college earlier. Students and their families save money on college expenses. States benefit by reduced subsidies to state institutions and by receiving income tax revenues earlier.

Although AP courses generally cost more per student than ordinary high school courses, there are significant cost benefits similar to the benefits of dual/joint enrollment.

Current Costs

- States provide up to $1,000 per course in subsidies to colleges and universities.[13]

Benefits/Savings

- If 50% of high school graduates go to state-funded colleges and each student takes one college-level course, the net savings to the state are $500 per student or $1 billion a year at the national level.
- Students who take dual/joint enrollment or AP courses often graduate earlier and get jobs earlier. Their income increases at graduation, along with the sales taxes, property taxes, and income taxes they pay.
- Each college course taken in high school saves a student and family approximately $2,000.
- State-level savings: If students in properly implemented technology-transformed schools take two or more college-level courses, the net savings to the state are $3.2 billion or $58 per student per year.

[13] U.S. Department of Education, National Center for Education Statistics, 2008, http://nces.ed.gov/programs/digest/d09/figures/fig_16.asp?referrer=figures. The total subsidy is $9,677 per student. Assuming five courses, this is $1,935 per student per course. Project RED assumes $1,000 per course as a conservative estimate.

Paperwork Reduction

Teachers and other school personnel have a significant paperwork burden. Teacher time saved on paperwork can be spent with students.

Current Costs

- The total cost of paperwork is tangible but difficult to quantify. Many teachers report dissatisfaction with the burden of paperwork and the loss of teaching time.

Benefits/Savings

- Teacher time saved from reduced paperwork can be re-allocated to additional student-facing time or large classes.
- Additional student-facing time should yield improvements in areas such as dropouts, disciplinary actions, joint enrollment, and high-stakes test scores. Financial benefits for each of these areas are discussed elsewhere. Assuming a paperwork reduction yields a 5% improvement in the above areas, an incremental $50 per student can be saved.
- If additional teacher capacity is available for a class size increase, the cost savings can be used to fund other activities. If two minutes, or 4% of time, are saved per class period, one additional student can be supported. At an ADA rate of $8,000, assuming 50% is allocated to teachers' salaries, $129 per student can be saved, amortized over the class. These funds could go toward increasing teachers' salaries or other worthwhile uses.
- In a technology-transformed school, the savings to administrators, staff, and others could be 2%, which could lead to a head count reduction, which could be converted to a per-student savings.
- 100% of the Project RED schools that deploy the top four key implementation factors report a paperwork reduction due to technology.
- **National-level savings:** From $3.3 billion to $7.1 billion per year, based on an average savings of $60 to $129 per student per year, assuming the savings can be recaptured.

Disciplinary Actions

Disciplinary actions cost schools money. They also consume a substantial amount of time for administrators, teachers, and clerical staff.

Current Costs

- Disciplinary actions reduce instructional time and affect outcomes for all students.
- Serious issues require police intervention. The cost to the taxpayer of a police visit is $100 or more.
- Some schools need full-time police presence or contracted security guards at a cost of approximately $50 per student per year.
- Suspensions frequently result in legal fees. One school district reported $250,000 in legal fees for a case that went to trial.

Benefits/Savings

- 92% of Project RED 1:1 schools deploying the top four key implementation factors report a reduction in disciplinary action, an improvement of 37 points over all 1:1 schools.
- Schools with low rates of disciplinary actions can reasonably expect a 10% cost reduction by implementing the key factors. Schools with challenging disciplinary action rates can experience a reduction of 50% or more.
- For example, Mooresville Graded School District in North Carolina (5,409 students) reported that short-term suspensions and expulsions dropped from 549 to 310, and long-term suspensions and expulsions dropped from 7 to 4 after the district moved to a properly implemented 1:1 solution.
- **National-level savings:** $1.1 billion a year for middle and high schools, based on an average savings of $20 per student per year.

Disciplinary Actions: Parks Middle School, Atlanta, Georgia

In 2001, Parks Middle School logged an average of three police actions a day. In 2002, the school launched a 1:1 laptop program supported by key implementation factors, such as intervention classes, online formative and summative assessments, games and simulations, teacher professional learning enabled by the principal, and change management led by the principal.

In 2003, the number of police actions dropped to three for the entire year. In addition, the percentage of eighth-grade students passing the state GCRT math exam jumped from 19% to 43%, and the writing test gap closed by 19%, compared with the rest of the state.

End-of-Course Failure

When a student fails a course, there is a significant cost to re-teach the course. Course failure is also a leading indicator of future dropouts.

Current Costs

- End-of-course failure can be devastating to students and increase the likelihood they will drop out.
- The cost to the district and state of re-teaching the course is $1,333, or higher in the case of intervention-type courses.
- Retained students increase the school population, contributing to teaching costs, overcrowding, and additional costs (such as portable buildings).

Benefits/Savings

- An additional 26% of Project RED schools report a reduction in end-of-course failure when they apply the key implementation factors.
- **National-level savings:** $5.9 billion a year. If properly implemented, technology-transformed schools experience a 20% reduction in end-of-course failure, and currently 40% of students fail classes such as algebra, the net result is 8% fewer failures, or a savings of $107 per student per year or $5.9 billion on a national level.

Digital Versus Print Supplemental Materials

Digital content can be re-purposed, accessed anytime/anywhere, searched according to a number of criteria, chunked and re-used, tagged and stored in a Content Management System (CMS) or LMS with CMS features. The content can be classified and indexed in a variety of ways, easily uploaded, stored on flash drives, and re-used on demand.

Current Costs

- Schools spend over $3.4 billion a year on print supplemental materials (some of which cannot be replaced by digital alternatives).
- The shipping, handling, and storage costs of print materials are substantial. One superintendent reported that the total cost of shipping, handling, and storage approached the cost of the materials themselves.

Benefits/Savings

- While difficult to quantify, the teacher time savings are substantial, since every question, picture, and chunk of text can be easily incorporated into lessons regardless of the source. Many teachers say they currently spend a significant amount of time searching for relevant resources.
- Digital materials appeal to today's digital natives and build student engagement, key to academic success.
- Schools save on storage and shipping costs.
- Schools can access millions of free online supplemental resources at no charge.

- One school district experienced a drop in supplemental materials cost per student, from $79 to $19 after switching to digital.[14]
- **National-level savings:** $1.7 billion, based on $31 per student per year.

Digital Instructional Materials: Empire High School, Vail, Arizona

Empire High School is the first high school in America designed from the ground up to be all digital. Many schools across the country have replicated the experience of this school in whole or in part.[15]

After the district provided the framework and posted the standards, teachers and the district began linking digital resources to the posted pages. This allowed teachers to produce their own current content related to the standards (instead of textbooks), using just-in-time production and peer review. Less than 1% of all teacher-submitted projects were removed due to lack of quality. District Chief Information Officer (CIO) Matt Federoff noted that teachers were becoming producers of knowledge and content, which allowed them to personalize teaching and learning.

The cost of teacher time to develop digital content, while not insignificant, is similar to that of their previous work of aligning analog content with state and district standards but with greater benefits.

Digital Content Costs (Core + Supplemental)	Total
Annual instructional materials cost per student 2006-2007	$51
Annual instructional materials cost per student 2008-2009	$9
Cost savings per student	$42 (82% savings)

[14]Jill Hobson presentation (Forsyth County, Georgia), FETC 2010.

[15]Presentation by Superintendent of Vail School District, Calvin Baker, MDR webinar, August 5, 2010.

Digital Versus Print Core Curriculum

Digital core curriculum has the potential to save money in reduced printing, transportation, and storage costs. In addition, they have the potential to be much more customized and much richer in content.

Current Costs

- Textbook costs receive a lot of attention, probably out of proportion to their relative share of the budget. The national textbook budget is estimated to be $4.2 billion or $76 per student per year.
- Since high-quality digital core curriculum materials can be more expensive to produce than textbooks and since printing and shipping are less than 25% of the cost of a textbook, the immediate savings of a switch from print to digital are limited. However, the switch enables a transformation of the classroom that is ultimately the source of significant long-term savings.

Benefits/Savings

- Students and teachers can access online coursework from anywhere with an Internet connection, allowing for cost savings in custodial care, electricity, administration, and other overhead expenses.
- Students can access courses from any location, saving transportation costs.
- Schools can contract with a virtual school that is responsible for student access to courses, technology devices, infrastructure, and teachers. If a school is overcrowded, there can be significant infrastructure savings.
- The trend to smaller high schools means that there are fewer students per class in honors and AP courses. The cost per student in these classes could be double the cost of a student in a regular class, because one teacher is teaching fewer students. There are cost savings to be had by switching from print to digital, but perhaps more importantly, there are significant financial benefits attributable to AP classes, as explained later in this chapter, because of reduced state subsidies to colleges and because students graduate earlier.
- Student engagement improves because of the personalized

learning experience, learning to more course completion, graduation rates, and other benefits.

- Online course delivery addresses the shortage of qualified teachers as well as the demand for additional course offerings, all of which have financial implications.
- **National-level savings:** $935 million per year, based on savings of $17 per student per year.

Blended Online Learning: Walled Lake High School, Michigan

Walled Lake High School, a high-achieving suburban school near Detroit, wanted to maintain academic excellence while saving money in light of the state's economic downturn.

Superintendent Dr. William Hamilton chose to address these two goals by integrating online coursework on a large scale within the traditional brick and mortar district. His analysis showed that the cost per student per course went from $900 to $383, a savings of 57%.

The district expects to experience additional savings as the online course integration program becomes more robust. The framework and protocol are still under construction, and the district is assessing whether the need for teacher support will decline as students become more familiar with virtual instruction.

Instruction has become highly individualized, and students are progressing more rapidly because of the faster feedback process and the extended time for learning.[16]

Regular School Year: Online Coursework, Walled Lake High School	Total
Incremental cost[17] per student per year, two face-to-face courses per semester	$900*
Digital cost per student per year, including teacher support	$383**
Digital per student per year cost savings, two online courses per semester	$517 (57% savings)***

*Based on 300 students at a 33:1 staffing ratio, including teacher salaries and benefits.
**Based on 300 students at a 150:1 staffing ratio, including teacher salaries and benefits and software license fee.
***Textbook and supply allocations have not been included, because at this time the district has not experienced reductions in these costs.

Summer School/Credit Recovery: Online Coursework, Walled Lake High School	Total*
Traditional summer school cost per teacher	$2,331**
Blended online summer school cost per teacher	$840***
Blended online summer school cost savings per teacher	$1,491 (64% savings)****

*Based on a maximum class size of 30.
**Based on a 60-hour course and 6.6 hours of teacher preparation, for a total of 66.6 hours.
***Based on an online course and 24 hours of in-person support (two teachers) at a rate of $35 per hour, including benefits.
****The cost to families went from $210 to $99 per class (57% savings).

Another school, Westborough High School in Massachusetts, is experiencing similar savings and benefits in a similar program.

Online Professional Learning

Professional learning is critical to the success of any school. Online professional learning has the potential to be more customized, meeting the specific needs of each teacher in terms of time, place, and content.

Current Costs

- *America's Digital Schools 2006* respondents reported spending an average of $100 per student for professional learning in 1:1 schools. Urban school districts in another study reported spending an average of $4,350 per teacher.[18]
- While some face-to-face professional learning is essential, it is the most expensive form of professional learning, and many would argue it is the least efficient.

[16] U.S. Secretary of Education, Arne Duncan, has spoken extensively about the merits of extended time for learning—the United States currently provides fewer days of instruction than most other industrialized nations.

[17] Fixed costs are not included. Adding students does not add to costs in a linear fashion. For example, one additional student does not require an increase in the number of superintendents. But at some point a new building is needed.

[18] *Journal of Education Finance*, 2004.

Benefits/Savings

- Transportation costs are reduced or eliminated when teachers no longer have to travel to on-site trainings, along with fees for substitute teachers, consulting services, and other expenses.
- Negative teacher attitudes toward professional learning, which are widespread, improve when teachers can select courses of personal interest, learn at their own pace, and communicate with colleagues.[19]
- **National-level savings:** $654 million, based on $12 per student per year.

