



One-To-One Solutions: *Where Are We Today?*

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Decision making surrounding technology for the K-12 classroom has become a topic of great debate. It was only a short time ago that colleges and universities faced the question of whether or not it was appropriate to allow students to bring their own computers and phones into the classroom. Concerns about distractions and cheating initially limited their use, but quickly those concerns faded, leading to higher education classrooms today that are filled with multiple devices for each student. K-12 schools now face a similar dilemma. The percentage of children that have a mobile device is rapidly increasing. New educational curriculum is exploding into the market. Textbooks are being transitioned to digital formats, including tools to annotate, collaborate and share information. With the advent of these new and abundant sources of learning material, school leaders are faced with deciding how best to make the transition to a digital learning environment. Will they provide devices to students to initiate a one-to-one environment, allow students to bring their own device (BYOD) or enact some blended approach?

One-to-One Learning Models

The publication, “America’s Digital Schools” (Hayes & Greaves 2008), presented a series of education technology trends and predictions. Extrapolated from the study is the statistic that national one-to-one programs were growing at a rate of 4% a year. In 2011, One-to-One Institute (OTO) researched the national landscape to determine how many such programs exist. There were approximately 2000 one-to-one sites across the country and that the number was increasing quickly. Clearly, there is an uptick in one-to-one teaching and learning models – though there may be variance in how each site defines and implements their respective programs.

The ideal one-to-one solution hones in on highly personalized student-centered learning which is most expeditiously and productively accomplished through the use of personal, portable technologies. The teacher’s role changes dramatically –but is necessary - to accomplish this scenario. The teacher is crucial to ongoing student progress, feedback, guidance, resource alignment and support. Students must be considered up front when planning for one-to-one scenarios. Some are adept at independently powering up and driving their learning and progress through online or stand alone instructional delivery programs. Some are not. At the heart of well implemented programs is to know the participants and to organize teaching and learning delivery to help meet their needs and to achieve to their fullest potential. That is true personalization. There is no one size fits all approach.

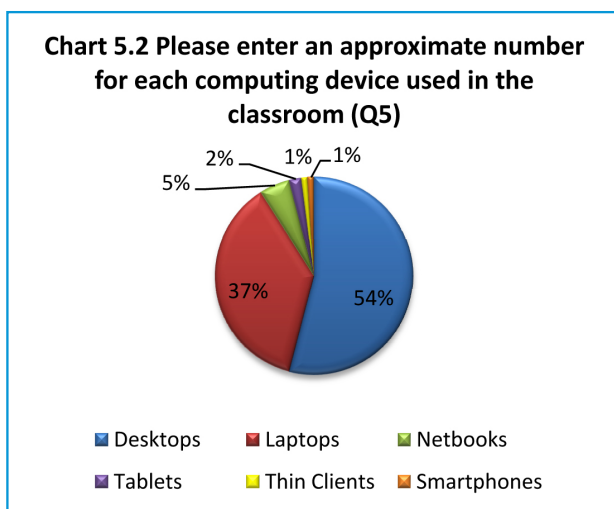
Integrating School Programs, Curriculum, Resources

For best results, the one-to-one solution must be integrated, inclusive and aligned with the other programs and initiatives happening in the school/district. Layering a new delivery model on top of all else will result in frustration and lack of fidelity to one or more goals of those programs. Skillful professional developers need to take time to make these connections and bring them to life in the program initiation and implementation. One-to-one teaching and learning combined with a guaranteed curriculum that is aligned with standards is also key to success. In developing and planning one-to-one delivery and professional development, the curriculum is the basis on which the structure must be built. Teachers and administrators need time, guidance and planning to determine effective strategies for powering up the curriculum through the use of technologies. Textbook publishers have heard and are responding to the cry for digital resources. There are two notable considerations. First, a static textbook gone digital is simply that. Publishers are trying to figure out costs and return on investment as they migrate to this kind of resource. For one-to-one classrooms, what matters is the dynamic nature of resources – no longer does the static textbook – either in digital or hard copy format satisfy the needs for today’s learner.

