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Educational Technology Plan for Virginia

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Virginia Department of Education

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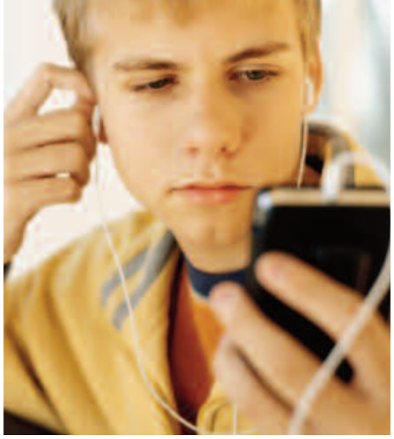

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Vision

The vision of the Virginia Board of Education and Virginia Department of Education, in cooperation with their partners, is to create an excellent statewide system of public education that derives strength from its diversity and that ensures equality of opportunity for each student in a safe and healthy learning environment. The goal of this system is to prepare all students to be capable, responsible, and self-reliant citizens in the global society. To that end, the Department of Education will integrate innovative and authentic technologies effectively throughout all facets of the educational system to improve student academic achievement and 21st century skills and knowledge.

Mission

The Virginia Department of Education's Division of Technology and Career Education supports school division educational improvement efforts through the use of technology. The division provides training, technical assistance, and information to agency personnel and school divisions. The 2010-15 plan outlines strategic direction for agency and local educational technology planning while providing the flexibility to accommodate ongoing changes, innovations, and emerging technologies.

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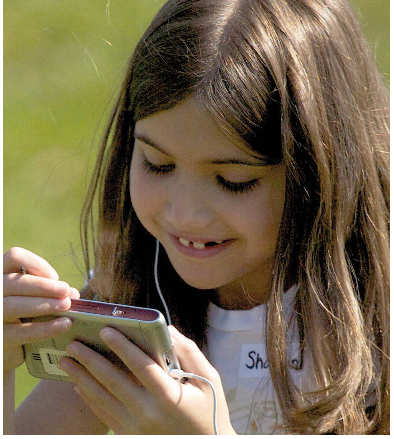
Acknowledgments

The development of the *Educational Technology Plan for Virginia: 2010-15* was coordinated by the Office of Educational Technology and represents more than a year of research, planning, and collaboration. Contributors to the plan include individuals and organizations from across the Commonwealth, representing school division technology directors, administrators, teachers, higher education representatives, professional organizations, the business community, and families. The level of participation precludes us from identifying each contributor by name; however, we want to extend our sincere appreciation to all those who helped shape this vision for educational technology in Virginia.



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Foreword

Virginia is consistently recognized as a national leader in the use of technology to expand student opportunities. In the most recent *Technology Counts* report, *Education Week* gave Virginia an overall grade of A-. Indeed, with the foresight and commitment of legislators, governors, and educators, the Commonwealth has an impressive list of accomplishments over the last decade.

In 2000, Virginia implemented the Web-Based Standards of Learning initiative—providing the infrastructure and hardware for instructional, remedial, and testing programs. The testing program has expanded with 1.7 million tests completed online in 2009.

In 2004, the Virginia Educational Information Management System began providing data disaggregation capabilities to help school divisions track student achievement longitudinally. This system provides instant access to data that shape instruction to meet the individual needs of Virginia's students.

In 2004, Virtual Virginia was launched to provide Advanced Placement (AP) and other challenging courses for more than 2,500 middle and high school students from 238 middle and high schools across the Commonwealth. In addition, approximately 5,700 students receive tailored remedial instruction through the Virginia Online Reading Tutorial and the Virginia Online Algebra Tutorial.

In 2005, Virginia created a network of more than 1,200 instructional technology resource teachers (ITRT) to help teachers integrate technology into the classroom effectively. With this action, Virginia became the first state in the nation to provide instructional technology support to teachers on this scale. At the same time, the Commonwealth added technology support personnel to ensure the effective operation and maintenance of the technology and supporting infrastructure.

In 2006, Virginia became the first state to require that Internet safety be taught as part of the instructional program, preparing students to experience all the offerings of the Internet and Web 2.0 technologies safely and fully.

In 2007, Virginia launched *Share the Skies*, which allows students and teachers to study astronomy in real time during the daytime without leaving the classroom. Virginia students can use research-grade telescopes to explore Australia's night skies via the Internet.

Since 2008, the *Learning without Boundaries* initiative has helped the Commonwealth understand the technical, social, and policy implications of integrating wireless handheld devices into schools.