Professional Learning: Online Versus Face-to-Face

The Association for Supervision and Curriculum Development (ASCD) is a membership organization that provides high-quality, self-paced online professional learning. Adult learners engage in a cycle of new learning, reflective practice, and discussion, with access to an online forum. The courses must be completed within six months and cost $99 dollars per teacher per course.

The Mid-continent Research for Education and Learning (McREL) is a nationally recognized organization that offers face-to-face professional learning of a similar caliber, conducted by well-known leaders, researchers, teachers, and writers. The cost of a two-day symposium for 40 participants is $7,000. When travel expenses are added, estimated at $1,300, the per-person cost is $207.50.

Online Professional Learning Versus Face-to-Face Costs (ASCD and McREL Models)	Total
Face-to-face cost per teacher per course (McREL)	$208
Online cost per teacher per course (ASCD)	$99
Online cost savings per teacher per course	$109 (52% savings)

Power Savings

The electricity costs of a single computer may appear to be trivial, but the cumulative cost of electricity for all computers in a school can be substantial. Desktop computers consume substantially more electricity than do laptops.

Current Costs

- The electricity to power one student desktop computer and display costs about $80 per year or $400 over five years.
- At the current national average of three students per computer, the approximate cost of computer power is $26 per student per year.

Benefits/Savings

- The electricity to power one student laptop costs about $11 a year or $55 over five years. Netbooks cost less, since they take less power. If students charge their laptops at home, the savings are higher.
- Schools also save on air-conditioning costs. Given the wide variation in schools and climates, calculations are not provided here.
- **National-level savings:** $862 million per year, based on $16 per student per year.

Space Savings

The use of space in schools has come under increasing scrutiny over the past few years, with an increased focus on designing schools to support improved learning and simultaneously cut costs. The transition to mobile computing can lead to fewer dedicated computer labs.

[19] Research tells us that reflection, discussion, and coaching are essential for effective adult learning. Online professional learning includes courses or workshops that are synchronous (real-time collaboration and communication) and asynchronous (time-lag collaboration and communication) as well as online professional learning communities.

Current Costs

- A 30' x 30' computer lab costs $150,000 or more to construct, including the extra wiring, furniture, and air conditioning, for an amortized annual cost of about $17 per student, not including the computers.
- Four computers in the back of a classroom require about 125 extra square feet of space, at $100 per square foot. They also require Ethernet cable drops and power drops at a cost of several hundred dollars per computer.

Benefits/Savings

- Equipped with laptops, students can transform a common area or cafeteria into an online learning lab in minutes. There is no need for a computer lab or dedicated space in the back of each classroom.
- In most cases, a cart of laptops can replace a computer lab.
- For example, Henrico County Public Schools reported a reduction of one computer lab per school after moving to a 1:1 implementation.
- **National-level savings:** $825 million, based on $15 or more per student per year. Actual savings will vary based on occupancy rates.

Student Data Mapping

Schools collect a substantial amount of data on students and performance. The data is often collected multiple times. Data cleaning is also an expensive proposition.

Current Costs

- Student data is often entered many times by many people, including teachers, principals, school staff, and district staff, resulting in duplicated and wasted effort.
- In addition, the Project RED team estimates the current cost of acquiring, cleaning, archiving, and accessing student data at $50 per student per year.

Benefits/Savings

- Districts that are mapping student data are reducing manual data acquisition and archival work by 30%, using their current student management information software more effectively and reducing the cost of acquiring, archiving, and accessing student information by 20%.[20]
- Districts are transferring these savings to other budget areas closer to students, in a range that has been reported to be $100,000 to $300,000.[21] The cost avoidance range varies depending on district size and level of implementation.
- In addition, these districts have created a platform upon which to review student mapping protocols with software providers and accelerate the use of technology in streamlining organizational processes.
- **National-level savings:** $605 million annually, based on an average savings of $11 per student per year.

[20] The Race to the Top funding criteria include numerous requirements for statewide longitudinal data systems, to capture data from one grade to the next, measure whether students are on track to graduate, indicate whether schools are preparing students to succeed, reward successful teachers, and help struggling teachers improve.

[21] These estimates were obtained from conversations with Holly Area Schools (3,947 students as of September 2008), Waterford School District (11,468 students as of September 2008), and Hillsdale County Intermediate School District (6,840 students as of August 2009) in Michigan.

Summary of Potential Savings

Table 9.2 shows the national savings, calculated by multiplying the average savings by 55 million students. The results are sorted by savings level, from low to high.

Table 9.2. Annual national financial impact – The potential of technology-transformation in U.S. K-12 schools

Category	National Impact	Per Student
Student data mapping	$605,000,000	$11
Online professional learning	$660,000,000	$12
Teacher attendance increase	$715,000,000	$13
Power savings	$880,000,000	$16
Digital core curriculum savings	$935,000,000	$17
Disciplinary action reduction	$1,100,000,000	$20
Post-secondary remedial education	$1,650,000,000	$30
Digital supplemental materials vs. print	$1,705,000,000	$31
Copy machine cost calculations	$2,200,000,000	$40
Online assessment savings	$2,420,000,000	$44
Dual/joint/AP course enrollment	$3,190,000,000	$58
Paperwork reduction	$3,300,000,000	$60
End-of-course failure	$5,885,000,000	$107
Subtotal	**$25,245,000,000**	**$459**
1:1 Technology cost delta	**-$16,225,000,000**	**-$295**
Net Savings	**$9,020,000,000**	**$164**
Dropout rate reduction	$3,095,015,000,000	$56,273
Total	**$3,104,035,000,000**	**$56,437**

Conclusion

Project RED's research indicates that we can address two of the biggest challenges facing our society. We can have a better-educated populace, and if we implement programs correctly, in the long term we can generate additional revenue at the state level far exceeding the total cost of the educational system. To our knowledge, this is the first time that the potential impact of properly implemented educational technology has been comprehensively estimated.

The incremental cost of a ubiquitous technology implementation, including hardware, software, professional development, and training and support, is roughly $100 to $400 per student per year, depending on the school's starting point. The positive impact could be as high as $56,442 per student per year after the full impact of a career lifetime of increased tax revenues, depending on the school and state. This number is based in large part on schools as we know them. In second-order change schools, it is likely that the impact would be higher.

It is important to keep in mind that there are other categories of savings not included here. One topic that receives frequent mention but is not included in this study is the cost of prisons. Some states even forecast prison growth requirements based on third-grade reading levels.

Net savings between a 1:1 technology installation ($593 per student) and a 3:1 technology installation ($298 per student). For more information see page 113.

The financial impact of dropout prevention continues for many years. When potential dropouts graduate from college, the benefit is delayed for several years after their high school graduation and increased tax revenues continue throughout their careers. Another graduating class starts contributing each year, and the per-year impact rises. After 40 years or so, the contributions reach a steady state. The net impact after steady state is $3 trillion per year, not indexed for inflation and other effects. This number is obtained by multiplying the net increases in tax revenues for male and female high school and college graduates by 10% of dropouts who are projected to complete a college degree by an expected working career of 40 years.

Under today's system, if money is saved via technology, the dollars saved will not go to the school's bank account. Schools will spend all the money they get, given the significant shortfalls in funding. But the savings will allow schools to move the dollars closer to students and moderate the effects of economic downturns. The challenge is to encourage schools to adopt cost-saving measures along with mechanisms for capturing the savings, so that the savings do not disappear into the system.

Considerations for Education Leaders and Policymakers: Removing the Barriers

The benefits of properly implemented educational technology clearly outweigh the costs, but many barriers prevent schools from moving in this direction. The Project RED data indicate that education leaders and policymakers can help remove the barriers as follows:

- Consider educational technology to be an investment rather than an expense.
- Look outside the box, since most financial advantages come through re-engineering.
- Insist on accountability. Technology investments must be coupled with a commitment to academic improvement, along with appropriate penalties, especially when technology is poorly implemented.
- Tie academic performance to financial results. Require policies that drive cost savings that can be captured for expense reductions or further improvements.
- Require that the institution of education understands and embraces the challenges of change management.
- Support leadership and vision development at all levels—governors, chief state school officers, superintendents, and principals.
- Provide legislative relief so that superintendents can realize the full benefits of technology in schools.
- Insist on standard metrics to ensure that technology cost-benefit analysis is part of school reform, especially in regard to sustainability and scaling. For example, school leaders should be required to know the cost to teach any individual standard.
- Insist on local financial responsibility for student failure. Schools should not receive additional funding when students fail, since this, in effect, penalizes effective school districts.
- Build awareness of the key implementation factors and cost-benefit information among school administrators. The Project RED team estimates that perhaps fewer than 100 out of over 13,000 superintendents nationwide currently have the knowledge and experience to be highly successful in implementing technology.

The Technology Factor

K-12 education expenditures have increased at over twice the rate of inflation from 1965 to 2005, yet U.S. school districts continue to deal with the problems of disengaged students and low achievement.

Education leaders and policymakers are looking for ways to improve the quality of outcomes while slowing the growth of expenditures. The positive financial impact of properly implemented educational technology can contribute substantially to the solution.

Research Basis

Belfield, Clive & Levin, Henry M., *The Price We Pay: Economic and Social Consequences of Inadequate Education*, Brookings Institution, 2007.

Greaves, T. & Hayes, J., *America's Digital Schools*, MDR, 2008.

Hawley Miles, Karen; Odden, Allan; Fermanich, Mark; and Archibald, Sarah, "Inside the black box: school district spending on professional development in education," *Journal of Education Finance*, Summer 2004, vol. 30, n1.

Mackinac Center for Public Policy, *The Cost of Remedial Education: How Much Michigan Pays When Students Fail to Learn Basic Skills*, 2000.

U.S. Department of Education, National Center for Education Statistics, 2006-07, *Integrated Postsecondary Education Data System (IPEDS)*, Spring 2008.

U.S. Department of Education, National Center for Education Statistics (NCES), "Public School Graduates and Dropouts," *The Common Core of Data*, 2007-2008, June 2010.

Hemera/Thinkstock

Appendix A

Roadmap for Large-Scale Technology Implementations

Many technology initiatives in schools have failed in the past because of a lack of attention to the key education success measures (ESMs), implementation factors (KIFs), and best practices.

The Project RED team has developed a roadmap for education leaders to guide schools embarking on large-scale technology implementations. The roadmap is based on the One-to-One Institute research, the One-to-One Institute consulting services to schools and districts, Intel's K-12 Blueprint, the Project RED research, and the *America's Digital Schools* research.[1]

Planning

Develop a well-designed plan for implementation and sustainability.

- Build a shared vision.
- Involve all stakeholders—principals, teachers, technology coordinators, curriculum directors, parents, students, and community members.
- Include vision, mission, goals, milestones, resources, roles, responsibilities, monitoring, and evaluation.

Leadership

Lead and support all aspects of the implementation effort.

- Develop a shared vision with focused goals based on research and best practices.
- Define a strategic action plan toward goals.
- Build ongoing professional learning to lead school transformation.
- Develop change management expertise, especially second-order change.
- Schedule team meetings.
- Schedule classroom observations and walk-throughs.
- Communicate formally and informally.
- Ensure funding for sustainability.

Technology Infrastructure

Build a solid technology infrastructure and maintenance/service plan.

- Ensure connectivity and access points.
- Include support policies and procedures.
- Pay attention to charging and storing needs.
- Ensure on-site presence by technical personnel.
- Develop teacher and student troubleshooting skills.

Professional Learning

Schedule regular professional development for administrators, teachers, and technical personnel.

- Include parents and guardians.
- Include all school personnel.
- Build a coaching/mentoring model for administrators, teachers, and technology staff.
- Create a train-the-trainer model to ensure internal capacity.
- Focus on changing the classroom culture through curricular integration and dedicated time and resources.

[1] Greaves, Thomas & Hayes, Jeanne, *America's Digital Schools*, MDR, 2006 and 2008.

Communications

Encourage viral information sharing among stakeholder communities.