Second, today’s resources must be up-to-date and interactive. Digital texts that are dynamic incorporate tools to create content, add notes, edit and collaborate. ‘Sit and git; read, digest and regurgitate’ are 18th and 19th century teaching strategies. In the 21st century, teaching and learning must be learner centered, current, and focused on inquiry based techniques that require student outputs and creations as demonstrations of learning.¹

Devices

The Project RED² (2010) study of 997 schools, 23% of which were one-to-one solutions, found the following statistics regarding the type of devices deployed in this cross section of robust, ubiquitous technology sites.



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¹FCC & USDOE, “Digital Textbook Playbook”, 2012; FCC & USDOE Publication.

²Greaves, T.; Hayes, J.; Wilson, L.; Gielniak, M.; Peterson, R., *The Technology Factor: Nine Keys to Student Achievement and Cost-Effectiveness*, MDR 2010.

The study found that desktop computers continue to be most frequently utilized with the second largest population using laptops. Only 5% of the sites used netbooks, and tablets were found in less than 2% of the studied sites.

The Project RED study was released at the time ‘tablets’ such as iPads came quickly and widely onto the education scene. There is no question that the penetration of tablets in schools would be much greater than 2 percent today. Project Tomorrow (2012), for example, found that personal tablet access for middle and high school students doubled from 2010 to 2011. The attraction is that tablet devices extend the ‘personalization’ initiated by smartphones. This personalization allows students to be ‘always on’ with 3G/4G connections. It provides multiple features that support the communication and collaboration students’ desire, and entertains them through a vast array of applications that complement their lifestyle.

A national debate continues regarding laptops versus netbooks versus tablets for the one-to-one classroom. Table 1 provides a high level comparison of laptop, tablets and netbooks.

Table 1

Topic	Tablet	Laptop	Netbook
Processor	High	High	Low
Keyboard size	Low	High	Low
Screen size	High	High	Low
Hard drive	Non-existent	High	Non-existent
Disc drive	Non-existent	High	High (SSD drive)
Content Creation/Productivity	Low	High	Low
USB ports	Non-existent	By design	Non-existent
Word processing oriented device	Non-existent	By design	By design
Information Consumption	Low	High	Medium-Low
Portability	High	High	High
Price	Medium/High	Medium/Low	Low
Multi-task Operations	Medium/Low depends on which generation device	High	Low
Full Emailing Features	By Design	By Design	By Design
Adobe Flash	Non-existent	High	Low
RAM Memory Capacity	Only Apple	Unlimited	Low
Standard Office Applications	Low	High	Low
Battery Life	High	Medium-low	Medium-Low

Source: One-to-One Institute 2012.
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Regardless of device, the conversation should focus around the device functionalities needed to achieve the desired learning outcomes in the one-to-one environment. Robust laptops are still widely used because of the ability to multi-task, to use learning media, and to create rich content. As enticing as tablets are, they are still limited in most of the noted functionalities listed above. They do, however, allow for immediate access to the Internet, have a long battery life, and provide access to a multitude of applications that have been successfully used for skill development. Other benefits of tablets are that they can be used effectively as e-readers, are extremely portable and can cost considerably less than a robust laptop.

Districts may look to use a variety of these technology options when moving to a one-to-one environment. Some districts with tablet programs may still utilize computer labs so that students have the functionalities of both. In a perfect world, and perhaps the one to which we are moving, students will have uninterrupted access to three to five personal, portable technologies in their learning worlds, with bandwidth and connectivity to accommodate 'peak' usage.

They would be able to seamlessly weave digital resources among devices for supercharged learning experiences.

Case Study #1 Fresno Unified School District

Fresno (California) Unified School District didn't think it could afford to equip all its classrooms in a one-to-one program. School leaders came up with a new solution that cut both the cost and the footprint of technology down to size. It's deploying some 10,000 netbooks in selected classrooms, giving many students throughout the district a one-to-one or two-to-one student-to-computer experience in the classroom.