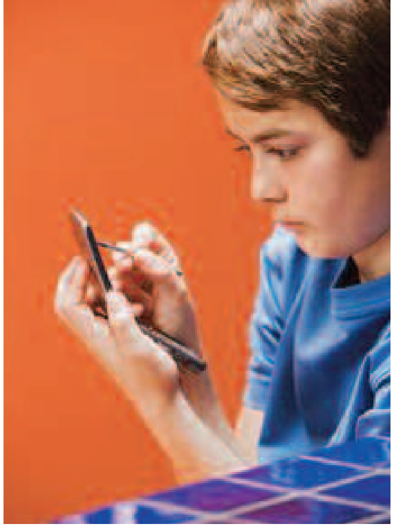
In 2009, the Commonwealth focused on innovative ways to provide high-quality content and instructional materials for students. Virginia on iTunes U provides a Web-based repository for standards-based media-rich content for schools and families. A physics *flexbook* also was created in 2009 to supplement traditional physics textbooks with emerging topics.

The Department of Education will continue exploring and implementing innovative ways to improve teaching, learning, and productivity in schools. The *Educational Technology Plan for Virginia: 2010-15* articulates our vision and provides a framework to support this work.

Patricia I. Wright, Ed.D.
Superintendent of Public Instruction

"Without continual growth and progress, such words as improvement, achievement, and success have no meaning."

—Benjamin Franklin



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Preface

The *Educational Technology Plan for Virginia: 2003-09* opened with the following statement:

Virginia's leaders have prepared the commonwealth to be attractive to companies and investors by providing the technology infrastructure and skilled workforce today's businesses require. Critical to the commonwealth's ability to capitalize on this advantage is the extent to which Virginia's schools prepare the next-generation workforce for knowledge-based jobs that utilize cutting-edge information technology.

These sentiments are remarkably insightful for not only 2003 and 2009 but likely 2015 and beyond. Virginia remains ahead of the curve nationally in its commitment to educational technology and focus on preparing students for the changing economy and information age.

While preparing children for this rapidly changing world, educators must incorporate technology that helps students better learn the skills they will need to participate fully in the global community. In the last six years, research (Hefzallah, 2004; Brown, 2006; Harwood & Asal, 2007) has revealed new realities about how the brain works and how people learn best; these studies not only reinforce Virginia's focus on technology integration but encourage greater use of the most recent technological advancements.

Students have discovered—often outside school—that new technologies offer excitement and challenges; these technologies, like mobile phones, worldwide interactive gaming, and social networks, are just now finding a place in schools. Interestingly, cognitive science is discovering that the interactive, creative, social, and real-life capabilities of these new technologies are precisely what students need to learn the skills required by today's world (Gee, 2003; Gee, 2005). Having accepted the possibilities and limitations of technology, students are more prepared than ever to take charge of their own learning.

One challenge for the current education system is how to prepare students for the future when the half-life of technology often is measured in weeks rather than years and when the stream of new information grows exponentially. Twenty-first century learning is often suggested as the answer to this challenge; however, it is an amorphous concept that cannot be defined by a mathematics equation, chart of periodic elements, or historic dates—therefore, it does not fit neatly into traditional education paradigms.

Twenty-first century learning, and the technology that supports it, is a broad concept—actually, much too broad—requiring us to rethink every aspect of our education system. It demands more than teaching students to be problem solvers and effective collaborators. It entails tough, broader questions, like how do we make room for 21st century skills in the current curriculum? What, if anything, can we throw out and still ensure that students have the knowledge and skills they need to succeed? We must look critically at our pedagogy and how we can move to more active learning in student-centered classrooms. How can we build reliable, valid, and useful assessment systems that meet accountability needs and ensure that all children receive a customized education reflecting their personal learning styles, needs, and interests? Confined to the current school day, schools cannot guarantee students will acquire 21st century skills and knowledge; consequently, we need to reconceptualize school more generally as a place and time for learning.

These are the underlying issues of Virginia's educational technology plan for 2010 through 2015. What role can technology play in addressing these questions?

When technology emerged as a significant education topic in the 1980s and 1990s, the focus was on teaching students to use specific software applications. All of those word-processing, database, and graphics programs—at least, the original versions—are now unrecognizable and obsolete; in all likelihood, today's most popular software applications eventually will go the same route, possibly before the end of this six-year plan. Although students need to learn how to use specific software programs, this must not be the end goal. It is more important for them to understand *why* they should choose a particular application or *how* that application functions in ways that support their learning and creative expression.

The process of developing a six-year plan for educational technology is intimidating if not impossible. Anticipating technological changes is a challenge six months in advance, let alone six years. Paradoxically, the quickly evolving nature of technology actually requires educators to develop long-range plans. Without a long-term framework, educational technology could easily be sidetracked by the latest fad. At the same time, though, the plan must be flexible enough not only to *allow* for the integration of technology innovations but to *encourage* teachers to take advantage of new tools.