- Clearly communicate the implementation research base, goals, vision, benchmarking/evaluation plans, and opportunities for feedback/input.
- Involve internal stakeholders, such as teachers, librarians, students, custodial staff, bus drivers, tech support personnel, curriculum directors, board members, and support staff.
- Involve external stakeholders, such as parents/guardians, media, legislators, businesses, religious groups, colleges, and universities.

Policies

Develop and document policies and procedures guided by instructional goals.

- Ensure school board agreement.
- Include student acceptable use policy.
- Stay flexible and open to alternative directions.

Support

Build a network of partners and experts.

- Develop showcase sites to demonstrate best practices.
- Build a team of lead teachers and super-coaches.
- Ensure regional support.
- Research lessons learned by other schools.
- Build vendor partnerships.
- Reach out to other districts and states.

Expectation Management

Set realistic goals.

- Communicate that research shows teachers need three to five years to seamlessly integrate technology and instruction.
- Understand that student achievement will not increase through 24/7 access to technology alone.
- Understand that student achievement will increase over time when a guaranteed curriculum and instructional program are integrated with 21st century tools.

External Evaluation

Include ongoing independent evaluation.

- Involve an outside research organization to provide consistent and focused review relative to goals.
- Be accountable for reaching benchmarks and adapt programs as needed.
- Build replicable, scalable, and sustainable models.

Roadmap Checklist

Leadership

- ☐ Identify district committee members and meeting schedule.
- ☐ Identify team leadership.
- ☐ Schedule district leadership planning sessions (with superintendents, curriculum directors, principals, technology directors, business officials, teacher leaders).
- ☐ Share and discuss the research on 1:1 and large-scale implementations.
- ☐ Draft the shared vision.
- ☐ Plan the timeline for building the infrastructure.
- ☐ Bring district leaders together in Dynamic Technology Planning Program (DTPP) training sessions.
- ☐ Develop and schedule the professional development plan.
- ☐ Establish the timeline for building-level training (principals, teachers, technical support, and lead teachers).
- ☐ Draft the administrative support plan for classroom teachers in pilot and ensuing years.
- ☐ Schedule and implement orientation plans for all stakeholders.
    - Students
    - Teachers
    - Bus drivers
    - Support staff
    - Parents/guardians
    - Community
- ☐ Plan the outbound communications program to community and parents/guardians.
- ☐ Secure signed acceptable use policies.
- ☐ Identify the assessment plan and timeline.
    - Create program goals.
    - Collect baseline data.
    - Develop assessment protocol and tools.
- ☐ Schedule the implementation timeline.
    - Wireless network testing
    - Bandwidth capacity testing in pilot class
    - Ongoing professional development
    - Troubleshooting protocol
    - Technology support protocol
        - Teachers
        - Students
        - Other personnel
        - Online
        - Help desk
- ☐ Plan the distribution of devices to students.
- ☐ Schedule site visits.

Technology Infrastructure (Initial Pilot Requirements)

- ☐ At least one classroom
- ☐ At least two teachers trained
- ☐ A laptop for each teacher

- ☐ A mobile computing device for each student in the classroom
- ☐ Infrastructure to support pilot
  - Bandwidth
  - Access points
  - Server space
  - Electrical capacity in classroom
- ☐ On-site technical support
- ☐ Relationship with vendor
  - Terms of contract
  - Support services
  - Swap out and repair policies
- ☐ One extra device for every ten laptops for loaners
- ☐ A charging cart for each classroom
- ☐ Two battery packs for each laptop
- ☐ Accidental damage and theft insurance for all computing devices

Other Beneficial Classroom Technology

- ☐ LCD projector
- ☐ Interactive whiteboard

District Infrastructure

- ☐ An implementation timeline
- ☐ Enough access points to ensure wireless connectivity for all students in the 1:1 learning space
- ☐ Awareness of how the program might affect other technology users
- ☐ An appropriate firewall, virus protection, and content filter
- ☐ Dedicated server space able to handle the capacity of the program (a folder for every student and teacher)
- ☐ Wireless network testing
- ☐ Bandwidth capacity testing
- ☐ Appropriate use policies for the network, the Internet, and the mobile computing device
- ☐ Appropriate device preparation
  - A good image
  - Adjustment of all settings
  - A device identification method
  - Loading and testing of all software
- ☐ A plan for the distribution of devices to students
- ☐ Enough technology personnel to support the 1:1 program
- ☐ An established relationship with the device vendor and teacher access to their help desk and other support
- ☐ A quick response support plan for repairs and other technical questions that can be easily communicated to teachers
- ☐ Appropriate damage and theft insurance

Developed by the One-to-One Institute. Used with permission.

One-to-one computing transforms the classroom from teacher-centered to student-centered by placing the technology in the hands of the students. No longer is the teacher the purveyor of knowledge but a facilitator, learning along with the students.

~ Alice Owen
Executive Director of Technology
Irving Intermediate School District
Irving, Texas

Hemera/Thinkstock

Appendix B

Research Methodology and Data Analysis

Research Methodology

Project RED follows standard survey methodology in that questions were asked of a population and relationships between the variables were studied. However, the population studied was not a stratified sample of all U.S. public schools but rather a self-selected sample of public and private schools responding to a variety of outbound messages. The respondents were compared with the public school universe upon completion in order to determine the level of representation.

Initial Plan

The initial research design was based on the assumption that a study of 1:1 schools would yield insights and distinctions among schools that had made the investment in technology necessary to provide continuous access for each student.

Database Development

A database of all U.S. schools, both public and private, was obtained from MDR, a D&B Company, that maintains the most robust database of schools in the nation. The initial target audience was school principals and technology coordinators in schools that are implementing robust technology programs. Responses were solicited from principals and technology directors in order to collect data from administrators close to the student. Project RED focused on a data set of schools identified as having more than 100 students and a 1.3:1 or lower ratio of students to computers.

Although the intent was to identify schools with a 1:1 student-computer ratio, a slightly higher than 1:1 number (1.3:1) was selected to provide for parents opting out of programs and the difficulty of accurately estimating the rapidly changing number of computing devices in any school.

Survey Design

Project RED was designed to identify the use of various educational technologies by frequency, as well as to identify several academic and financial outcomes. A four- or five-point scale was devised to discriminate the level and frequency of usage. Since these data were self-reported, a simple, multiple-choice scale was used to illuminate differences in usage, so that building-level administrators did not need to search records or poll staff for more precise reporting. We also asked questions in isolation about education practices that we intended to link to outcomes.

The survey instrument went through many iterations, in which we focused on the language, added and deleted questions, and tested the instrument with a pilot group of administrators. When we had a good working draft, a meeting was held with a team of survey methodology experts to review and make recommendations for additional changes. All the questions were reviewed in light of our objective to obtain accurate data about classroom practice.

The meeting resulted in extensive editing of the text of the root questions, as well as the potential responses and their layout. We are indebted to Rodney Muth of the University of Colorado, Denver, and Arlen Gullickson from Western Michigan University, with their background in survey design and education issues. We then field-tested the questions again by having a number of our colleagues in the profession take the survey.

At the end of this three-month process, the survey was opened to respondents in early September 2009. The first response was received September 10, 2009, and the survey was closed with the last response received on May 5, 2010. This was a long time for a survey to be out in the field. We originally anticipated closing the survey in late November 2009 but were concerned that we did not have enough respondents or a representative sample. Late in the survey timeline, we worked to get more responses from urban schools.

Survey Methodology Review Team

- Alan Davis, University of Colorado
- Arlen Gullickson, Western Michigan University
- Carrie Germeroth, McREL
- Dan Thatcher, National Conference of State Legislatures
- Mark Weston, Dell
- Noe Cisneros, Education Commission of the States
- Rodney Muth, University of Colorado
- Sandra Elliott, Texas New & Charter School Initiative

State-Level Standardized Test Score Data

To try to triangulate self-reported achievement data, we discussed collecting state-level standardized test score data, tying it to the self-reported achievement data, and then analyzing trends by a variety of variables. Because of time and financial constraints, we decided to focus on a few states with the highest number of survey respondents. Texas, New Jersey, and Ohio were ultimately chosen. Unfortunately, it became clear that state-to-state comparisons of the test data could not be made. Because the specific content tested and the metrics used to report results are not consistent, any comparison would prove invalid.

We then decided to analyze school test scores and the relationship of this data to survey variables in a single state. This exercise also posed major challenges. We tried to collect test-score data for each respondent from Texas. Schools were asked to report when they first implemented their technology program and in which grades the program was implemented. Test-score data was collected from one year prior to implementation through at least two years of implementation. Schools that began their program in 2009 were then eliminated because baseline data and trend data were not available.

A number of schools did not respond to the program implementation date question, posing another challenge. Private schools were also eliminated because they do not report state test scores. To further complicate the issue, because Texas changed its state test in 2002, the data before 2002 is not consistent with the data after 2002, and no trends can be validated across this time span. Therefore, only test data from 2002 through 2009 was used.

The final challenge was that the remaining schools that met the implementation criteria also had diverse implementation years and grade levels. This resulted in sample sizes that were too small to validate. The end result was that no verifiable trends could be identified.

Cleaning Process

To make the survey more accessible, we did not require respondents to enter their U.S. Department of Education ID number or any other institutional ID. In our experience, requiring the USDOE number (NCES ID) discourages respondents. We believed that the survey population would be more robust if new schools, such as charter schools, were represented. Since Project RED focused on building-level respondents, we wanted the survey to be more accessible. Because we did not require an ID, we required every responding institution to meet a series of validity tests:

- Was the school in the NCES database of public or private schools or districts? These data sets are available through http://nces.ed.gov/datatools/.
- If not, was the school in the MDR database? We had available the entire MDR database of 120,000 institutions, including public schools, private schools, charter schools, school districts, and regional agencies. This major database supplier has a strong maintenance program in which schools are added, changed, and deleted at least annually.
- If not, did the school have a robust web presence with links to state or other regional institutional sites? We found a small number of schools in this category that added the freshness of newly created entities to address the issues of school transformation through technology.
- Was the responding entity a school, district, or subset population, such as special education students in a district or regional education service agency? These responses were discarded.

More than 500 phone calls and emails were sent to clarify these questions. A minimum of a deliverable email address and a positive response were required to retain a questionable entry.

School districts represented a special challenge. Since districts are used to responding to surveys, we found many respondents wishing to respond for a group of schools or for the district as a whole. In every case, we queried the respondent as to the population represented. If they were a district with fewer than 1,200 students and therefore "acted" like a school, we coded the respondent as a "combined" K-12 school. Of the 68 public schools coded as combined schools, a substantial number were of this type. The rest were true public K-12 schools. By coding the districts as schools, we were able to access the NCES demographic data about schools.

Advisory Board

This group was formed to provide general feedback about the state of technology and education processes in schools.

- Calvin Baker, Superintendent, Vail School District, Vail, Arizona
- Anita Givens, Associate Commissioner, Standards and Programs, Texas Education Agency
- Scott Hochberg, State Representative, Texas House of Representatives
- Doug Levin, Executive Director, State Educational Technology Directors Association (SETDA)
- John Musso, Executive Director for Association of School Business Officials International (ASBO)
- Rodney Muth, Ph.D., Professor of Administrative Leadership and Policy Studies, School of Education and Human Development, University of Colorado, Denver

Survey Dissemination

- In late September 2009, letters were sent to every superintendent of districts that contained any of the schools with low student-computer ratios; 4,300 districts that met this criterion were identified. The package included letters for the principals, heads of curriculum/instruction, and technology leaders.
- In early October and again two weeks later, a link to the online survey instrument was sent to the principals of the schools that we had identified or that had identified themselves as being "technology-transformed."
- Letters requesting support and dissemination of the survey were sent to all national sponsors and supporters of the project. Many state groups, such as the Texas Education Association, were also contacted.
- Email messaging was also deployed to all audiences—superintendents, curriculum/instruction heads, technology leaders, and school principals. Emails were sent twice to each group, staggered to drop after print materials to create an echo effect.