The netbook is small enough to fit on a student's desk without taking over the desktop and powerful enough to give students and teachers the tools they need to learn and explore. This strikes a good balance with size, price, and capacity for classroom computing.

The district's goal is that over the course of a student's entire K-12 journey, their best work will be digitally saved and gathered in a portfolio. Each student will have a DVD of their finest work, ideas, and school years' history.

Benefits that Fresno Unified is experiencing include:

- The number of computers in selected classrooms increased.
- There was the freedom to pursue individual research projects online.
- Its small footprint allows the mini notebook to share desktop space.
- There is the ability to work collaboratively in classrooms.
- Teachers are able to move from "sage on the stage" to coach/guide/mentor.



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According to Project Tomorrow's recent survey (2012), over the last few years students have begun using an increasing variety of mobile devices. Because so many students now have access to disparate devices, the conversation about the appropriate device for a one-to-one educational setting needs to be broadened to include students bringing their own device (BYOD). This subject will be addressed in more detail in a subsequent section.

Connectivity

Robust broadband connectivity is a prerequisite to implementing a one-to-one solution. It is important to accurately estimate the current and future demand requirements to ensure that there is uninterrupted bandwidth capacity. Lack of sufficient bandwidth will cause interruptions to teaching and learning, causing frustration and potentially leading to less use of the technology in the classroom.

Case Study #2 Alexandria City Public Schools

Alexandria (Virginia) City Public Schools has equipped every student and teacher with netbooks to enable the use of a learning-management system and a variety of computer-based instructional resources.

Program benefits include:

- Improved technology literacy
- Ability to test, re-teach, and re-test on state standardized tests
- Near-paperless workflow
- Access to external instructional resources, including a virtual teaching consortium
- Guaranteed quick turnaround or immediate swap for notebook PC hardware service needs
- Three-year lease program met the district's cashflow needs while helping ensure regular technology refresh

The reality of one-to-one technology access is living up to the promise. Technology is treated as an integral part of Alexandria curriculum. A Technology Services director coordinates implementation of the system's technology plan, using input from and involvement of students, teachers, staff, administrators, parents, and citizens.

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In order to forecast connectivity needs, districts must consider the variety of activities and educational applications that will be used on the network. Multimedia streaming, Internet research, online assessments and interactive digital resources can require high levels of bandwidth. It is important to understand the volume and timing of these activities to ensure appropriate bandwidth.

“Peak” demand must also be considered. This refers to the level of bandwidth needed to meet maximum simultaneous access. “For example, if a school or district is implementing a digital learning platform that relies heavily on video delivered to a student device, the school can approximate the maximum percentage of its students and faculty streaming a video at a given time (e.g. 50%) multiplied by the minimum bandwidth required to stream that content (e.g. 756 kbps, or kilobits per second). In this example, if a school has 1,000 students and faculty, the maximum bandwidth needed would be 500 mbps (megabits per second) delivered to the school ($1,000 \times 50\% \times 756 \text{ kbps} = 378 \text{ mbps}$).”² A US Department of Education tool is available to help estimate bandwidth needs (updated February 2012): http://etoolkit.org/etoolkit/bandwidth_calculator/about.

Another good resource to review on topic is from the State Education Technology Directors Association: <http://www.setda.org/web/guest/broadbandimperative>.

Traditionally, schools oversubscribe their networks by a 10:1 or even 20:1 ratio. They assume that 10 or 20 students at a time are online at any one point in time. For a one to one environment it must be assumed that all students will be online most of the time which will greatly reduce the above ratio in order to effectively provide for students’ uninterrupted access. Experts advise that ratio be 1:1 or as close to that as possible – always monitoring and staying way ahead of the connectivity curve for the district/school population. If educators and/or students experience delays and inability to get or stay connected, they will resort to the traditionally ‘known’ modes of teaching and learning.

Finally, it is always important to work with content and application providers to be sure to accurately estimate bandwidth needs with chosen content/solutions.