Although it seems like educational technology has existed for a long time—which it has in some ways—it really is in a nascent stage. The possibilities for the future are infinite, making it all the more difficult to anticipate where educational technology will be in six years. In fact, a reader examining *this* plan with the benefit of six years of hindsight may rightfully wonder, "What were they thinking?"

The reality is that educational technology has become pervasive, interlinking with every aspect of teaching and learning. When the *Educational Technology Plan for Virginia: 2003-09* was published in 2003, the principal objective was to integrate technology into classrooms across Virginia. This goal largely has been achieved with exceptional results—thanks, in part, to an aggressive financial commitment by the General Assembly and by the mounting indispensability of the Internet. While some schools are still struggling to integrate technology effectively, most educators are prepared to take the next steps.

Perhaps the greatest change during the last six years is that students of all ages have transitioned from being just *consumers* of content and media to also being *producers*. Educational technology is no longer a one-way learning resource. The Internet is much more than a high-tech encyclopedia; it is a virtual world, with all the pros and cons of the real world. To oversimplify the daunting goal of the next six years, educators must find ways to maximize the positives of the Internet and other technologies while preparing students and their families for the potential negatives. This is an ambitious goal, especially when set against the demands of meeting state and federal standards.

The realities of the world and economy further complicate the immense challenges of planning the future of educational technology. For decades, U.S. schools emphasized mathematics and science in direct response to the Soviet Union's launch of *Sputnik 1* in 1957 and the belief that the Cold War would be won through superior technological knowledge. While mathematics and science are as important now as they were a half-century ago, the challenges of the 21st century have supplanted the threats of the Cold War as the driving force behind American education.

Computers can easily perform complicated mathematics equations, and complex scientific formulas are instantly available with the click of a button. The test for students is to understand how these subjects relate to the real world and evaluate when to perform a particular mathematics equation or apply a scientific formula. Mathematical logic problems should no longer consist of phrases like "two trains leaving Cleveland at different speeds"; rather, they should concern real issues such as the rate of the Earth's temperature change or the world's ability to provide enough food to satisfy a swiftly multiplying population. In other words, good educational logic problems are no longer hypothetical; they must be developed and solved in the context of the real world. Today's students potentially will confront some of the most severe problems in the history of the planet; the next six years will be a key part of their training.

As a result of the continually changing nature of educational technology, state and federal standards, and the world's economy, this six-year plan is not a *plan* in the traditional sense; rather, it is a framework that permits ongoing changes, innovations, and emerging technologies. It allows educators and students to think differently about how technology can change teaching and learning.

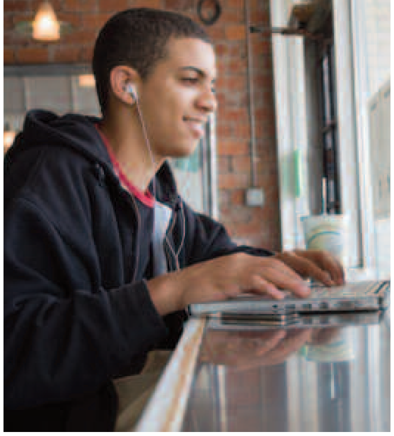
Education in the 21st century is a complex system, and we must consider it from this perspective. By their nature, children are naturally creative and curious; however, self-expression does not come easily for some children. Over the next six years, countless emerging technologies could help all students better communicate their questions, knowledge, skills, and thoughts, which can only help them learn more. The challenge for educators is to help students identify and use tools to express themselves more effectively and creatively and accomplish work that would be difficult, or even impossible, to do without technology.

To meet this challenge, most educators will need to approach technology from a radically different perspective. They increasingly will spend more time modeling creative thinking and showing how to probe information rather than teaching facts. In many instances, they will find themselves serving more as facilitators of information gathering and analysis than as the conduits.

This evolution does not portend the end of teaching; to the contrary, educators will play a larger role than ever before. The availability of the Internet and other instant-technology-information sources will free up time, which can be dedicated to teaching critical-thinking skills, encouraging creativity, and relating learning directly to real-world situations that are meaningful to students. As a result, this plan takes a systemic approach, focusing on the roles of technology in the entire education process.

"Arriving at one goal is the starting point of another."

—John Dewey



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Introduction

In 1983, the U.S. Department of Education published *A Nation At Risk* (USDOE, 1983), which alerted Americans that failures in the American education system could hinder economic development and the country's role as a global leader. The department reported, "The educational foundations of our society are presently being eroded by a rising tide of mediocrity that threatens our very future as a Nation and a people" (paragraph 1). A quarter-century later, the U.S. Department of Education revisited this report in *A Nation Accountable* (USDOE, 2008a), which warned Americans once again:

> If we were "at risk" in 1983, we are at even greater risk now. The rising demands of our global economy, together with demographic shifts, require that we educate more students to higher levels than ever before. Yet, our education system is not keeping pace with these growing demands (bullet 1).

