



White Paper
Education
One-to-One Computing

Five Years, 30,000 Laptops

Henrico County Public Schools
Virginia, U.S.A.

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About Henrico County Public Schools

- Located just outside Richmond, Virginia
- 47,071 students, including 14,096 high schoolers
- 31% free lunch, 8% reduced-price lunch
- Approximately 15% special education students
- 66 schools, including 9 high schools
- 3,520 teachers
- Operating budget of \$411 million
- Per-pupil expenditure of \$7,768
- Recipient of the U.S. Senate Award for Continuing Excellence, nine U.S. Dept. of Education Blue Ribbon School Awards, and three 2005 awards from the National Association of Counties

Introduction

Insights from a Pioneering Leader of One-to-One Mobile Computing

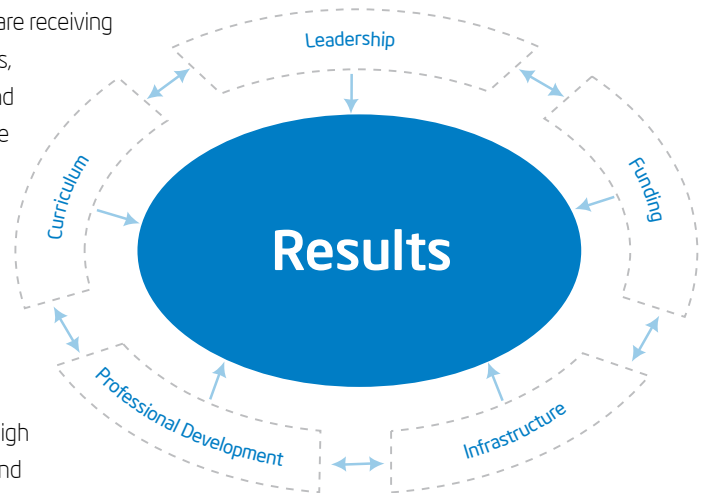
Henrico County Public Schools was one of the first and largest districts to issue a laptop computer to each middle and high school student, teacher, and administrator. They managed the feat while spending approximately \$1,700 less per pupil than the state average. See how they did it, how teaching and learning have changed, and why they never want to go back.

With roots stretching back to 1611, Henrico County, Virginia, is one of the most historic regions of the United States. But its children are receiving the most modern of educations, thanks in part to a Teaching and Learning Initiative based on the view that ubiquitous, mobile access to computers and the Internet is as essential for learning and teaching as pencils and paper were for an older generation. The Henrico County Public School District equips all middle and high school students, all teachers, and administrative staff members with wireless laptop computers.

As a result of the initiative, teaching has become more active and individualized. Students are better organized and more engaged in their learning. They graduate better prepared to become 21st century citizens and critical thinkers. “You can’t think critically if all you do is take in information from a textbook,” says Aaron Spence, Ph.D., Principal of Deep Run High School. “But if you can interact with the world through a computer and

do things you could not have done sitting in the classroom, that’s a really powerful way to help students learn. And that’s the bottom line. It’s all about learning.”

Success hasn’t always come easy. It required extensive planning—and adjusting when reality didn’t match the plan. It demanded leadership at all levels and risk taking by teachers who had to become learners. It rested on a shared belief expressed by individuals across the district: this is the right thing for our students.



In this white paper, Henrico County Public Schools shares key learnings from five years of one-to-one computing experience, with a focus on the high school level. This paper follows the framework outlined by *Blueprint Solutions for K-12 One-to-One Computing Initiatives*,¹ which identifies six essential components of successful one-to-one computing: leadership, funding, infrastructure, professional development, curriculum, and results.

¹Intel, 2005. www.k12blueprint.com



Fred Morton

Leadership

"We can take kids places we've never been able to before, and open up the world in a brand new way. But it's important to do it in a way that connects with the world that the kids are moving into. We never want to be using technology just because it's cool. It always has to be about learning."

Fred S. Morton IV
Superintendent

For successful one-to-one computing, leaders at multiple levels must create a vision, enlist the support of key stakeholders, and realign policies. Communication, team building, and leadership are essential, both initially and throughout the project. Henrico developed a student-centered vision and uses a variety of methods to communicate and build support.

Establishing the Vision

21st century students live in a world transformed by technology. Cell phones and iPods* are second nature to them, and the Internet has brought the world into their living rooms with an immediacy that television could never match. Advances in computer and communication technology have reshaped the workplace and inaugurated an era where job competition can come from any part of the planet, and work colleagues may be many time zones away. Success in the 21st century often requires not just mastering basic computer skills, but also being able to filter and analyze floods of information, synthesize it into new

knowledge, communicate it effectively, and collaborate with individuals from different cultures and backgrounds.

Henrico County Public Schools looked at those requirements—and at its mission of preparing students to be 21st century citizens—and drew a clear conclusion: technology is critical to fulfilling our mission, and the district needs to provide equal access to it. "There's a tremendous amount that you can do with technology to enhance teaching and learning, but you can't do it unless everyone's got access," says Fred S. Morton IV, who joined the district as superintendent four years into the initiative.

Henrico County Public Schools Mission

To provide a nationally recognized educational program and staff to develop 21st century citizens who can achieve full development of their potential and, as critical thinkers and lifelong learners, exhibit through their character and values, a commitment to their community and the nation, as well as personal integrity, which will enable them to meet the challenges of change.

Bordering the city of Richmond, Virginia, Henrico is a diverse district that encompasses farmlands and office parks, urban areas and suburbs. While many of its families are middle or upper-middle class, the district population also includes 39 percent who receive free or reduced-price lunches. Half its students are people of color.