Funding and Sustainability

Funding is part of the short and long term planning for one-to-one programs. It must be part of the vision. Thoughtful, focused funding planning with a collaborative leadership team is imperative. First, a careful look at current technology expenditures and their return on investment is important. As in any other industry, it is crucial that districts identify funding streams as part of their technology and IT plans. This often will require recapturing resources from other areas of less importance, cost avoidance and funding reallocation. There is no silver bullet.

Reliance on soft money, i.e. grants and one-time gifts, will not result in long term sustainability. Many districts will seek a one or two time bond issue to jumpstart the initial education technologies investment. However, a long term plan for growing, sustaining, refreshing and replacing the technology must accompany initial expenditures. Reliance on repeated bond issues provides no guarantee for continued funding.

²Ibid

Case Study #3

Lake Tahoe Unified School District

Lake Tahoe is a California resort community near the Nevada border in the Sierra Nevada. The Lake Tahoe Unified School District (LTUSD) operates six schools, working collaboratively with parents and the community to provide a quality learning environment in which all students develop competence in basic skill areas and are prepared to be responsible, contributing citizens.

When some of its students did not make adequate yearly progress, Lake Tahoe USD renewed its commitment to improving test scores and increasing equity across its schools. Officials were especially interested in one to one computing – providing every child with a netbook and Internet access to promote learning – but had to move carefully because of the costs and concerns about Internet safety.

Recognizing the power of technology to engage students and improve their performance, LTUSD considered several providers and selected AT&T to assist in the launch of a pilot program to distribute netbook computers to about one-third of its student body. The powerful yet inexpensive computers provide Internet access via AT&T Wi-Fi and 3G connectivity, giving students an instant connection to information in school and at home; AT&T Web Security prevents access to inappropriate content. After seeing almost immediate increases in student engagement and achievement, officials decided to expand the program to include 3,000 students in grades three through twelve for the 2011/12 school year.

AT&T worked with Insight, a large systems integrator and hardware reseller, to help select the computers: affordable netbooks that provided significant savings over laptops.

AT&T provided a range of connectivity options for accessing the Internet that included local area networks, Wi-Fi and the AT&T mobile broadband network. This allows students and teachers to use the computers in and beyond the classroom.

To control the Internet content students can access, the district uses AT&T Web Security. The network-based service provides adjustable filtering through a web-based portal. The district can offer age-appropriate access for its 3rd through 12th graders, while preventing all from accessing offensive sites. The service doesn't require the installation and management of additional hardware, making it easy for the district to use.

Some teachers reported an immediate difference in students who received the netbooks. Typically, about half of 6th graders would complete homework assignments, but as soon as they integrated the netbooks, they saw 100 percent engagement.



Strategic planning for education technology must be a systemic solution integrated with curriculum, teaching, instruction and learning. In education environments transformed by technology, there are a variety of measures of education success and financial variables. Here are a few types of financial impact:

- Cost avoidance that leads to savings
 - Establishing more efficient non-instructional ‘business’ processes for human-resources, finance, and operations.
 - Creating a single-point student data input site to facilitate data acquisition, archiving, analysis and distribution. This would also expedite the adoption of robust response to intervention (RTI), special education, classroom, student, and media-management information systems that interface directly or through the use of middleware.
 - Adoption of free Web-based digital content to replace purchased materials.
- Cost savings
 - Using technologies that provide less expensive ways to perform tasks, e.g., using cloud based services to reduce expenses associated with storage and data back-up.

Bring Your Own Device

The growth in popularity of Bring Your Own Device (BYOD) programs hastens the need for a broader discussion about the appropriate computing device for the one-to-one classroom. Many schools are now deciding that it no longer makes sense to continue banning cell phones and other computing devices brought from home. Instead of continuing to fight an unending battle, district leaders are beginning to embrace the fact that many students have access to computing devices that could enhance learning in the classroom.