Table B.1. Project RED outreach activities

Item	Date Dropped
Web survey launch	9/9/2009
Superintendent kit mailed	9/24/2009
CoSN, ISTE, AESA, AASA, ASBO, TX, ME emails	10/2/2009
eSchool News October issue announcement article	10/3/2009
T+L email blast	10/5/2009
eSchool News October issue print copy	10/6/2009
T+L newsletter no. 1	10/7/2009
T+L October issue print copy with space ad	10/7/2009
Principal postcard to 5,400 schools	10/8/2009
OTO newsletter	10/20/2009
Principal postcard to additional 600 schools	10/22/2009
Principal postcard no. 2	10/26/2009
T+L breakfast briefings: eChalk	10/29/2009
T+L newsletter no. 2	10/29/2009
T+L email blast no. 2	11/5/2009
State outreach	11/8/2009
Principal email blast	11/12/2009
T+L newsletter no. 3	11/16/2009
T+L newsletter no. 4	12/7/2009
T+L email blast no. 3	12/7/2009
T+L email blast no. 4	12/15/2009
Phone calls to schools	Oct.-Nov. 2009
Social media	Oct.-Nov. 2009
Adwords	Nov. 2009
State department efforts	11/16/2009
Superintendent and technical director clarification email blast	12/3/2009
Clean up of responses	Mid-Dec.
T+L eBook	Jan. 4, 2010

All respondents were thanked via email for their participation and asked which source had caused them to respond. Approximately 23% responded to this request.

Table B.2. Outreach effectiveness by source

Source	% of Respondents
Superintendent mailing	51
Media coverage	27
Referral from colleagues	10
Email	5
Postcards	3
Other	4

Data Collection Process Modification

As noted, we compiled a list of 6,000 schools that appeared to have a low student-computer ratio and that were intended to be our population for a study about 1:1 computing. However, in our effort to attract possible respondents, in addition to contacting our target data set by email and phone, we also:

- Created a website and encouraged schools to sign up
- Promoted the survey with a booth at ISTE 2009
- Sent out a press release announcing the survey opening
- Conducted an interview with eSchool News requesting participation that received prominent placement
- Sent out messaging to the Tech & Learning list of ed tech readers

These efforts resulted in a far wider population of respondents than our original target. For example, our letters to superintendents of districts with schools with 1:1 student-computer ratios resulted in many requests to cover other schools that they considered more appropriate (i.e., more technology-transformed) than those we had identified.

Many hundreds of district people wished to take the survey and report results for the entire district. Seventy-five percent of our school responses came from schools with a much higher student-computer ratio than our original population.

So we adjusted to this new reality. We discarded any surveys that were for a special population, such as special education students. We discarded any surveys not from the U.S. or Puerto Rico and territories. We encouraged any district people who had initially responded to have their schools respond. We emailed or phoned every one of the more than 800 respondents who did not complete the survey. In general, they agreed that they were district-level, not school-level, personnel, and most did not have access to school-level daily functioning. Some agreed to have schools in their district complete the survey.

Table B.3. Project RED respondents (after cleaning)

Grade Span	Total	Public	Private
Elementary school	282	278	4
Middle school	136	134	2
Senior high school	202	191	11
Combined school (elem. and secondary)	109	68	41
Voc-tech	10	10	—
Adult	1	—	1
Special education	4	3	1
School district	169	168	1
Preschool/kindergarten	4	4	—
PK-3	29	29	—
7-12	51	51	—
Total Respondents	**997**	**936**	**61**
Schools	**828**	**768**	**60**
Elementary	319	314	5
Middle	136	134	2
High	264	252	12
Combined (K-12)	109	68	41
Districts	**169**	**168**	**1**

Respondent Job Functions

While we viewed Project RED as a school-building survey, many of our respondents were district-level people who were often asked by their superintendents to complete the survey. However, almost one-half of the respondents were principals, and more than 75% of respondents were school-level people.

Table B.4. Respondent base by job function

Job Function	Number	% of Total
Principal	485	48.6
Technology coordinator, school	250	25.1
Technology director, district	48	4.8
Assistant/deputy principal	38	3.8
Instructional coordinator, school	34	3.4
Technology specialist/teacher	25	2.5
Superintendent	23	2.3
Department chair	12	1.2
Curriculum/instruction director, district	20	2.0
Media specialist	12	1.2
CFO/finance	5	0.5
Other	45	4.5
Total	**997**	**100.0**

Table B.5. Respondent base by student-computer ratio

Category	Number	% of Total
1:1 students per computer (.1 to 1.3)	227	22.9
2:1 students per computer (1.4 to 2.3)	295	29.6
3:1 students per computer (2.4 to 3.3)	199	20.0
4:1 students per computer (3.4 to 4.3)	104	10.4
5:1 or more students per computer (4.4 or more)	172	17.3
Total	**997**	**100.0**

Our sample contains a much higher percentage of 1:1 schools than the general population. To offset this, we have made every effort to report results separately for 1:1 learning environments.

Legislative Meeting

In December 2009, we convened a group of researchers and government/industry experts to discuss the outreach program for Project RED. Our initial plan had been to work with a select group of state legislatures to address the barriers to re-engineering education. Before the meeting, we asked the group to complete a survey in which they ranked some of our ideas about transforming schools.

However, the consensus after the meeting was that working closely with state legislatures is a multi-year process that does not permit rapid movement toward substantive goals. Instead, the group recommended a focus on national education policy via three target audiences inside the Beltway, as well as the educational technology and publishing industries. The legislative meeting did generate many valuable ideas that will be addressed in Phase 2 of Project RED.

Legislative Meeting Attendees

– Jim Doyle, Apple
– David Byer, Apple
– Mark Weston, Dell
– Paul Kuhne, eChalk
– Torrance Robinson, eChalk
– Molly Ryan, ECS
– Brian Dietrich, Intel
– Dan Thatcher, NCSL
– Alan Morgan, Pearson
– Mark Soltes, Qwest
– Cathy Mayer, Qwest
– Mary Ann Wolf, SETDA
– Scott Hochberg, Texas State Legislature
– Rodney Muth, University of Colorado

Project RED Target Audiences

The Project RED research was designed to assist four groups—legislatures, school districts, industry, and agencies.

- **Legislatures:** Since education is one of the largest budget items for every state, Project RED can be used to introduce legislatures to the cost savings and return on investment (ROI) that result from technology implementation as part of education reform. For example, technology can help solve the problem of a lack of highly qualified teachers, pointing to the need for legislative action to remove barriers to new educational practices.
- **School districts:** Superintendents are under pressure from a variety of sources to improve outcomes. The models and strategies provided by Project RED can be helpful, especially in light of the differences revealed among high-need, rural, and affluent schools. Further research is needed on why some districts have chosen technology as one of their main tools of education reform.
- **Industry:** Publishers and producers of hardware, software, and infrastructure products and services need to understand trends and differences among various segments.
- **Federal and state agencies:** Groups such as the National Governor's Association, the Council of Chief State School Officers, and other education leadership associations, many of whom supported this research, are interested in understanding the cost savings associated with effective practices and identifying an action agenda they can share with their members.

Data Analysis

Four data analyses were conducted:

- Frequency analysis of the survey responses
- Logistic regression of the survey responses
- Predictive modeling of the full data set
- Cross-tabulation of demographic data for selected public school respondents

Frequency Analysis

The survey was conducted in Survey Monkey, an online survey tool with good data analysis tools that allowed us to filter results to analyze frequencies, such as the frequency of use of two or three factors combined (see Finding 1).

Logistic Regression

Logistic regression analyses provided some indication of positive correlations, but the sample sizes were too small to validate the results. Therefore, these findings are not reported.

Predictive Modeling

Since one purpose of the Project RED study was to identify the implementation factors most strongly associated with the education success measures (ESMs), predictive models were created to try to identify the key drivers of the ESMs (see Chapter 1).

Before the predictive models were created, principal component analysis was used to transform the relatively high number of variables into a much smaller, possibly correlated number. First, factor analysis was used to find communalities. Then initial eigen values were calculated and the sums of squared loadings were extracted. Finally, a Quartimax with Kaiser Normalization rotation method was used.

The following 35 principal components were identified:

- Ongoing principal training
- Principal training—don't know (negative relationship)
- Principal training exists
- Daily communication via technology
- Technology implementation effectiveness
- Core subjects—technology is integrated into daily curriculum
- Ancillary classes—technology is integrated into every class
- Intervention classes—technology is integrated into every class
- Principal trained via short courses in teacher buy-in, best practices, and technology-transformed classroom
- Principal trained via long courses
- Principal enables teacher education/collaboration and leads change management
- Social media once or twice a semester
- Weekly social media
- Instructional network available at home
- Instructional network available in other locations outside of school
- Instructional network available at school for teachers and students
- Instructional network for community and parents
- Occasional virtual field trips—effect strengthens with frequency
- Less frequent virtual field trips
- Frequent virtual field trips
- Daily games, simulations, and social media
- Weekly gaming
- Monthly teacher email
- Teacher email at least once per day
- Collaboration among students
- Collaboration other than weekly
- Monthly collaboration with students outside of school
- Weekly collaboration with students outside of school
- Online formative and summative assessment frequency
- Frequent assessments
- Daily assessments
- Weekly use of spreadsheets
- Weekly use of LMS and email
- Daily use of search engines
- Monthly use of LMS or once or twice per semester

These principal components were then loaded and adjusted to build models that were predictive of the Project RED education success measures. Eleven dependent variables make up the education success measures:

- Disciplinary action rate
- Dropout rate
- Paperwork reduction
- Paper and copying expenses
- Teacher attendance
- High-stakes test scores
- AP course enrollment
- College attendance plans
- Course completion rates
- Dual/joint enrollment in college
- Graduation rates

For the purposes of this study, we limited our predictive modeling analysis to the following four education success measures:

- Disciplinary action reduction
- Graduation rate improvement
- High-stakes test scores improvement
- Dropout rate reduction

While two of the four measures were not applicable for elementary or middle schools, we felt that their importance in the national conversation merited this attention.

The relatively high percentage of schools with a 1:1 student-computer ratio in the Project RED sample provided an important variable for which we needed to control. Twenty-five percent of Project RED respondents were from 1:1 schools, while only 2% of the general population has a student-computer ratio that low. The load on the student-computer ratio variable was therefore rebalanced. The principal components were then reloaded, and models for the four education success measures were recreated. However, the same nine key implementation factors (KIFs) were found to be predictive in both models (see Chapter 3):

1. Intervention classes. Technology is integrated into every class period.
2. Change management leadership by principal. Leaders provide time for teacher professional learning and collaboration at least monthly.
3. Online collaboration. Students use technology daily for online collaboration (games/simulations and social media).
4. Core subjects. Technology is integrated into core curriculum weekly or more frequently.
5. Online formative assessments. Assessments are done at least weekly.
6. Student-computer ratio. Lower ratios improve outcomes.
7. Virtual field trips. With more frequent use, virtual trips are more powerful. The best schools do these at least monthly.
8. Search engines. Students use daily.
9. Principal training. Principals are trained in teacher buy-in, best practices, and technology-transformed learning.

Cross Tabulation With Demographics

Because we were searching for strong demographic indicators, we linked all respondents to both the government database (National Center for Education Statistics) as well as to the MDR database. Both data sources provide more robust data for public schools than for private schools or school districts. To maximize our demographic assessment, we limited the cross-tabulation to those public schools with links to at least one of the data sources.

We found that the 2007-2008 NCES database often did not have information on newer charter schools and that both sources were missing data on current school-year openings. Whenever we were not able to link to either source, we searched for a website with extensive information about the institution. Every respondent institution not contained on the NCES or MDR database had to have a web presence with links for authentication. Unfortunately, these newer schools are not included in the representativeness of population charts below.

MDR data:

- Grade level
- Student enrollment
- Minority percentage
- Instructional materials expenditure
- Claritas™ household income
- Claritas™ lifestyle

NCES data:

- Locale
- Region
- Poverty percentage (Percentage qualifying for free and reduced-price lunch)
- Regions
  - Central: Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, Wisconsin
  - Northeast: Connecticut, Delaware, District of Columbia, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont
  - Southeast: Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee, Virginia, West Virginia
  - West: Alaska, Arizona, California, Colorado, Hawaii, Idaho, Montana, Nevada, New Mexico, Oklahoma, Oregon, Texas, Utah, Washington, Wyoming

Representativeness of Population

Since the schools in the Project RED database were self-selected and may be biased in favor of technology, their demographics were compared with those of the universe. They align quite well, as follows.