When the initiative began, some 40 percent of district students did not have a computer at home. High schools had computer labs and an average of five desktop computers in each class room, but the district wanted to move to the next level.

Communicating with Stakeholders

Henrico established a cross-functional leadership team to create the vision, build consensus, and lay out plans. "It's not best practice if people feel like you're forcing it on them," says Dr. Spence. "We've worked hard at every phase to be open about what we're doing, address concerns, and obtain buy-in."

Led by then-superintendent Mark Edwards, the core team included the district's director of technologies, the assistant superintendents of curriculum and finance, and several principals. During in-depth conversations with school board members, teachers, students, parents, and the broader community, the team explored skills needed for 21st century teaching and learning, as well as key implementation issues.

The focus was on student needs. "The student's voice has to be the strongest in all of this," says Assistant Superintendent for Instruction Lynn H. Thorpe, Ed.D. "We need to make sure that we listen to our students and we include them as we think about what is valuable in our classrooms.

If our purpose is to provide students with opportunities to grow and become productive citizens, then we have to listen to them as they become our advisors, not just with this initiative but with any initiative."

Teachers

The initiative enlisted strong support from the business community and from many teachers, although some felt threatened. "Many teachers were not of the generation that had looked to electronic resources as their source," recalls Dr. Thorpe. "They were still bound by the textbook as the resource. Many were excited by the opportunity, but some were not."

In response, Henrico's leadership team worked hard to create a safe environment for teachers to be learners. "I have to live what I claim to be," says Superintendent Morton. "I'm the Chief Learning Officer, and I model it. We're not saying, 'Do it like I do.' We're saying, 'It's okay to risk and be the learner instead of the expert. It's okay to ask questions. The only bad question is the unasked question.'"

Parents

Superintendent Morton describes parents as a key stakeholder and often "the missing component" in discussions of one-to-one computing. While surveys confirm that a strong majority of parents support Henrico's initiative, a contingent of parents has criticized it on several grounds. The issues include a preference for traditional methods, concerns over what children may be exposed to on the Internet, and a belief that providing equal technology access is not the district's responsibility.

Five Years, 30,000 Laptops

"We have a very diverse community, and you can't satisfy everybody," says Dr. Spence. "But we work hard to make sure all voices are heard and taken into account. We bring parents into study committees, seek their input when we're forming policy and show them what's happening in the classroom. It's a constant effort, and an important one."

Henrico uses the Web and e-mail as important communication vehicles, but is quick to point out that these methods don't replace phone calls, written letters, and face-to-face communications, whether with individual parents or through forums such as the PTA. The district publishes extensive information about the initiative on its Web site. In addition, it maintains an e-mail "blast list" of school, parent, and community members that it can reach quickly to share breaking news or provide solid information on rumors.

Establishing Policies

Leadership includes defining appropriate behavior and establishing policies that keep students safe without limiting the power of the computer and the Internet as learning tools. "If you give students free reign, they're going to test the limits," says Eric L. Jones, Director of High School Education. "We want to keep students safe and keep them from going places they shouldn't. The question is: how much can you lock the machines down and still retain their full educational value? It's a balancing act."

What sites get filtered? At Henrico, that decision is based on a site's pedagogical value. "We don't want a piece of software or an individual who knows nothing about what's going on in the classroom and nothing about instruction deciding what is appropriate and what's not," Jones explains. "If a teacher finds a great Web site that we've blocked, we have a process in which a team of teachers and technology people reviews the site and makes the call."

Before students are issued a laptop, they and a parent must sign an Acceptable Use and Internet Safety Policy that delineates expectations for laptop use. A chapter in the student code of conduct describes acceptable uses and behaviors relating to the laptops. Among other restrictions, students are forbidden to play games or access instant messages, chat rooms, forums, e-mail or message boards during the day. Cyber-bullying and changing the system configuration are forbidden at any time. The code of conduct also lists consequences, which range from a student conference through a recommendation of expulsion.

The district also encourages parents to talk to students about safe and responsible online behavior, monitor their student's online activities, take advantage of available filtering solutions, and encourage children to share any concerns about content or behavior they encounter online.

The Teaching and Learning Initiative

- Equipped all teachers and administrative staff with wireless laptops and provided a range of ongoing training opportunities.
- Leveled the playing field for technology access by deploying 30,000 laptop computers to middle and high school students, as well as to faculty and administrative staff across the district.
- Provided wireless Internet access to 65 school buildings and 10 public libraries through 1,800 Cisco* access points.
- Facilitated inexpensive Internet access for families, making at-home access feasible for all students.

Funding

“We did not add any additional dollars outside of our budget process. We did not have any special tax assessment. We didn’t have any special appropriations. We stayed exactly within our growth plan, our funding plan, with our local government.”

David Myers
Assistant Superintendent
for Finance

Funding challenges for one-to-one computing initiatives include aligning resources, acquiring technology, and protecting the investment. Henrico implemented one-to-one computing while spending approximately \$1,700 less per pupil than the state average, according to David Myers, Assistant Superintendent for Finance. Myers says the total cost of the initiative is around \$7.5 million annually, which comes out to around \$300 per year per pupil, or around 4 percent of the total budget.

Aligning Resources

The Henrico County Public School District deployed its Teaching and Learning Initiative without resorting to special tax levies or funding sources. The initiative has been funded by a combination of general, state, and federal monies, with around one third coming from federal and state funding sources.

“It’s not easy to realign resources enough to cover four percent of the budget when about 85 percent is tied up in salary and benefits,” says Myers. He believes the district has been helped by the deep support it enjoys from parents and businesses, as well as by its success in accommodating special needs students in mainstream settings. Both factors give the district more room to maneuver.