Currently, most BYOD programs do not create a site-wide 1:1 learning environment, and are not being used to transform teaching and learning. Many BYOD programs simply allow students to bring their own device to school, without much consideration as to how it can most effectively be used to enhance learning. A BYOD program can provide a tremendous opportunity to a school district to engage learners in new ways and to improve student outcomes. In order to reap these benefits, however, BYOD programs should focus on how student-owned technology can personalize instruction, and engage creative and innovative thinking in a systemic way that meets the needs of all students.

With this new perspective comes the need for new policies to address the unique issues of BYOD programs. Two districts that have successfully made the shift to BYOD are Hanover Public Schools in Pennsylvania and Forsyth County Schools in Georgia. Examples of their BYOD policies as well as other valuable information can be found on their websites at <http://byod.hanoverpublic.org> and <http://www.forsyth.k12.ga.us/byot>.

BYOD is not automatically an education technology panacea. There are numerous challenges to be addressed prior to implementing. Although it is seen as a cost effective option to achieve one-to-one, there are still many expenses associated with a BYOD program. It is necessary to provide a secure network, bandwidth and/or wireless infrastructure and mobile device management tools. Teachers will need professional development in order to effectively integrate the technology into instruction. Supplemental devices will be needed in order to provide an equitable learning environment for all students.

The cost of a BYOD program will be unique to each setting. There is currently not a benchmark figure from which we can extrapolate costs. Each setting will be implemented and supported differently. When students bring their own technologies to school, in lieu of having the district purchase them, cost savings will likely occur. To determine overall costs, the district must:

- Assess current technology expenditures to see where costs will be defrayed, reallocated or eliminated due to a BYOD implementation
- Determine the kinds of devices, platforms that will be supported by current infrastructure/network or plan for the necessary changes to support network bandwidth/connectivity enhancements
- Determine kinds of services, support and related costs to be provided in the BYOD setting
- Plan for educators' professional development for BYOD implementation
- Plan for parents'/caregivers' education and engagement of the BYOD

Student Safety – BYOD and All Technologies

Student safety and compliance with the Children's Internet Protection Act (CIPA) are also very important considerations for school administrators. In 2000, Congress enacted CIPA that directs for three types of technology funding: 1) aid to elementary and secondary schools; 2) Library Services and Technology ACT (LSTA) grants to states for public libraries; and 3) the E-Rate program which provides technology discounts to schools and public libraries. The law requires public libraries participating in LSTA and E-Rate programs to verify they are using computer-filtering software to prevent on-screen depiction of resources harmful to minors.

The same safety rules and expectations apply to BYOD sites as they do to other one-to-one iterations. Security software for school and student-owned devices is essential to protect student information and other sensitive data. School/district leaders should standardize the security software for all devices that access the school network. Mobile device management is one approach schools may look to in order to address security concerns.

Using a mobile device management solution, the district can extend content filtering policies to these mobile devices to help ensure safety. Schools can effectively do this by pushing a VPN client to the student's device to allow the student to authenticate into a school server, thereby providing a means to filter out inappropriate web sites. The district can also remotely disable cameras, messaging applications, and other applications during designated times that teachers deem inappropriate. Each district will have unique policies and protocols – but they must be aimed at the same goal of protecting students. There is movement away from the former 'lockdown' approach taken by many technology departments of old. As more technologies have permeated schools, it is recognized that students and parents/caregivers have responsibility for monitoring and choosing safe Internet sites. Clear guidance and expectations must be set forth and accepted by all users. This is often accomplished with an acceptable use policy, signed document, by teachers, students and parents/caregivers. A helpful site is the AUP 2.0 Site at <http://landmark-project.com/aup20>.

In a BYOD and any one-to-one environment, districts may also employ classroom management strategies that provide for scanning of students' site access, either via software or physical presence. Districts should recognize that students need consistent reminders and reinforcement about online safety. Some teachers present mini-lessons on digital safety. "Cybersmart" (www.cybersmart.org) is one website that is used to develop these lessons. Educators need to be consistently 'teaching' students and parents/caregivers about protection, safe measures, etc., for engaging in online creations, collaborations and communications. We are definitely in the era of personal responsibility and accountability for using technologies.