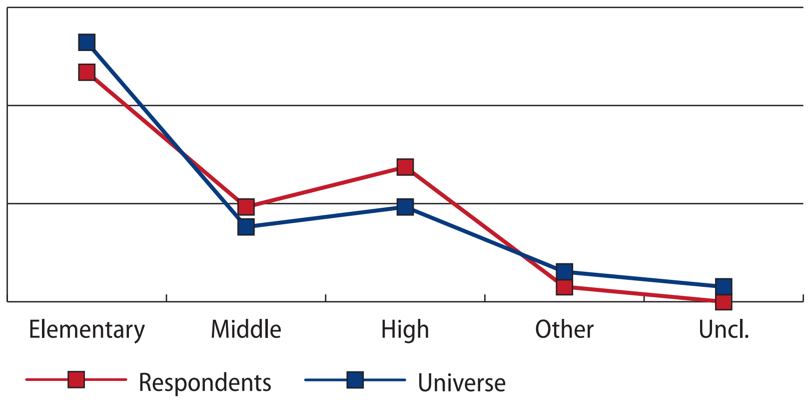
Grade Level

Project RED public school respondents align well with school universe data, although they represent proportionally fewer elementary schools and more high schools.

Table B.6. Grade-level representativeness

Level	Respondents, Public		Universe	
	Frequency	%	Frequency	%
Primary	341	46	54,789	53
Middle	142	19	17,008	16
High	217	29	20,620	20
Other	34	5	7,423	7
Unclear	15	2	3,989	4
Total	**749**	**100**	**103,829**	**100**
Data: NCES Public Schools, 2007-2008.				

Chart B.1. Grade-level representativeness respondent data versus NCES universe



Percentage of Public School Respondents and Universe by Grade Level

Source: Project RED respondent data compared with NCES Public School Universe, 2007-2008. Respondent data aligns well by grade level.

Enrollment

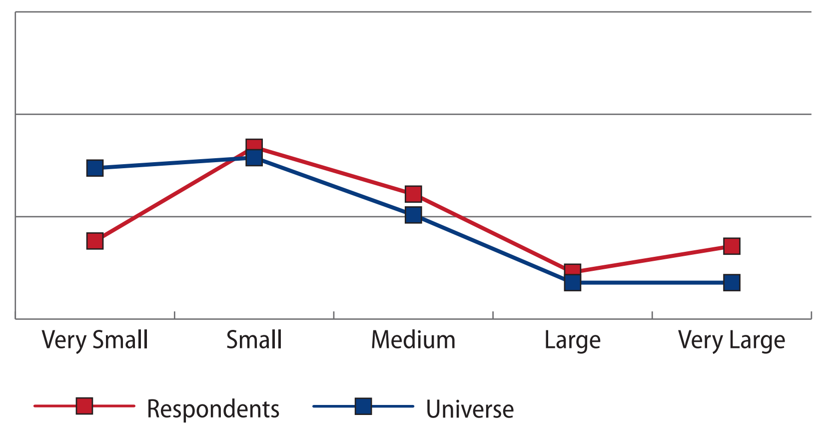
Project RED schools are slightly larger than the average. The average U.S. school has 504 students, while the average Project RED public school has 644 students. This is because of the disproportionately high percentage of high schools that took the survey. Project RED also limited its survey population to schools with 100 or more students, as shown in Table B.7.

Table B.7. Enrollment representativeness

Category	Enrollment Range	Respondent Public Schools	%	NCES Universe	%
Very small	100-249	114	15	14,548	14
Small	250-499	258	34	32,667	32
Medium	500-749	187	25	21,850	21
Large	750-1,000	76	10	8,576	8
Very large	1,001+	104	14	8,681	8
Unclassified	Under 100	10	1	16,897	16
Total	—	**749**	**100**	**103,219**	**100**

Data: NCES Public Schools 2008 Preliminary.

Chart B.2. Enrollment range representativeness



Percentage of Respondents and Universe in Public Schools by Enrollment Range

Source: Project RED respondent data compared with NCES Public School Universe, 2008 Prelim.

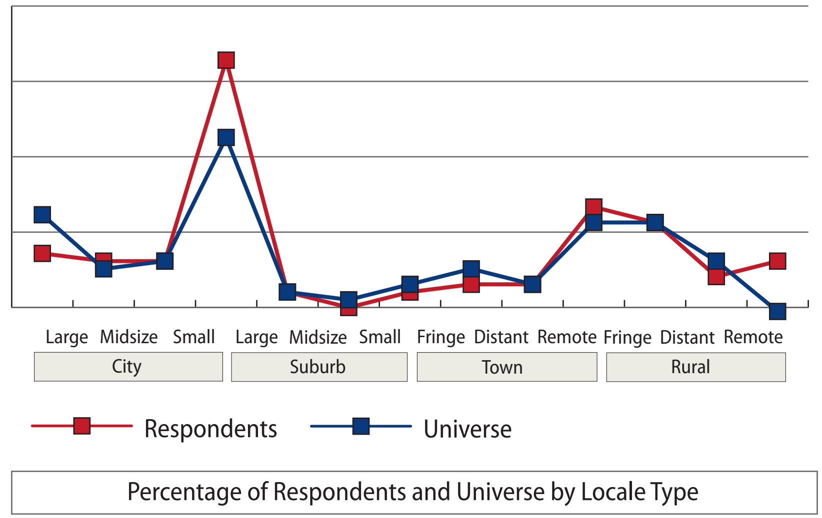
Locale

Traditionally, suburban school districts have been leaders in technology use. Project RED respondents represent slightly more suburban respondents than the school universe, as is typical in school surveys. Despite efforts through NSBA and others, Project RED received a lower-than-average response from urban districts.

Table B.8. Distribution by locale

Group	Respondent Public Schools	%	Universe	%
Large city	44	6	13,471	13
Midsize city	49	7	6,031	6
Small city	49	7	7,436	7
Suburb, large	235	31	23,946	23
Suburb, midsize	21	3	3,125	3
Suburb, small	3	—	2,098	2
Town, fringe	28	4	4,522	4
Town, distant	34	5	5,994	6
Town, remote	30	4	4,626	4
Rural, fringe	105	14	12,473	12
Rural, distant	94	13	12,064	12
Rural remote	34	5	7,512	7
Unclear	23	3	513	—
Total	**749**	**100**	**103,811**	**100**
Source: NCES Public Schools 2007-2008.				

Chart B.3. Locale representativeness respondent data versus NCES universe



Source: Project RED respondent data compared with NCES School Universe, 2007-2008. Respondent data aligns well with universe although slightly under-represented in large cities and over-represented in large suburbs.

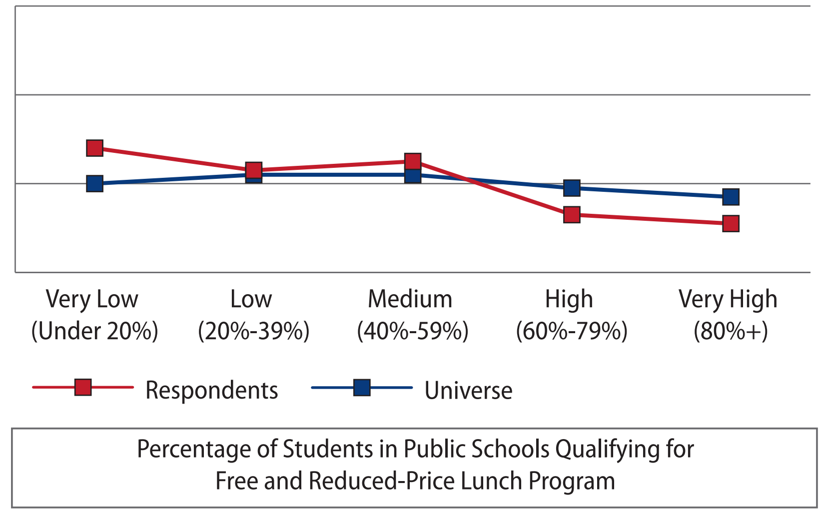
Poverty Level

Of the 749 public schools with demographics in the study, 640 were linked to NCES data for poverty percentages. Project RED respondents were slightly more affluent than the universe of respondents. Respondents in the low poverty category were 38% of the total, compared with 29% of the school universe. Similarly, respondents in the very high poverty category were 14% of the total, compared with 18% of the school universe.

Table B.9. Poverty level of respondents compared with universe

Group	Poverty Level	Respondent Public Schools	%	Universe	%
Low	Under 35%	287	38	29,700	29
Medium	35%-49%	134	18	13,000	13
High	50%-74%	150	20	21,000	20
Very high	75% or more	107	14	18,100	18
Other	Uncl.	71	9	21,519	21
Total	—	**749**	**100**	**103,319**	**100**
Data: NCES Public Schools 2005-2006.					

Chart B.4. Poverty-level representativeness respondent data versus NCES universe



Source: Project RED respondent data for 640 public schools compared with NCES Public School Universe, 2007-2008. Mean: 45.3% of students in poverty.

Lifestyle Cluster Analysis

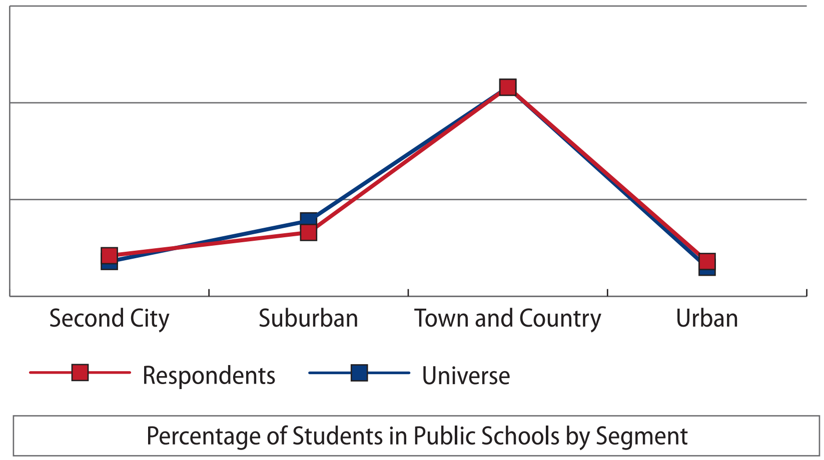
Claritas, Inc., pioneered the clustering of data into segments by lifestyle. This analysis provides different insights by reviewing both location and income. Since Claritas clusters are linked to geographic data rather than school data, this profile also includes private schools linked to the database. Note: The crosstabs contain a fifth category of rural, which is folded into the town and country category shown here.

Table B.10. Lifestyle cluster analysis

Description	Respondents	%	Universe	%
Second City	**102**	**13**	**19,346**	**17**
Second city society	27	3	4,041	3
City centers	40	5	7,668	7
Micro-city blues	35	4	7,637	7
Suburban	**175**	**22**	**24,815**	**21**
Elite suburbs	53	7	5,723	5
The affluentials	37	5	7,630	7
Middle burbs	45	6	6,252	5
Inner suburbs	40	5	5,210	4
Town and Country	**347**	**44**	**54,076**	**46**
Landed gentry	79	10	9,995	9
Country comfort	70	9	13,312	11
Middle America	79	10	14,043	12
Rustic living	119	15	16,726	14
Urban	**111**	**14**	**18,709**	**16**
Urban uptown	57	7	7,934	7
Midtown mix	25	3	4,427	4
Urban core	29	4	6,348	5
Unknown	**14**	**2**	**—**	**—**
Total	**749**	**100**	**116,946**	**100**

Source: MDR database with Claritas New Evolution segmentation.

Chart B.5. Lifestyle representativeness respondent data versus NCES universe



Source: Project RED respondent data for 712 public schools compared with Claritas New Evolution segmentation on MDR database.