“But the real foundation for our success,” he adds, “is that throughout the system, folks have been willing to accept additional roles, whether it’s teachers who learned to build a Web site on their own or assistant principals who were willing to assume responsibility for coordinating fee collections.”

The district’s early planning and communication activities paved the way for the high level of cooperation. “Because we had a comprehensive rollout plan and communicated it well, everyone was on board with what we were trying to do and the fact that it was going to create more work,” Myers says. “We all kept focusing on the fact that we were going to provide a new learning opportunity that students had never had before.” The district also restructured central office and administrative workloads to reduce demands on the schools.

Acquiring Technology

Henrico leases its laptops on a 4-year cycle with 0 percent financing. All student laptops are shipped at the start of the lease cycle, and the district loads software and issues them to students when school starts in September. At the end of the school year, students turn in their laptops; the district refurbishes them and reissues each laptop to its previous owner at the start of the following year. Seniors’ laptops are passed down to incoming freshmen, and any extras are redistributed across the district to schools that are growing.

Protecting the Investment

Henrico protects its technology investments by stamping each laptop with an antitheft tag; the district collaborates with local police and pawn shops to minimize theft and loss. “At the beginning of every year, one of our police officers speaks to students, not just about theft but also things like Internet safety and staying away from predators,” says Jones. “If a laptop is lost or stolen, we’ll go through the police process and report it, but theft and loss haven’t been a huge problem.”

Henrico requires parents to pay a \$50 fee per student, but realized even that amount was a significant inhibitor for many families. “At some of our at-risk schools, even several years into the program, we had 30 percent of our students without a laptop,” says Superintendent Morton. “If you’re going to do one-to-one computing, you really have to include every student.” The district’s Education Foundation was enlisted to provide scholarships to cover necessary fees.

Infrastructure

“The transition to the Intel® platform has been a good experience. We thought a lot of teachers would be upset about it, but they grabbed it and ran with it. A lot of teachers and students already knew how to use the Intel and Windows* platform, so there was not much of a learning curve. It’s been very successful.”

Lloyd Brown
Director of Technology and Information Services

Infrastructure for one-to-one computing consists of the laptops themselves and the underlying network. Districts must consider the costs and processes necessary not only to acquire technologies, but also to issue, manage, and support them. Henrico has succeeded by keeping educational goals paramount and fostering collaborative working relationships between instructional and technical staff.



Laptops for All

After in-depth planning and evaluation, Henrico began its Teaching and Learning Initiative by issuing an Apple Macintosh* portable computer to each high school and middle school student. In 2005, with its 4-year lease coming up for renewal, the district decided to shift to Intel® processor-based Dell* laptops for its high school students. The 4-year contract brought 15,800 Intel-based laptops into the schools at an announced value to Dell of \$17.9 million.

The new laptops come with a 1.30 gigahertz (GHz) Intel processor and built-in wireless card. Laptops are configured with a 14.4-inch display and a 60 gigabyte (GB) hard drive and weigh just 5.3 pounds with the CD drive.

Before new laptops are issued, district staff add bar code identification tags and Stop Theft antitheft tags, and install more than 20 software applications. Software literally runs the gamut from A to Z—in this case, from Adobe Acrobat* for viewing formatted documents, to the geometry package Zirkel*. Other applications include the full Microsoft Office Professional* suite, a comprehensive set of math applications, Java* for software development, and multimedia applications such as Flash*, Power DVD, QuickTime*, and Shockwave*. Each student also has a 1-GB virtual digital locker on the district’s servers for backing up critical files.

Safety and Security

Keeping students and resources safe is a priority for any one-to-one computing deployment. Henrico uses a security suite on its laptops that includes pop-up blockers, firewall software, commercial virus and anti-spyware applications. Laptops run the Microsoft Windows XP* operating system with Service Pack 2, which contains a variety of security features. To support established behavior policies, the systems are configured to disallow e-mail functionality during the school day and prevent students from installing their own software.

The district combines server and client filtering solutions from 8e6 Technologies to shield students from inappropriate Web content. Four 8e6 R3000 Internet Filter appliances, each running on dual Intel® Xeon® processors, restrict access to forbidden Web sites while students are connected to the Henrico County Public School network. The 8e6 Mobile Client runs on each laptop and performs a similar function, even if the student connects through an external service such as AOL*, Comcast*, or Earthlink*. The laptop's browser history cannot be deleted, adding further accountability.

Making the Transition

Migrating to the Intel platform for its high schools "wasn't rocket science," according to Lloyd Brown, Director of Technology and Information Services. "We were simply being open-minded," he says. "We didn't want to get into platform battles. We looked at what the industry was using and did a teacher survey, and tried to figure out what would be best for our program and our students." The district went through an open and competitive RFP process; Dell and Apple were the final bidders, and Dell won.

The transition process was straightforward, particularly for students. "We brought some students in when we knew we were going to have the Dell contract and asked them what they needed to learn," recalls Dr. Spence. "They all told us they were used to working with PCs and

they didn't need a lot of instruction." Teachers received more intensive training, and Brown's team developed scripts to transfer files and system preferences to the new systems.

Access Anywhere

Henrico undertook extensive, up-front planning before beginning its laptop initiative. Even so, its network and server infrastructure proved insufficient to handle the demands of tens of thousands of students hitting it simultaneously. "That was definitely a major surprise that first year," recalls Brown. "No district had done one-to-one computing on this scale. We were truly on the bleeding edge."

The district quickly added capacity. Today, it provides ubiquitous Internet connectivity via 1,800 Cisco* wireless access points (APs) across 65 Henrico County Public School buildings. Each classroom has an AP, with additional APs providing the ability to get online in cafeterias, school libraries, and other common areas.