BYOD – Parents'/Caregivers' Perspective

Parents and caregivers have their own concerns with BYOD programs.

1. Security

Parents/caregivers are concerned about keeping their children safe online. It will be important to explain to parents how the district intends to filter student Internet access, as well as how teachers will monitor what students are doing on their devices.

2. Loss, damage or theft of device

Many parents/caregivers seem to think their child is not responsible enough to take care of an expensive electronic device. It will be important for the district to explain when, where and how student-owned devices will be used during the school day and what procedures will be in place to ensure devices are kept safe and secure.

Theft is also a concern for many parents/caregivers. Therefore, how personal devices will be insured and protected on and off school property will need to be addressed between home and school.

Hanover Public Schools, PA, for example, addresses this issue directly with parents/caregivers, but also has instituted a Digital Citizenship program for all of their students. The program is based on the nine elements outlined by the organization, digitalcitizenship.net, and revolves around the concepts of “Respect, Educate, and Protect.” The ninth element deals specifically with digital security and self-protection. It states,

“In any society, there are individuals who steal, deface, or disrupt other people. The same is true for the digital community. It is not enough to trust other members in the community for our own safety. In our own homes, we put locks on our doors and fire alarms in our houses to provide some level of protection. The same must be true for the digital security.”

3. Appropriate use of technology

Many parents/caregivers are not clear why technology is necessary in the classroom, or how it will be used in appropriate ways. Significant parent/caregiver education is needed to help them understand the tremendous benefits of tech and learning. During this education campaign, it will be important to demonstrate to parents/caregivers how the world is changing, and the imperative for schools to teach students how to use technology ethically, as well as for the acquisition of information, collaboration, productivity and development of a skilled workforce. For stakeholder messaging examples, see:

- <https://sites.google.com/a/godfrey-lee.org/1-1-learning-initiative/>
- <http://www.kent.k12.wa.us/Page/3350>
- <http://www.wlcsd.org/programs.cfm?subpage=359522-for>

4. Cost and Equity

Some parents are not able to afford technology, or feel this should be the responsibility of the district. Equity in BYOD programs is an important issue to address. Even with a BYOD program, the district should consider providing some devices for students who would not be able to participate without them. Forest Hills School District (OH) and Walled Lake Consolidated Schools (MI) provide a common example of how districts address the equity issue. Both districts provide laptop carts with devices that students who do not bring their technology can use. BYOD, then, becomes a parental choice, with the district suggesting that a student owned device provides a more personalized experience. Most districts that provide supplemental devices also do not allow the students to take the devices home.

Research Says

There is another continuing national debate regarding the return on investment of educational technology. Many one-to-one programs over the past decade have not seen the anticipated return on investment or academic benefits anticipated by educators. There is a growing body of evidence, however, that one-to-one computing programs can impact student achievement in a number of positive ways. Bebell and Kay (2010) in their study of the Berkshire Laptop Learning Initiative, for example, reported a significant increase in student engagement and motivation. Although the researchers were not able to build a direct link between student engagement and higher academic achievement, the importance of motivation and engagement to student success has been clearly documented (Christenson et al., 2008).

In Texas, Dr. Kelley Shapley and her colleagues at the Texas Center for Educational Research (TCER) examined factors such as student engagement, as well as achievement. They studied 22 schools in a Texas one-to-one program, the Technology Immersion Pilot (TIP). In their first year evaluation, teachers reported that student engagement and motivation had increased, while student disciplinary actions decreased. By the third year evaluation, TCER was also able to begin tracking achievement trends on the Texas Assessment of Knowledge and Skills (TAKS) tests. They found that technology immersion had a statistically significant effect on TAKS mathematics achievement. They also found that students who used laptops more extensively for learning had significantly higher TAKS reading and mathematics scores (Shapley, et al., 2008).