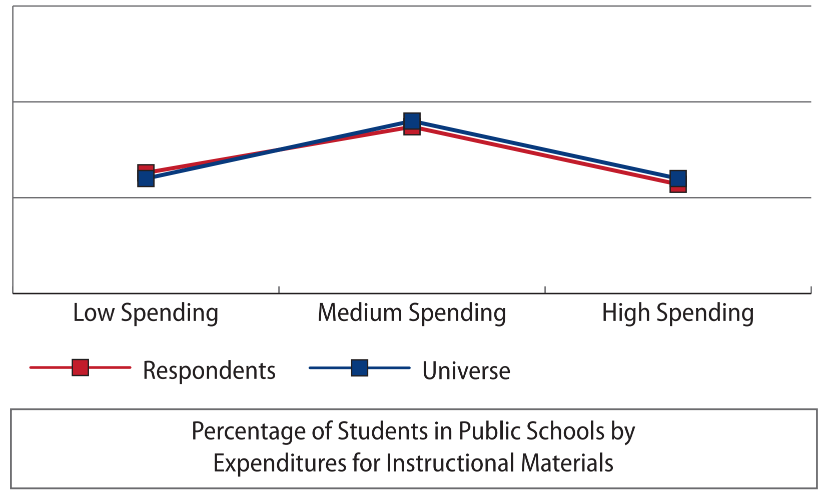
Instructional Materials Expenditures

This is an MDR database component, collected every year at the district level and assigned to all schools within districts based on the number of students. These data are collected on public schools only, and 642 of the respondent schools were linked to this variable with the following highly aligned results.

Table B.11. Instructional materials expenditures

Spending Category	Description	Respondents	%	Universe	%
$.01-$144.99	Low	50	8		
$145.00-$179.99	Low	84	13		
$180.00-$199.99	Low	66	10		
Low Spending		**200**	**31**	**26,578**	**30**
$200.00-$219.99	Medium	63	10		
$220.00-$249.99	Medium	76	12		
$250.00-$269.99	Medium	39	6		
$270.00-$299.99	Medium	73	11		
Medium Spending		**251**	**39**	**36,142**	**40**
$300.00-$349.99	High	59	9		
$350.00-$399.99	High	55	9		
$400.00-$499.99	High	43	7		
$500+	High	32	5		
High Spending		**189**	**29**	**27,109**	**30**
Unclear	Unclear	2	—	—	—
Total	—	**642**	**100**	**89,829**	**100**

Chart B.6. Instructional materials expenditures representativeness



Source: Project RED respondent data for 642 public schools compared with MDR Public School Universe, 2009-2010.

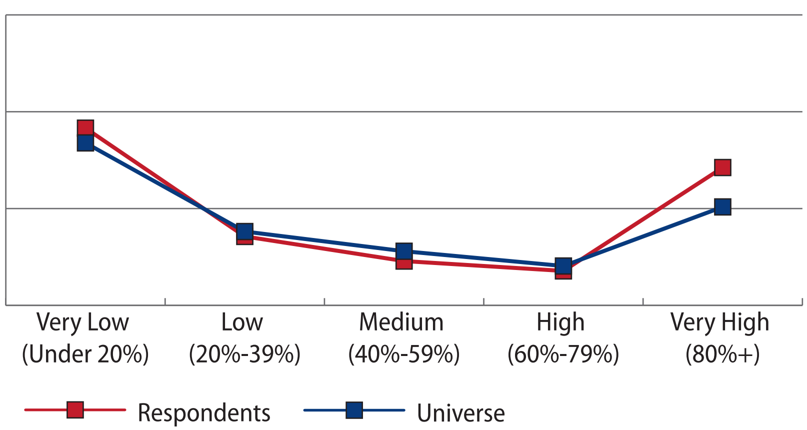
Minority Percentage

The respondent base appears to have a slightly higher percentage than the universe of very high minority student population. This is surprising since the respondents appeared to be somewhat more affluent than the universe, and affluence is usually correlated with a lower percentage of minorities.

Table B.12. Minority percentage

Category	Minority %	Respondent Public Schools	%	Universe	%
Very low	Under 20	273	37	35,001	34
Low	20-39	108	15	16,783	16
Medium	40-59	70	10	12,052	12
High	60-79	60	8	9,387	9
Very high	80+	215	29	21,597	21
Unclear	—	23	1	8,991	9
Total	—	**749**	**100**	**103,811**	**100**

Chart B.7. Minority percentage representativeness



Percentage of Respondents and Universe by Minority Percentage

Source: Project RED respondent data compared with NCES Public School Universe, 2007-2008. Respondent data aligns well with universe.

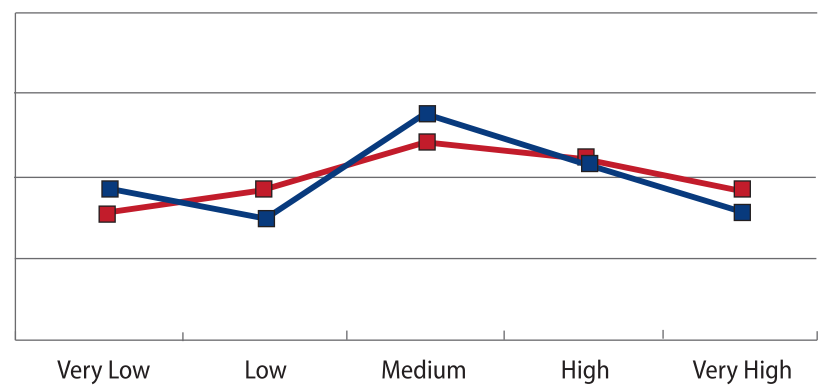
Household Income

The respondent base aligns well with the universe on household income.

Table B.13. Household income

Income Category	Description	Respondents	%	School Universe	%
Very low	Under $35,000	115	16	22,351	19
Low	$35,000-$40,999	132	18	19,012	16
Medium	$41,000-$51,999	177	24	31,291	27
High	$52,000-$69,999	160	22	25,753	22
Very high	$70,000+	127	18	18,435	16
Unclear	—	14	2	—	—
Total	—	**725**	**100**	**116,842**	**100**

Chart B.8. Household income representativeness



Percentage of Respondents and Universe by Median Household Income

Source: MDR database. Claritas-supplied median income projections applied by ZIP Code.

Crosstabs Availability

Cross tabulations with these demographic data are available at no charge for purchasers of the report. Please contact survey@projectred.org for a copy of the 317-page Word document.

Research Challenges

It could be argued that the self-reported data on outcomes, such as test-score improvement, dropout rate reduction, and course completion, is self-serving and that respondents to a survey on "technology-transformed schools" might be biased in favor of reporting strong outcomes. Our efforts, therefore, have been to look within the survey population for differences, including the differences between 1:1 schools and those with higher ratios—differences that often turned out to be startling. Deeper, more detailed study, ideally including automated system detection of student usage linked to education outcomes, would be enlightening.

It could also be argued that this respondent data set is self-selected and therefore not representative of all schools. It is certainly likely that the respondents are biased in favor of technology and responded to the survey as technology enthusiasts. However, the public school respondent base is surprisingly representative of the public schools universe, as illustrated in the above charts.

Recommendations

The Project RED study, like most research, has revealed many questions for further investigation, including the following:

- Why do schools that report the use of gaming, simulations, collaborative tools, and virtual field trips also report greater educational outcomes?
- What are teachers and students actually doing in technology-integrated intervention classes that is leading to the success reported by respondents?
- Since only about 1% of the responding schools are using all the key implementation factors, what can be learned about their methods, processes, and resources, and can we verify their self-reported success?

We also experienced many challenges while conducting this research that point to improvements for future Project RED studies, including:

- Several questions have multiple variables imbedded. In the future, we will simplify each survey question so that it reflects only one variable, for ease and clarity of analysis.
- We originally intended to study technology-rich school environments, and our survey was designed to address that population. However, our respondents are more diverse. In the future, if we continue to survey a broader population, we will reword some of the survey questions and potential responses to account for schools without robust technology implementations.
- Ideally we need to find ways to verify self-reported data. Human collection of data in the field is very expensive, so we will look for automated ways to at least collect student usage data rather than relying on self-reported data.
- Our survey respondents are diverse and include all grade levels and school configurations. Although our total population is reasonably large, the population within each subgroup was too small to validate many serendipitous findings. Follow-up research could be conducted on specific demographic populations, grade levels (elementary, middle school, high school), or school types (private, public, charter, etc.). By narrowing the focus of future studies, it may be easier to garner a large enough population to validate the findings.

Project RED
REVOLUTIONIZING EDUCATION

"We are experiencing cost savings by having students create electronic student handbooks and store them on their mobile learning devices, and by sending homework electronically and eliminating the use of notebook paper or printer paper."

~ Kyle Menchhofer
District Technology Coordinator
St. Marys City Schools
St. Marys, Ohio

Pixland/Thinkstock

Appendix C

Survey Instrument

Technology-Transformed Schools 2009-2010

Thanks for completing the Project RED initial survey. We'll be sending you a copy of the report when it is completed in Spring 2010.

You have shared your insights with other educators which can help our entire community understand just how technology is contributing to learning gains. Thanks, The Project RED Team

For questions and comments, please contact Project RED by e-mail, survey@projectred.org, Email Me or at 1-877-635-4198. For further information about the Project Red initiative, go to our website, www.projectjed.org. Click here.

* **1. Please give us your contact information. Our purpose in collecting this information is to contact you for follow-up clarification of your answers to the survey, if necessary.** ***Please click on 'Next' when you are ready to start the survey.***

Name:

School Name

School Address:

City/Town:

State:

ZIP:

Email Address:

Phone Number:

* **2. What is your position in the school?**

- a. Principal/Headmaster
- b. Assistant/Deputy/Vice Principal
- c. Technology Coordinator at school
- d. Instructional Coordinator at school
- e. Other

Other (please specify)

* **3. What is the student enrollment in your school?**

Student Enrollment

Technology-Transformed Schools 2009-2010

* **4. What is the total number of computing devices (desktops, laptops, netbooks, tablets, smartphones, thin client, etc.) being used in your classrooms?** ***Estimate the total number here.***

Total Number of Computing Devices

5. Please enter an approximate number for each computing device used in your classrooms. The total should equal your response to Number 4 above.

a. Desktops

b. Laptops

c. Tablet Computers

d. Netbooks

e. Thin Client (e.g., Neoware or Wyse)

f. Smartphones (e.g., iPhone, Blackberry,Windows Mobile, etc.)

g. Other

6. Categorize your school to help us understand your school environment. (Please select only one.)

- a. Each student has full-time use of a computing device to use at both home and school or any other location.
- b. Each student has full-time use of a computing device only at school.
- c. Each student does not have an assigned computer, but can access the school network and Internet via a unique student profile on a computing device throughout the day.
- d. Many of our students have access to computing devices throughout the school day, but most students do not have continuous access.
- e. Some students in specific grades have access to a computing device throughout the school day, but we have not yet implemented access for all grades school-wide.
- f. Few students have access to computing devices throughout the school day.
- g. Other

Other (please specify)

Technology-Transformed Schools 2009-2010

7. Check the grades taught in your school this year.

- Preschool
- Kindergarten
- Grade 1
- Grade 2
- Grade 3
- Grade 4
- Grade 5
- Grade 6
- Grade 7
- Grade 8
- Grade 9
- Grade 10
- Grade 11
- Grade 12
- Other

Other (please specify)

* **8. Please indicate the year in which 90% or more of the students received access to a computing device (e.g., laptop, PDA, etc.) to use regularly in all of their classes. If a grade in your school does not have regular access, please write 9999 in the box, just for the grades you have in your school.**

Preschool deployed in Year
Grade K deployed in Year
Grade 1 deployed in Year
Grade 2 deployed in Year
Grade 3 deployed in Year
Grade 4 deployed in Year
Grade 5 deployed in Year
Grade 6 deployed in Year
Grade 7 deployed in Year
Grade 8 deployed in Year
Grade 9 deployed in Year
Grade 10 deployed in Year
Grade 11 deployed in Year
Grade 12 deployed in Year

Technology-Transformed Schools 2009-2010

9. How frequently do your students use technology as an integrated part of instruction?
Indicate frequency for each subject and intervention.