Henrico standardized on Cisco wireless infrastructure because of the company's support for industry standards, its extensive technical resources, and its commitment to work through technical issues and strengthen the networking infrastructure. Brown says the standards-based network enables the district to connect a wide range of devices, including laptops outfitted with customized gear to accommodate the requirements of special needs students. "Whatever our teachers need to do, our network should be able to support it," he comments.

Wireless APs connect over a 100 megabit-per-second (Mbps) wide-area network to the district data center in Newbridge, Virginia, and then out to the Internet via another 155-Mbps pipe. Brown says the network moves 70–80 MB of Internet traffic daily, despite the extensive use of Internet caching engines and local applications.

Five Years, 30,000 Laptops



Beyond the School

Reflecting its commitment to bridge the digital divide, the district has worked to help students get online outside of school. Based on parent input, the district arranged with a local Internet service provider, Access Technology of Richmond, to offer inexpensive dial-up access to families of district students. Again, financial support is available for families that cannot afford the charges. Students whose families are already connected can use their existing services to get online.

The district has also worked with 10 public libraries to install APs and connect them to the district's network. As a result, students can access the Internet from the public libraries and get to their virtual storage locker at the school's servers; students are still filtered through the school's Internet filtering technologies. Parents can have their child's laptop configured to prevent Internet access via any network other than the Henrico County Public School and Henrico County Public Library wireless networks, thus giving students the benefit of the district's filtering software 24/7.

Day to Day

The district handles much of the work of managing and repairing the laptops in-house—an approach that develops local expertise and avoids the expense of a third-party service company. Under Brown's guidance, it also produces a streamlined process that supports the district's educational objectives. "At every step, you want the technology to meet the educational goals," says Superintendent Morton. "A key learning has been that if you treat laptops as essential for teaching and learning, you need to keep them in the hands of students 24/7 and you need an accelerated repair cycle."

Initially, repairs were viewed as insurance claims. Problem laptops were shipped off-site to be fixed, and central office staff assembled claims-processing paperwork for each problem. Today, each Henrico high school has its own help desk, where Brown's support technicians oversee student assistants who diagnose and fix problems and flag any systems that need further repairs. "This is a win - win," says Brown. "It's great hands-on experience for the student assistants, it keeps costs down, and it gets the laptop back to the student faster."

The district uses Altiris* remote management software, so when student tech scans a laptop's bar code identifier, the software reports any problems. Close to 40 percent of issues, including those related to software, keyboards, hard drives, and wireless cards, can be resolved at the school. Laptops needing to be sent for repairs are generally back in the student's hands within 24–48 hours. The district has negotiated with its vendors to maintain a stock of loaners so students have a system to use while theirs is in the shop.

Vendor Relationships

Henrico representatives say the district has received extensive support from its vendors and views them as technology partners, not just suppliers. Apple, Cisco, Dell, Intel and Verizon are strategic collaborators; the district also works with a number of security and educational software vendors, which are often eager to try their products in Henrico's demanding environment.

Vendor relationships extend well beyond just supporting the laptops and networks. For example, Intel and Dell are working with Henrico on ways to measure student performance, evaluate next-generation classroom technologies, and expand the network's community connections via WiMAX* or cellular broadband technology. "Dell and Apple have been great partners, both in providing competitive pricing and in being receptive to creative ways to keep the units in service and keep repair costs as low as possible," says Brown. "They've been very responsive and eager to work through any issues that come up."

Intel, too, plays a strategic role, according to Brown. "Intel's support has been an outstanding asset, particularly in keeping us up-to-speed on new technologies and helping us do our long-range planning," he says. "They've stepped up to the plate on multiple occasions to provide additional resources and help us accomplish things on our wish list."

Cultural Factors

As with other aspects of change, cultural issues are as important as technologies, if not more so. Henrico personnel say the collaborative working relationship between its technology and instructional staff has contributed to their success.

"You see a lot of districts where there's an adversarial role between technology and instruction because they're battling for resources and for control," explains Jones. "In our district, Technology and Information Services falls within the Division of Instruction, and many of their employees are former classroom teachers. If you want to do one-to-one computing and you don't have a collaborative spirit, it would be very beneficial to work on developing it."

Brown agrees. "Henrico is family," he says. "We support each other 120 percent. Our success is because we all work together as a team. I've seen districts where the instructional people barely talk to the technical people. They would have a hard time succeeding at one-to-one computing. It's not a technical issue—it's a fundamental cultural issue."

Professional Development

“The technology has to work. After that, professional development for teachers has to be first and foremost. If you give laptops to teachers without giving them any professional development, you might as well just throw them in the trash can. They’re not going to use them. It’s too big a leap.”

Eric L. Jones
Director of High
School Education

Professional development for one-to-one mobile computing encompasses all the activities and approaches needed to empower teachers to fully embrace technology and make it an integral part of teaching and learning. “You don’t want teachers thinking, ‘I’m teaching technology today,’” says Dr. Spence. “You don’t want it to be an exercise in using technology but an exercise in teaching using technology.”

Teachers as Learners

Henrico’s Teaching and Learning Initiative put teachers in the role of learners. “Just as you have diversity and a need for differentiation in the classroom of students, you had that same need for differentiation and that same diversity of learning with the teachers,” says Dr. Thorpe.

Acknowledging the diversity is a first step in addressing it, according to Jones. “We explicitly say, ‘There is a continuum of skill sets, from maybe a 30-year teacher that’s never used a computer before, to somebody that’s doing things with technology that are beyond what any of us dreamed,’” he says. “It’s okay to be wherever you are along that continuum, as long as you’re moving forward.”