Lowther, Ross and Morrison (2003) also found an increase in writing scores and problem-solving skills for students in the one-to-one program in their study of middle school students in the Anytime, Anywhere Laptop Program in Walled Lake Consolidated Schools. Likewise, Silvernail and Gritter saw significant improvement in writing scores on statewide tests for students in Maine's laptop program.

Two common themes surface from these research findings. First, students need to use technology on a regular basis for it to have an effect. Secondly, it needs to be used effectively in order to realize the desired academic benefits. These factors are strongly supported by Project RED's research (2010).

Project RED research

The Project RED research team found that very few schools in America have implemented technology in effective ways. Their 2010 report, *The Technology Factor: Nine Keys to Student Achievement and Cost Effectiveness* was the first national research focusing on academic results and the financial implication of education technology. The research shows that very few schools were using technology in all academic classes on a daily basis. If implemented properly, however, one-to-one programs can lead to improved student achievement and a significant return on investment.

Case Study #4

Mooreville Graded School District

Mooreville is a blue-collar former mill town in suburban Charlotte.

In 2007, Mooreville Graded School District launched a one-to-one program called “Digital Conversion”. Laptops were provided to every 4th through 12th grade student and all licensed staff across the district for their use at school and at home during the school year. Although technology was seen as the tool, the driving force was a desire to provide more relevant content and tools to engage students.

Results from the program quickly showed improvements in student engagement. By the 2009 school year, Mooreville was one of only six districts that made all of its Adequate Yearly Progress (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. 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. Furthermore, Mooreville had the highest 2010 graduation rate when compared with other districts in the Charlotte region and the three largest districts in North Carolina. The graduation rate was highest for every subset, including ethnicity, low income, disabled, and limited English proficient.



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There are four key findings the Project RED research reveals about using technology in schools to improve learning performance and financial outcomes:

1. **Personalize learning for all students through *frequent, appropriate* use of technology integrated with curriculum and instruction in all classrooms and other learning places.** Technology cannot be viewed as a supplement. It must be an integral part of students' lives in the classroom and must be integrated in meaningful ways into the core curriculum. In Kent Technology Academy, for example, students use technology in creative ways to do things that wouldn't be feasible through traditional means. Students in Kent are using simulations in their learning, are creating professional level multi-media productions, are collaborating in dynamic ways within and outside the classroom, and are connecting in meaningful ways to the world outside the school.
2. **Make professional learning and effective use of technology high priorities for administrators and teachers.** High-quality professional learning for teachers is key to using technology to its fullest potential. To truly personalize learning, and create student-centered learning environments, educators must overcome their own insecurities regarding technology and be able to confidently integrate the technology into every aspect of their instruction.

Transformation of this kind can be a slow and difficult process for some teachers, and administrators must facilitate the learning. It is important, for example, that administrators provide a non-threatening environment in which teachers feel free to try new instructional strategies, debrief the experience with colleagues, and make the necessary adjustments to improve their effectiveness. This type of professional learning and growth does not happen through a periodic workshop for teachers. The process must be ongoing and built into teachers' job expectations and regular work day. Online communities of practice, such as edweb.net, provide continuing education and opportunities for peer dialogue to help teachers and administrators learn from one another.

3. Use technologies such as social media, games and simulations to engage students and encourage collaboration. Today's students have been learning, communicating and collaborating through technology their entire lives. It is essential to leverage the extraordinary power of technology to connect with students, excite them about learning and empower them to lead their own learning.

4. Use weekly online assessments to gauge student learning and then tailor instruction for personalized learning experiences. Technology can assess each student's learning on an ongoing basis and provide valuable information to the student and teacher. Teachers need to learn to use this data to guide instruction, remediation and to accelerate learning when appropriate.

Conclusion

Many educators today recognize the moral imperative for the integration of education technology in schools-and many value the concept of one-to-one teaching and learning. There is much to be said for having reached that 'attitudinal' tipping point. The road work to bring this to fruition is the hard part. Careful planning, developing shared vision, goals and strategic plans, allocating short and long term resources, and developing human and infrastructure capacities is on the short list of what districts must do to be successful implementers of a one-to-one education solution.

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