	Used in every class as digital core curriculum	Used in every class with textbook as core curriculum	Weekly Use	Monthly Use	Not At All	N/A (Not Applicable)
a. Art	•	•	•	•	•	•
b. Career Tech	•	•	•	•	•	•
c. English/Language Arts	•	•	•	•	•	•
d. Health/Physical Education	•	•	•	•	•	•
e. Math	•	•	•	•	•	•
f. Music	•	•	•	•	•	•
g. Reading	•	•	•	•	•	•
h. Science	•	•	•	•	•	•
i. Social Studies	•	•	•	•	•	•
j. World Language	•	•	•	•	•	•
k. English Language Learner intervention	•	•	•	•	•	•
l. Reading intervention	•	•	•	•	•	•
m. Special Education intervention	•	•	•	•	•	•
n. Title I intervention	•	•	•	•	•	•

Additional Comments

Technology-Transformed Schools 2009-2010

10. What was the original impetus for your technology initiative? *Choose the primary driver for your initiative.*

- Academic standing of school
- Adequate yearly progress (AYP) concerns
- Building skills to participate in the 21st Century Workforce
- Closing the digital divide
- Don't know. Wasn't involved.
- Engagement of students in learning
- Enhancement of student learning and achievement
- Funds becoming available
- Providing equal access to greater educational opportunities
- State mandate
- Superintendent mandate

Other (please specify). Please check here if you don't have an initiative.

11. How was your technology initiative funded? *Check all that apply.*

- a. Operating budget or capital budget
- b. Formula grants from state or federal
- c. Bond issue (or similar)
- d. EETT (Enhancing Education through Technology)
- e. Competitive grants (other than EETT)
- f. Special taxes
- g. Shift of funding from textbooks to technology
- h. Foundation or private individual
- i. Other (Including Not Applicable)

Other (please specify) or Explain

Technology-Transformed Schools 2009-2010

12. Indicate what percentage of parents participated in face-to-face meetings or training on their role in helping the technology initiative succeed.

- a. Less than 10%
- b. 10-25%
- c. 26-40%
- d. 41-50%
- e. 50-74%
- f. 75-84%
- g. 85-89%
- h. 90-94%
- i. 95-100%
- j. N/A

13. *Indicate when the teachers were issued a computing device compared to students.*

- 12 or more months before students
- 9-11 months before students
- 6-8 months before students
- 3-5 months before students
- 2 months before students
- 1 month before students
- Same time as students
- After students

Other (please specify). Include Not Applicable.

14. How well did your technology implementation plan specifically address each of the following?

	Very well	Adequately	Not well	Not addressed at all	Don't know; I wasn't part of the plan
Long-term funding	•	•	•	•	•
Teacher training	•	•	•	•	•
Instructional network	•	•	•	•	•
Parent training	•	•	•	•	•
Service and support	•	•	•	•	•
Teacher buy-in	•	•	•	•	•

15. Indicate for how long you think your program is sustainable.

- One year or less
- Two years
- Three years or more
- Five years or more

Technology-Transformed Schools 2009-2010

16. Indicate how teachers and students in your school use technology in instruction.

	Many Times a Day	At Least Daily	At Least Weekly	At Least Monthly	Once or Twice a Semester	Not At All	N/A
Students take control of their learning including choosing research topics for assignments and choosing ways to both gather and present information.	•	•	•	•	•	•	•
Students use a wide range of electronic materials including courseware, collaboration tools, and access to multimedia databases.	•	•	•	•	•	•	•
Students use problem-based learning (cooperative groups seeking solutions to real-world problems).	•	•	•	•	•	•	•
Teachers spend more time on small group and individual instruction than on lectures.	•	•	•	•	•	•	•

Additional Comments

Technology-Transformed Schools 2009-2010

17. How frequently do you expect your students to use technology in the following activities?

	Many Times a Day	At Least Daily	At Least Weekly	At Least Monthly	Once or Twice a Semester	Not At All	N/A
Collaboration with peers in any school	•	•	•	•	•	•	•
Collaboration with peers in own school	•	•	•	•	•	•	•
Communication with teacher via e-mail, chat or other electronic methods	•	•	•	•	•	•	•
Games and Simulations	•	•	•	•	•	•	•
Google or other search engines.	•	•	•	•	•	•	•
Learning Management System (LMS) to receive assignments and submit homework	•	•	•	•	•	•	•
Online formative assessments	•	•	•	•	•	•	•
Online summative assessments	•	•	•	•	•	•	•
Social media (e.g., blogs, tweets, wikis)	•	•	•	•	•	•	•
Spreadsheets, graphs, tables and charts	•	•	•	•	•	•	•
Student response systems (including clickers)	•	•	•	•	•	•	•
Virtual field trips	•	•	•	•	•	•	•

Other (please specify)

Technology-Transformed Schools 2009-2010

18. How frequently do students actually use technology for these activities? We know there are many variables outside of your control that may cause a different result from your expectations. *Check the appropriate boxes of all the instances that occur in your school or indicate Not Applicable (N/A).*

	Many Times a Day	At Least Daily	At Least Weekly	At Least Monthly	Once or Twice a Semester	Not At All	N/A
Collaboration with peers in any school	•	•	•	•	•	•	•
Collaboration with peers in own school	•	•	•	•	•	•	•
Communication with teacher via e-mail, chat or other electronic methods	•	•	•	•	•	•	•
Games and Simulations	•	•	•	•	•	•	•
Google or other search engines	•	•	•	•	•	•	•
Learning Management System (LMS) to receive assignments and submit homework.	•	•	•	•	•	•	•
Online formative assessments	•	•	•	•	•	•	•
Online summative assessments	•	•	•	•	•	•	•
Social media (e.g.,blogs, tweets, wikis)	•	•	•	•	•	•	•
Spreadsheets, graphs, tables and charts	•	•	•	•	•	•	•
Student response systems (including clickers)	•	•	•	•	•	•	•
Virtual field trips	•	•	•	•	•	•	•

Other (please specify)

Technology-Transformed Schools 2009-2010

19. Did the principal receive specific training to prepare to lead a technology-transformed school?

	Short course (Two days or less)	Long course	Ongoing	No	Don't Know	N/A (Current principal was not principal at beginning of initiative)
The role of the principal in leading change	•	•	•	•	•	•
What a technology-transformed classroom looks like	•	•	•	•	•	•
How to get teacher buy-in	•	•	•	•	•	•
Best practices for improving academic success	•	•	•	•	•	•
Communicating with the community	•	•	•	•	•	•
Preparing for a successful computer distribution	•	•	•	•	•	•

20. Describe the principal's role as the leader of the technology initiative.

	At Least Weekly	At Least Monthly	At Least Quarterly	At Least Annually	Not At All
The principal enables regularly-scheduled teacher professional learning activities.	•	•	•	•	•
The principal enables regularly-scheduled time for teacher collaboration.	•	•	•	•	•
The principal enables online professional learning opportunities.	•	•	•	•	•
The principal models technology use in both communications and other administrative functions.	•	•	•	•	•
The principal uses change management strategies to lead the school.	•	•	•	•	•

Technology-Transformed Schools 2009-2010

21. In support of your tech program, how frequently does the typical teacher experience the following professional learning activities?

	At Least Weekly	At Least Monthly	At Least Quarterly	At Least Annually	Not At All
Coaching	•	•	•	•	•
Co-planning (teachers planning together use one of the models of co-teaching to decide how they will implement instruction to meet the needs of all students)	•	•	•	•	•
De-briefing on coaching and mentoring	•	•	•	•	•
District-provided professional learning	•	•	•	•	•
Faculty / departmental training and meetings focused on integration of technology into the curriculum	•	•	•	•	•
In-class mentoring (shoulder to shoulder)	•	•	•	•	•
Online professional learning courses	•	•	•	•	•
Teacher collaboration, (i.e., professional learning communities)	•	•	•	•	•

Other (please specify)

22. What is the total Professional Learning budget in whole dollars for your school? Include costs for substitute teachers, outside professional learning courses and any other relevant expenses. If you don't know the answer, just skip the question. *Please do not use dollar signs or commas, just enter numbers.*

From District Budget

From School Budget

From Other Sources

23. Systems reliability: On average over the last year, what percent of the school day is your instructional network up for student and teacher use?

- Less than 95% Uptime
- 95% - 20 minutes per day of downtime
- 98% - 8 minutes per day of downtime
- 99% - 4 minutes per day of downtime
- 99.9% - 30 seconds per day of downtime

Technology-Transformed Schools 2009-2010

24. Systems accessibility: Is your instructional network accessible?

	Students	Teachers	Parents	Other community members
At home for...	•	•	•	•
At school for...	•	•	•	•
Other location (such as libraries, hot spots, etc.)	•	•	•	•

25. Speed of Connection: How fast is the speed of your Internet connection to your classrooms?

- Very fast
- Fast
- Not fast
- Not fast at all
- Don't know

Technology-Transformed Schools 2009-2010

26. The following list is designed to identify activities that may have financial impact at some point in some place. *We will work with your raw estimates to create a model of financial savings.* How has deployment of ubiquitous technology changed the following?

	Greatly Improved	Somewhat Improved	No Change	Made It Worse	N/A
a. Disciplinary action reduction	•	•	•	•	•
b. Drop-out rate reduction	•	•	•	•	•
c. Paperwork reduction	•	•	•	•	•
d. Paper and copy machine expense reduction	•	•	•	•	•
e. Teacher attendance increase	•	•	•	•	•
f. High-stakes test scores increase	•	•	•	•	•
g. AP course enrollment increase (high schools only)	•	•	•	•	•
h. College attendance plans increase (high schools only)	•	•	•	•	•
i. Course completion rates increase (high schools only)	•	•	•	•	•
j. Dual/joint enrollment in college increase (high schools only)	•	•	•	•	•
k. Graduation rates increase (high schools only)	•	•	•	•	•

Other (please specify)

Warning: Once you finish the survey, you will not be able to return. If you would like to review the questions and your answers, please do so now before hitting the 'Submit' button below. If you would like to exit the survey and return to it later, you may do so as long as you do not hit the 'Submit' button.

Technology-Transformed Schools 2009-2010

*** 27. May we contact you again?**

- Yes
- No

Additional Comments

28. Student Computer Ratio: Please indicate the most accurate description of your student/computer ratio; i.e., number of students in the school divided by the total number of computing devices.

- a) 1:1 students per computer (Range of .1 to 1.3 students per computer)
- b) 2:1 students per computer (Range of 1.4 students per computer to 2.3 students per computer)
- c) 3:1 students per computer (Range of 2.4 students per computer to 3.3 students per computer
- d) 4:1 students per computer (Range of 3.4 students per computer to 4.3 students per computer
- e) 5:1 or higher students per computer (4.4 students per computer or higher
- f) Unknown (missing data)

Other (please specify)

29. School Or District Classification:

- a) Elementary school
- b) Middle school
- c) Senior High School
- d) Combined school (Elem. and Secondary)
- e) Voc-Tech
- f) Adult
- g) Special
- h) School district
- i) Unknown
- j) Preschool/Kindergarten
- k) PK-3
- l) 7-12 (or 6-12)

Technology-Transformed Schools 2009-2010

30. School or District Affiliation: Please indicate your affiliation.

- Charters Two (charter schools coded as public on Project RED)
- Public (excluding virtual/online schools)
- Catholic
- Private non-denominational
- Private denominational
- Charter
- Regional Service Agencies (other than Charter)
- State-Run (Other than Charter)
- Online/virtual school

Other (please specify)

Thank you for your participation in this important survey. You have helped inform your fellow educators and provided input to federal and state officials. You will also be able to use this ground-breaking information for your own school and district decision-making.

As thanks for your participation, you will receive a complimentary copy of the report of findings.

Project RED
REVOLUTIONIZING EDUCATION

"Students who are behind their peers are more likely to drop out. Through the use of technology we are able to help them graduate with their friends, and their self-esteem increases as they see their progress."