Connie Fuller exemplifies the “teacher as learner” paradigm shift—and she’ll be the first to tell you it wasn’t always easy. Fuller teaches 11th grade English at Deep Run High, both advanced placement classes and several classes that include mainstreamed special needs students. She entered the district as a 24-year teacher when the Teaching and Learning Initiative was already in full swing.

“I didn’t even know how to check my e-mail when I came here, and it was intimidating to go into an environment where I’m not only learning the new curriculum and the new school, but all of the new technology,” she remembers. “Posting grades, creating a Web page to post our homework—it was just an incredible amount to learn. There were nights I went home crying. But I knew I wanted to teach at this school, so I accepted that I was going to have to come up to the 21st century, and it has made me a far better teacher.”

Two years later, Fuller has mastered the challenges and loves incorporating the laptops into her teaching. Among other tools, she creates inquiry-oriented “WebQuests” that require students to conduct research on different Web sites. One of her WebQuests provides the equivalent of 30 pages of background information on Arthur Miller’s *The Crucible* and the locale in which the play is set—much more detail, she says, than students would stay engaged with in textbook form. “Kids follow hyperlinks that let them take a virtual tour of the Salem Museum and read actual trial transcripts of some of the trials,” she explains. “It’s very interactive, very interesting, and the kids love it.” By the end of the year, Fuller has students work in small groups to create their own WebQuests.

In-School Experts

An important contributor to Henrico’s success is that each high school has a technology teacher-trainer and facilitator who combines past experience as a master classroom teacher with advanced technology skills. These technology trainers have been key in developing content and lessons as well as in modeling best practices and helping classroom teachers identify ways to incorporate technology into their teaching strategies.

“This technology trainer is an instructional model for using technology as a teaching tool across the curriculum, which for a secondary school is a very demanding position,” says Dr. Thorpe. “These individuals also play a significant role as staff developers within each school, on site every

day and in the classrooms. It is a tremendous responsibility, and much credit goes to them for helping their teachers move forward.”



Connie Fuller

Building Skills and Enthusiasm

Henrico has used a constructivist approach and a variety of methods to help teachers build on their current skills and move to the next level.

Formal coursework has covered everything from operating the machines to creating videos and Web sites. Ongoing education is offered through a variety of summer opportunities as well as courses in-service training courses. Teachers earn college credit, and tuition payments are reimbursed for related coursework.

To accommodate the continuum of skills, the district has offered tiered courses, particularly during the first few years. “Everything has a beginner, an intermediate, and an advanced level,” recalls Eric Jones, who was a novice principal when the Teaching and Learning Initiative kicked off and a curriculum writer for Henrico’s first U.S. History materials. “If you’re doing the same course for someone who’s excited about creating their first PowerPoint* foils and someone who’s doing amazing things with Movie Maker* or Dreamweaver,* they’re both going to be frustrated and neither one is going to get much out of it.”

Content specialists and technology trainers work with teachers throughout the summer and during the school year educating and reinforcing teachers on how to use technology within the classroom. The district has also set up hot lines to answer technology questions.

Motivation

The wide range of skills among teachers is matched by an equally broad range of attitudes—from enthusiastic to reluctant. Schools use a mix of formal expectations and informal rewards as motivators. Technology trainers use faculty meetings to showcase the work of trailblazers, both to honor their success and to inspire and inform other teachers. The Henrico County Public Schools television network develops programming that highlights innovative uses of technology, giving well-earned recognition to high achievers and letting parents know the types of work their children are doing.

“We also send folks to conferences nationally to talk about what’s going on in their classrooms when we have the opportunity to do so,” Dr. Thorpe says. “That builds a sense of pride within the district and brings attention to what best practices are being developed locally.”

Creating a culture that values active learning and student engagement over passive, right-answer thinking takes time. “It’s a process, and you have to keep working at it,” says Dr. Spence. “It’s a paradigm shift. You show people ways to use the technology to support active learning and give them time to practice. You find your trailblazers and have them share with their colleagues and get their peers to tap into their own creativity in using the technology. We’re by no means done with this transition, but we’re all talking about ways we can do this better, and that’s exciting.”



Curriculum

“Accountability has brought a lot of discussions around what we were teaching. Technology sets us up to focus on how we’re teaching. That’s been a powerful paradigm shift.”

Aaron Spence, Ph.D.
Principal, Deep Run
High School

What do teaching and learning look like in a one-to-one computing environment? Like other Virginia school districts, Henrico follows the state-mandated curriculum framework spelled out in the Virginia Standards of Learning. But the Teaching and Learning Initiative presents new opportunities to teach the curriculum in ways that promote student-led, independent learning and collaborative, research-focused projects. And while Henrico leaders are quick to say the district is still learning and evolving, they point to a range of ways in which the initiative has indeed led to deeper and more satisfying methods of teaching and learning.

A Broader Shift

Henrico’s leaders say one-to-one computing fits into the broad paradigm shift that’s been in progress for a number of years—the evolution from the teacher as the answer person to the teacher as the facilitator of learning, and from teaching the content to a higher level of attention on the learner.

“Laptops enable us to move away from teacher-centered, teacher-directed teaching to

student-centered, student-engaged teaching, and from passive to active, exploratory learning,” says Dr. Spence. “As educators, we get to ask ourselves some very exciting questions. How do I get away from being in front of the classroom like we did back in the Eisenhower era? How do I let kids tap into what is interesting to them, what is powerful to them? What will speak best to the way that they’re able to learn, the way that they interpret the world? The technology opens up some exciting answers to those questions.”

Maryann Davina, who's in her eighth year as a history teacher, agrees. "The laptops are another instructional resource in your repertoire—a tool to reach more students, meet them where they are, and get them to be successful learners," says Davina. "Kids come to my classroom already set in their mind that they don't want to learn about history. It is not reflective of their life; it doesn't connect to their life. With the laptops, there are so many ways to help them connect history to their daily lives, and show them that history is more than just dead white presidents."

The laptops are a great motivator, according to Davina. "I ask students to open their Dells, and they get excited. It's so much better than me just standing in front of the classroom and lecturing," she says. "I can stand here and say, 'Lewis and Clark went from point A to point B,' but now they can go to the National Geographic Web site, see original documents and diaries, and trace the journey step by step. What were Lewis and Clark doing in St. Louis? What were they doing at the Pacific Ocean? What were they doing when they saw the Mandan Tribe? It's so much more realistic, and a much more in-depth process."

Engaged Learning

Henrico's leaders say having a wealth of resources at every student's fingertips help kids engage deeply with their learning and make broader and deeper connections to the world in which they will live as 21st century citizens.

"I can ask my Government class to find and analyze one person's perspective in support of this issue and one person who opposes it, and they can do that very quickly," says Vincent Boggs, a fourth-year History and Government teacher at Varina High. "When I taught a unit on Imperialism and introduced the poem, 'A White Man's Burden,' one student instantly, without my asking, found a response called 'A Black Man's Burden' and brought that into the discussion.

That's real education, when they're seeking out information on their own, and it has a lot more meaning than me giving them the facts and them writing them down."

The wealth of resources takes teachers out of the traditional role that Dr. Spence refers to as the sage on a stage. "Back when I taught French, I was the only source of French to my students," recalls Dr. Spence. "We didn't have access to the world—we had a PC with some software that played *Le Marseillaise* and showed the French flag. But one of our French teachers this morning had students warm up by listening to the news on French radio and answering questions about the stories. In this classroom, the teacher is not the sole provider of the French language. The teacher is creating the opportunities for students to interact with the world."

Not only do the laptops bring the world into the classroom, they help teachers move learning beyond the school's boundaries. One Deep Run class studied a wetlands environment near the school, and researched federal regulations on wetlands. "They made a multimedia PowerPoint presentation to the Board of Supervisors talking about why it was important to preserve Henrico County's wetlands, and it blew the board away," says Dr. Spence.

Different Strokes for Different Learners

In addition to supporting a more active approach to learning, one-to-one computing gives teachers more leeway to meet individual students' needs. "We have a greater ability to integrate visual images, video and music—for better understanding and learning, and to reach students with different learning styles," Superintendent Morton says. "If I want to understand the Civil War, I can view Brady's photographs, listen to Civil War music, look at contemporaneous art and read soldiers' letters home. It becomes much more tangible."

Five Years, 30,000 Laptops



The laptops also help students work at their own pace. Boggs has his world history classes view a video of one of Hitler’s speeches and see how many elements of fascism they can identify in the speech. He could also do that using traditional technologies, but with the laptops, he says, “Students can replay it back and forth at their leisure and try to pick up those things. They’re more in control.”

One of Henrico’s geometry teachers has made QuickTime* movies simulating the behavior of three-dimensional objects. Students can review the demonstration as many times as they need to. In an AP Art History class, students go on a virtual field trip to the Louvre. They proceed at their own pace and use interactive study guides to explore what they’re seeing.

Technology throughout the Lesson Plan

With one-to-one computing, teachers can use technology at any stage of their lesson plans. “When you’re working in a PC lab environment, you’re there maybe once a week or once a month,” Jones explains. “You’d use curriculum labs for drill and practice—or drill and kill, as we used to call it. It was enrichment, not the meat of the course. With one-to-one, a teacher can present any part of the course electronically—warm-up activity, practice, direct instruction, remediation, assessment.”

At Varina High School, Cheryl Weening’s biology and AP biology classes conduct pre-lab exercises that simulate what they’ll be doing in the physical laboratory. Students can work at their own pace and repeat the exercises, if needed. The physical lab experiences often proceed more quickly and with less waste of chemicals and other materials. Students reinforce their learning by accessing biology journals online that are not available at the school.

Dr. Spence recounts the activities he observed in a Deep Run's geology class where students created and interacted with virtual earthquakes, and followed a series of guided questions to help them understand the interplay between P-waves and S-waves. "You should see the light bulbs going on for these kids," he says.

And English classes? "We've all had the experience of going into our English classrooms and being told, 'Okay, write this prompt in your journal as a way to get started for the day,'" says Dr. Spence. "But most of us have never been in an English classroom where the teacher said, 'All right, go to my blog site, read what I posted last night and respond.' Or taken a virtual tour of the Old Globe Theater and talked about how its layout might have influence Shakespeare's writing."

Student Output

The laptops provide a greater variety of ways for students to demonstrate what they've learned, and teachers to evaluate student achievement. "When everyone has a laptop, students can be much more creative in demonstrating what they know in ways that make sense to them," says Dr. Spence. "One student might use the computer to type a book report. Another may create his own myth and act it out in a movie. Another may create a Web site that links to various sources that talk about mythology and explain those sources. It's all good because you're tapping into all the different learning modalities and giving students more resources to work with."

In a physics class, students studying air pressure use probeware to inflate a ball and understand the relationship between temperature and air pressure. They reinforce their learning by graphing their results in an Excel* spreadsheet. English classes have created public service announcements and published them on the Internet.

Students and teachers use a "drop box" to send work back and forth. Teachers also use online assessments that provide instant feedback on a student's progress. Teachers customize their approach to individual students by monitoring and providing feedback on students' work in progress.