~ Rosemary Williams
Principal, Burkeville High School
Burkeville, Texas

Stockbyte/Thinkstock

Appendix D

Research Team

Project RED began with the big idea that the re-engineering of American education could revolutionize our schools. Since the idea that technology enhances learning is not a provable hypothesis, we focused on investigating the dramatic gains and cost savings achieved by some schools when they deploy technology. We wanted to determine how widespread the improvements were and to what degree the frequent use of technology was a factor.

Tom Greaves and Jeanne Hayes had researched district-level use of technology earlier in the *America's Digital Schools* series. In order to bring a firm grounding in daily practice to Project RED, they asked the One-to-One Institute to join the team, bringing on board practitioners with many years of experience in providing professional learning for schools and districts as they embark on technology initiatives.

Thomas W. Greaves
CEO and Founder, The Greaves Group

Tom is recognized as a visionary in the conceptualization, design, engineering, and marketing of technologies for schools. He holds multiple patents and patent disclosures for student-computing technologies and has been involved in hundreds of 1:1 computing projects at the district, state, and federal levels. He has published widely and is currently the Software Information Industry Association (SIIA) Mobile Computing Trends Watch Report Editor. Along with Jeanne Hayes, he is co-author of the 2006 and 2008 *America's Digital Schools* surveys.

Tom has 44 years' experience in the computer industry, including 26 years at IBM, where he was a member of the IBM EduQuest senior management team. In 1996, he co-founded NetSchools, the first company to focus on comprehensive curriculum-integrated, Internet-connected 1:1 laptop solutions. He now leads the Greaves Group, a strategic education consulting organization. Tom is the recipient of the prestigious 2010 SIIA Ed Tech Impact Award and is a well-known speaker and panelist.

Jeanne Hayes
President, The Hayes Connection

Jeanne established The Hayes Connection in 2005 to serve education market companies and school districts, based on her 30 years of experience in creating school databases, analyzing market trends, and helping clients market to schools at Quality Education Data (QED), which she founded in 1981.

A former educator and debate coach, Jeanne has testified before Congress and speaks at conferences nationwide about instructional technology and other education issues. She is co-author with Tom Greaves of *America's Digital Schools* 2006 and 2008. She has served as a board member of the CEO Forum on Education and Technology, the Consortium for School Networking (CoSN), and the Education Section of the Software Information Industry Association (SIIA). She was recognized as the 2002 CoSN Private Sector Champion for 2002, one of the Converge Magazine Those Who Make a Difference for 2000, and one of the eSchool News Impact 30 for 2001. In 2002, Jeanne was inducted into the Association of Educational Publishers' Hall of Fame.

Leslie Wilson
CEO, One-to-One Institute

Leslie is a founding member of the One-to-One Institute, where she created the highly effective programs and services model based on the Michigan Freedom to Learn Program. She now leads the institute's leadership team and works with a collaborative cadre of state and national service providers. Leslie is a thought leader in the 1:1 community and a tireless advocate for ubiquitous technology at the state, national, and international levels. She provides assistance with the planning, design and launch, curriculum and content integration, online assessment, leadership, and sustainability of 1:1 programs.

Leslie served in public education for 31 years in seven school districts. As co-chair of the National Steering Committee of One-to-One Directors, she facilitates networking and collaboration among 1:1 visionaries. She is a well-known presenter on educational transformation topics and serves on numerous national and state committees and advisory boards.

Michael Gielniak, Ph.D.
Director of Programs and Development
One-to-One Institute

Mike is a key member of the One-to-One Institute leadership team, responsible for the creation, implementation, and oversight of the institute's professional learning activities, new programs, fund development, and research activities. Before joining the institute, he served as the Executive Director at the Anton Art Center and the Center for Creative Learning and Teaching.

Both a Fulbright Scholar and an Emmy award winner, Mike has worked with creative and educational environments around the globe for 25 years. As a consultant to the Macomb Intermediate School District, he developed the Macomb New Teacher Academy, where he trained over 1,000 teachers. He has worked with the Michigan Department of Education on a variety of projects since 2003. He managed the development of arts content for the Clarifying Language in Michigan Benchmarks (MIClimb); served on the rubric development committee for the Michigan school assessment program, Education, Yes!; and was a reviewer for Michigan's teacher preparation standards.

Eric L. Peterson
President and CEO, Peterson Public Sector Consulting
Advisor to One-to-One Institute

Eric has worked with the Michigan Departments of Education, Treasury, and Management and Budget, as well as with Michigan legislators and Michigan House and Senate fiscal agencies, for over 19 years. In his work with over 500 school districts, he has developed numerous techniques for customizing operational, instructional, and financial solutions. Most recently, he assisted the Detroit Public Schools, in partnership with another consulting firm, in the district's quest to right-size the organization and reduce debt.

A frequent presenter at national and state-level conferences, Eric performs process and organizational studies for public schools and businesses throughout Michigan. In 2004, he received the Distinguished Service Award from the MSBO Board of Directors for 13 years of outstanding support to Michigan school business officials.

As we manage the transition from predominantly print-based classrooms to digital learning environments, we have the opportunity to truly personalize learning, engaging and inspiring students everywhere.

~ Karen Cator
Director of the Office of Educational Technology
U.S. Department of Education


iStockphoto/Thinkstock

Appendix E

Case Study in Digital Conversion

This district is one of the few respondents to the Project RED study that deployed virtually all of the key implementation factors (KIFs). We thought an examination of their purpose, process, and results would be enlightening.

Mooresville Graded School District, Mooresville, North Carolina

Demographics	
Schools	8
Students	5,409
Poverty	39% Free and reduced-price lunch (up from 31% in 2006-2007)
Ethnicity	73% Caucasian 15% African-American 7% Hispanic 2% Asian 3% Multiracial

The Community

Mooresville is a blue-collar former mill town in suburban Charlotte. Affectionately known as "Race City, USA," Mooresville is home to several NASCAR teams, the NASCAR Institute of Technology, and the national headquarters for Lowe's Home Improvement.

The Need

In the 2006-2007 school year, Mooresville Graded School District initiated a review of district results in teaching and learning. A new superintendent, Dr. Mark Edwards, who had pioneered the use of a digital environment in Henrico County, Virginia, was on board. A review of test scores and other education success measures by the leadership team revealed that results were acceptable but not leading edge. The goal was to transform the school district into one of high achievement, both within the state and nationally.

The team looked at how students learned now and how to engage them at a higher level. Although technology was seen as the tool, the driving force was a desire to provide more relevant content and tools to engage students.

The project was launched in fall 2007 with the name "Digital Conversion." The impetus was multifaceted:

- **Close the digital divide.** While one-third of students qualified for free lunch, many others were from affluent homes and had their own computing devices.
- **Provide relevant instruction.** Students were used to accessing information quickly at home; at school they often encountered out-of-date information in static formats.
- **Ensure 21st century readiness.** Students needed the skills necessary to function in an increasingly connected and collaborative world.
- **Create real-world experiences.** Students needed to work with one another as work teams do and learn how to work cooperatively.
- **Use best instructional practices.** Much research shows that students who construct meaning learn far better than those who just absorb facts from others.
- **Improve academic achievement.** The hypothesis was that the goal of improving learning might also lead to significant gains in test scores.

So the planning began. Because of research and personal experience, the team knew that teacher empowerment and community buy-in were essential characteristics, and they included those elements in the plan.

The Timeline: August 2007-August 2010

The rollout of laptops was phased to ensure a smooth transition and working environment.

- August 2007. Four hundred laptops on carts were rolled out in Mooresville High School.
- December 2007. Every teacher in the district received a laptop. (Project RED says this is a best practice—giving devices first to teachers ensures they maintain control of their own learning and can develop integrative practices for teaching on a developmental basis.)
- January 2008. Professional development began, followed by a Summer Institute for faculty in July 2008.
- August 2008. Laptops were distributed to all students in Mooresville High School and Mooresville Intermediate School. Interactive whiteboards were installed in all K-2 classrooms at Parkview and South Elementary Schools.
- November 2008-June 2009. Phased distribution of laptops to students at various schools began.
- July 2009. A second Summer Institute took place with more than 300 teachers in attendance.
- August 2009. At this point every student in Grades 4-12 had a laptop to use at both school and home, and every student in Grades K-3 was in a classroom equipped with an interactive whiteboard.
- July 2010. The third Summer Institute took place, with continuing refinement of professional development and integration of technology into the curriculum.
- December 2010. Mooresville Graded School District viewed the initiative as one of continuing movement toward adaptation and adoption.

The Results

North Carolina State Performance and Academic Composite Data	
2007-2008	73%
2008-2009	82% (ranked 8th in state)
2009-2010	86% (tied for 4th in state while ranked 101 out of 115 in per-pupil expenditures)

In 2009-2010, Mooresville was one of only six districts that made all of its AYP targets and also had the highest number of targets met. All schools in the district were recognized in 2009-2010 as Schools of Distinction. Rocky River Elementary School was recognized as an Honor School of Excellence by the state.

Aside from the impressive improvements in education success measures, the results in Mooresville can be evaluated through the body language of the students. A visit to the schools, which have received more than 750 visitors from 150 districts from more than 25 states, is inspiring. The hum in the schools' hallways is energetic. The students lean forward into their laptops as they work.

Technology has played a significant part in improving teaching and learning through increased student engagement in Mooresville classrooms. Laptop computers have significantly enhanced the level of student interest, motivation, and engagement to learn. The focus is to engage students with instructional tools, add value to their performance, and realize improved achievement in all aspects of their school experiences.

> *"We knew that our Digital Conversion was the right move for students, teachers, and the community based on the need to create a relevant experience in our schools that will prepare students for their future."*

~ Mark Edwards, Ph.D.
Superintendent
Mooresville Graded School District

Other Education Success Indicators

Out-of-school suspensions have decreased by 64% since 2006-2007, and the go-to-college rate has increased from 74% to 75% since 2006-2007.

Mooresville Graded School District had the highest 2010 graduation rate when compared with other districts in the Charlotte region and the three largest districts in North Carolina. (The numbers reflect the percentage of students who started ninth grade in 2006-2007 and graduated by 2010.) The graduation rate was highest for every subset, including ethnicity, low income, disabled, and limited English-proficient.

Cost Savings

As one of the lowest expenditure per-student districts in the state (101 out of 115 districts), Mooresville continues to look for economies from its Digital Conversion initiative. As the district moves into this digital world, the need for traditional tools like textbooks continues to wane. As a result, Mooresville has redistributed funds to help fund the Digital Conversion.

Modeling the business environment, students now work around tables with their laptops instead of at individual desks. This change has saved approximately 20% on furniture costs. Additional cost savings have resulted from embedded graphing calculators and online access to maps, three-dimensional globes, dictionaries, libraries, thesauruses, and publications.

Statewide Adoptions of Digital Content

The textbook has long been a fixture in American classrooms, but a convergence of forces is up-ending this paradigm. With shrinking school budgets and the growing need to meet 21st century learners in their digital world, education decision makers are embracing digital solutions.

Twenty-two states currently adopt textbooks statewide. In recent adoption cycles, however, states have become increasingly receptive to digital products that offer cost savings, function as stand-alone core programs, and provide new ways to meet the needs of all students. Indiana, Oregon, Florida, and Louisiana have now adopted online science solutions in place of print materials.

The Digital Glue

Many school systems, including Mooresville Graded School District, are increasingly turning to Learning Management Systems as the glue that connects all the pieces of the teaching and learning puzzle. Schools are using their LMS to connect students, teachers, and administrators; manage and store data; build the home/school connection; train teachers; and collaborate across groups.

Learning Management Systems support anytime/anywhere interactivity, personalized learning, real-world instruction, curriculum solutions, online resources, and many more aspects of teaching and learning in today's classrooms. In addition, Mooresville teachers commented that their LMS gave them greater confidence in creating test questions to conduct formative assessments.

Project RED
REVOLUTIONIZING EDUCATION

Project RED Lead Sponsor:	**Intel**
Project RED Sponsors:	**Pearson Foundation** **Qwest Communications** **Apple** **eChalk**
Project RED Supporters:	**AASA** **AEP** **AESA** **ASBO** **CoSN** **iNACOL** **ISTE** **NAMTC** **NSBA** **SIIA** **SETDA**

Project RED
Publishing Partner

MDR
A D&B Company
Grow with us