Tools for Teaching

To help teachers integrate the laptops into their teaching, teams of principals, classroom teachers, curriculum specialists, and technology trainers have worked together to supplement existing resources with additional content, lessons, and other materials to support technology-enabled teaching.

Teachers use resources from numerous content sites, programs, and tools. Examples include Apex Learning* for advanced placement content material, ExploreLearning* for science and math content, and Kuia*, which helps teachers build Web sites for classroom instruction and assessment.

The district has spoken with a number of educational software houses about the software changes that are needed to support a one-to-one environment. "There isn't any reason to go to one-to-one if you're going to teach whole group, and there isn't any reason to have software that is based on whole group if you have the facility and the power of a one-to-one environment," Dr. Thorpe says. "That's something from a basic education resource paradigm that we've talked about, and I believe and hope it helps our entire profession move forward."

Results

“The laptop is such an incredible tool to use with the kids. It makes you such a better teacher. It makes your classroom run so much better and be so much more engaging—and that is what we have to do with kids today.”

Connie Fuller
English Teacher

Far-reaching results can be achieved when teachers and students are immersed in the opportunities of technology rather than limited to an hour a week of a computer lesson or accessing a PC in the back of the class. Henrico personnel say their Teaching and Learning Initiative has generated a broad range of benefits for students, teachers, parents, and the district as a whole—including some surprises.

Students

Because of the Teaching and Learning Initiative, students are more engaged in their learning. That’s a result of teachers’ success in using technology to provide experiences that reflect the world students live in. “You have to remember this is the millennial generation,” explains Dr. Spence. “Many of them are so immersed in technology that they would tend to dissociate school from the rest of their lives if they didn’t have the laptops in front of them. As I heard someone say, asking these kids to pick up a composition notebook and start writing a journal would be like asking us to pick up a quill and dip it in ink and start writing.”

The flexibility of the laptops, along with the wealth of resources they bring into the classroom, helps the district meet each child’s individual needs. “Inherent in No Child Left Behind is attention to the individual,” says Dr. Thorpe. “Having the laptop gives me a powerful tool as a teacher for differentiating and attending to the needs of the individual. The power of the laptop is that I have the opportunity to structure a classroom for a child, and it doesn’t have to be the other 20 children’s experience. I have video, sound, image, and more rolled into one.”

This flexibility has been of particularly benefit to students whose primary learning modality is other than auditory. “Research shows that less than 30 percent of students are auditory learners, so having a laptop, with that visual and kinesthetic element, captures more learning styles and appeals to more students,” Jones says.

Perhaps the biggest surprise of the program has been how much the laptops have benefited special needs students. “The laptops are a huge win for our special education students because it gives them something they can focus on and interact with,” Jones says. “The laptop is a tool they can use to direct their learning instead of being the passive receptacles of learning. It helps them feel like they’re in control. Walking through the special ed classrooms, even that first semester, you could see a huge difference.”

Mainstreaming of special needs students has increased within the district; Henrico’s leaders attribute the change in part to the skill with which its teachers use the laptops to accommodate individual needs. The laptops and their associated software also help teachers manage the work of addressing special needs.

“These children have laptops that are customized for their needs, for example with headphones for those who need audio, or special input devices for those with limited motor control,” explains Fuller. “When I type a quiz into Word*, the computer translates it and reads it to the students who need it read to them. The laptop enables a lot of children who were sort of lost in the past, to come into a mainstream classroom. It opens the whole world in so many ways for these children.”



Another unanticipated benefit is how much the laptops help kids who have trouble with organization. Students quickly learned to use the laptops to organize and manage their work—and they love it. “Probably the number one thing students say is, ‘The laptop keeps me organized. It gives me a single place where I can keep everything together—I don’t have four different notebooks and papers flying around. I know where everything is,’” says Jones. “With a lot of teens, staying organized is half the battle.” Students can also check homework assignments and test dates online.

Feedback from graduates is positive. College students report that they’ve already mastered the knack of using a laptop for note taking, communicating, and organizing their lives, while peers are just starting up the learning curve. One student who went on to an Ivy League college reported that he earned money the first semester helping his peers get up to speed on the finer points of taking notes in class and other aspects of ubiquitous computing. Grads who go straight to the workforce or the military report feeling similarly well prepared.



Maryann Davina

Teachers

Many teachers are energized by the power of one-to-one computing and the opportunities to teach in new and different ways.

Does the Teaching and Learning Initiative promote better teaching? Just ask Maryann Davina.

“Absolutely it does, absolutely,” she responds. “It makes me more excited about learning, and hopefully that passes on to my students. I’m also more organized. I can get on the list serve and communicate with teachers throughout the country, and we can share ideas. Not only does it open up the world for my students, but it opens up the world for me.”

Davina recalls early fears that the laptops would lead to student isolation. “The concern was that it would close them up and they wouldn’t interact with classmates,” she remembers. “In fact, the laptop opens up the world to the students. There are so many resources for them.”

The initiative has been an unforeseen catalyst for a more collaborative culture in the high schools. “High school teachers are notorious for being in their classrooms by themselves, being the expert in that classroom and working alone,” says Jones. “Because of the Teaching and Learning Initiative, teachers were thrown into waters where they weren’t comfortable. We didn’t do it with a sink-or-swim mentality. It was more, ‘we’re going to get through this together!’ They developed a real spirit of camaraderie as a result.”

Teachers say the laptops save time in some ways and add to the workload in others. “E-mail contact with parents saves me the time of hunting down phone numbers and try to find them where they are,” says Weening. “It’s the best way to contact parents and stay in constant communication about the success of their child.”

Davina points to a variety of ways in which the laptops help simplify teachers' administrative workloads. "There's organizational methods, ordinary routine things, daily things like taking roll, computing grades, recording grades, doing lesson plans—there's a whole plethora of things that make our lives easier as teachers," she says. With wireless laptops, teachers can access those tools wherever they can get online, whether at home, the teacher's lounge, or their favorite coffee shop.

On the other hand, teachers put considerable time and effort into modifying lesson plans and finding or developing new materials that take advantage of the laptops. "You put in a tremendous amount of hours when you're just starting out with it," says Fuller. "If you want to do the same old same old, and you don't want to put in any more time, and you want to use the same quizzes and tests that you did 20 years ago, then you probably aren't going to want to do one-to-one. But if you really, really want to reach children and you love your job enough to put in that time, it will be the most rewarding step that you make."

Parents

Students are not the only people who crossed the digital divide in Henrico County. The district's commitment to make inexpensive Internet access available at home has helped many families afford Internet service for the first time, enabling parents, grandparents, siblings, and cousins to access digital information and tools.

The initiative and the district's overall use of technology have also had a positive impact on parent communications. Parents like the fact that they can check on their kids' grades at any time and e-mail teachers to ask a question or monitor a student's progress in completing assignments. "Parents are able to stay on top of their kids," says Boggs. "If their kid has missed a test, they'll know it right away. People have so many things going on in their life. It's hard for them to call the school and personally talk to each teacher. This is a way they can quickly check."

District

The district as a whole has achieved a variety of direct and indirect benefits:

- **Better ROI** on overall technology investments because students use their equipment more often and more effectively
- **Better use of classroom space**—dozens of computer labs across the district have been converted to classrooms, giving schools more flexibility in using space and accommodating growth. Many schools maintain one or more labs to run specialized software, but with the Intel-based laptops, the district hopes to reduce labs further or eliminate them altogether.
- **Avoiding the cost** of wiring each room and physically connecting each system
- **Enhanced recruiting**—district leaders say they receive more applications from more highly qualified applicants than they did five years ago, due in part to the success with one-to-one computing and the resulting favorable publicity.

Community

The Teaching and Learning Initiative has enhanced the county's reputation as a desirable place to live and do business. The Greater Richmond Technology Council and Greater Richmond Chamber of Commerce have been staunch supporters of the initiative, and local businesses say they appreciate the technology literacy of the district's graduates.

**What Works: 5 Years, 12 Tips
from Henrico County Public School**

- **Buy-in.** Earn buy-in from teachers, parents, local businesses, and the community at the outset, and keep them in the loop as you go forward.
- **Time.** Give teachers the time needed to practice and experiment with technology, both before issuing laptops to students and on an ongoing basis.
- **Teamwork.** Create a culture of respect and cooperation between instructional and technology staff. Recruit master classroom teachers to be master technology teachers.
- **Trailblazers.** Promote success by identifying and rewarding teachers who excel at using the laptops as effective teaching tools. Encourage them to share their best practices.
- **Inclusiveness.** Make sure one-to-one computing reaches everyone. Provide scholarships for families who can't afford fees.
- **Balance.** Implement policies to keep kids safe and enforce appropriate behavior, but don't let excessive fearfulness lead to overly strict lockdown policies.
- **Variety.** Continue to use a mix of teaching methods—lectures, books, group work, and time on the laptops.
- **Textbooks.** Don't ask kids to carry both laptop and text books. Invest in extra sets of texts so students can keep their books at home and reference them in the classroom as needed.
- **Technology.** Prepare for demands on your network and server infrastructure.
- **Partners.** Work with technology vendors who are deeply committed and will help you address challenges.
- **Patience.** Effective one-to-one computing is part of a broader shift to more active, student-centered teaching and learning. The shift is an exciting and necessary one, but it won't happen without planning, risk taking, and hard work.
- **Focus.** Keep your eyes on the prize. It's all about preparing kids for the 21st century. It's about teaching, not technology.

Looking Ahead

“This is a Teaching and Learning Initiative. It is not one-sided. It isn’t only what teachers are doing to students. It is what teachers and students are doing together with this equipment.”

Lynn Thorpe, Ed.D.
Assistant Superintendent
for Instruction

Despite its successes, Henrico County Public Schools is not resting on its laurels. Entering its sixth year of the Teaching and Learning Initiative, the district has infrastructure and laptop logistics well under control. Now the emphasis is on continuing to help teachers integrate technology effectively into their teaching.

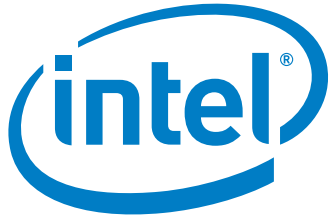
Henrico doesn’t consider the digital divide to be fully closed, and is looking at options for a high-speed countywide wireless network using WiMAX or cellular technologies. The district also keeps an eye on next-generation mobile platform technologies, including ultra-mobile PCs and smaller, tougher laptops.

In addition, the district is looking at complementary technologies that will expand the value of its investments in laptops and network infrastructure. Among these are interactive whiteboards and other intelligent classroom solutions, as well as a virtual test location that keeps students from accessing other electronic resources while taking a digital exam.

Meanwhile, Henrico continues to look forward. “You could ask almost everybody in this district, from students to teachers to administrators, if they would want to go back, and they would say, ‘No way,’” says Jones. “It would feel like going back in time.”

Even worse, it would feel like letting students down. “In the 21st century, we are not preparing students for anything if we prepare them to be passive learners,” Dr. Spence says. “They just can’t survive that way in the real world. This is absolutely the right thing to do.”





For more information about using technology effectively to support learning, please see:

www.intel.com/go/education

www.k12blueprint.com