The U.S. Department of Labor (2000) voiced its concerns about the country's educational focus in the report *A Nation of Opportunity: Building America's 21st Century Workforce,* which noted that employers increasingly look for skills beyond academic knowledge. This emphasis on nonacademic skills has inspired other organizations to define *21st century skills* more precisely. In 2001, the CEO Forum, a temporary working group of technology industry and education leaders, published *School Technology and Readiness Report, Year 4: Key Building Blocks for Student Achievement in the 21st Century*. Two of the forum's six recommendations focused on 21st century skills: (1) making the development of 21st century skills a key educational goal and (2) aligning student assessment with educational objectives, including 21st century skills. The report affirmed that technology integration could help foster these 21st century skills.

The 21st century skills adopted by the CEO Forum actually were articulated by the Metiri Group (2003), in a work commissioned by the North Central Regional Educational Laboratory (NCREL). This publication categorized the skills needed for the 21st century under these topics: digital age literacy, inventive thinking, effective communication, and high productivity.

In response, government, education, and business leaders formed Partnership for 21st Century Skills, which published two seminal reports: *Learning for the 21st Century* (2003) and *Framework for 21st Century Learning* (2007, rev. ed.). This latter work outlined student outcomes and support systems essential for 21st century skills. Outcomes were grounded in core subjects and 21st century themes, including skills related to life and career, learning and innovation, and media and technology. Support systems included standards and assessments, curriculum and instruction, professional development, and learning environments. It has become apparent that education must focus on these subjects to help students compete in the global economy and be responsible citizens (Conference Board, Corporate Voices for Working Families, Partnership for 21st Century Skills, & Society for Human Resource Management, 2006; CEO Forum, 2001; Partnership for 21st Century Skills, 2007).

The *Educational Technology Plan for Virginia: 2010-15* focuses primarily on one specific component of 21st century skills: information and communications technology (ICT) literacy. The most recognized definition for this topic was formulated by the International ICT Literacy Panel (2002): "ICT literacy is using digital technology, communications tools, and/or networks to access, manage, integrate, evaluate, and create information in order to function in a knowledge society" (p. 2). The State Educational Technology Directors Association (SETDA) (2002) further explained: "Technology literacy is the ability to responsibly use appropriate technology to communicate, solve problems, and access, manage, integrate, evaluate, and create information to improve learning in all subject areas and to acquire lifelong knowledge and skills in the 21st century" (n.p.).

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Computer and Technology Standards

Technology will play a key role in the teaching and development of 21st century skills and knowledge. The International Society for Technology in Education (ISTE) released the initial National Educational Technology Standards for Students (NETS*S) in 1998. In response, the Commonwealth of Virginia incorporated these standards into the Standards of Learning (SOL) and revised the computer technology SOL in 2005 to reflect 21st century skills.

In 2007, ISTE updated the NETS*S to recognize the importance of the following 21st century factors:

- **Creativity and innovation**
- **Communication and collaboration**
- **Research and information fluency**
- **Critical thinking, problem solving, and decision making**
- **Digital citizenship**
- **Technology operations and concepts**

While some of these skills may be taught without technology, others are dependent on technology. Even the skills not dependent on technology are strengthened and enhanced when appropriate technology is used effectively and modeled on research-based best practices.

Core-content knowledge is necessary, but not solely sufficient, to succeed in a competitive world. Even if all students mastered core academic subjects, they still would be woefully underprepared to succeed in postsecondary institutions and workplaces, which increasingly value people who use knowledge to communicate, collaborate, analyze, create, innovate, and problem-solve. Used comprehensively, technology helps students develop 21st century skills (Partnership for 21st Century Skills, 2007). Research (Dede, 2007) and practical experience show that students develop 21st century skills most effectively when teachers combine situated learning and effective ICT literacy.

In 2008, ISTE updated the National Educational Technology Standards and Performance Indicators for Teachers (NETS*T) based on the philosophy that teachers should model effective technology use. The NETS*T require teachers to meet specific standards and performance indicators:

- **Facilitate and inspire student learning and creativity**
- **Design and develop digital-age learning experiences and assessments**
- **Model digital-age work and learning**
- **Promote and model digital citizenship and responsibility**
- **Engage in professional growth and leadership**

The ISTE National Educational Technology Standards for Administrators (NETS*A) were updated and released in June 2009. These new standards also incorporate more aspects of 21st century learning and teaching, just as the refreshed NETS*S and NETS*T have done. They still focus, however, on the leadership and oversight roles of administrators, though an emphasis on systemic transformation through technology expands the administrative vision. Specifically, the NETS*A articulate standards and performance indicators around the following:

- **Visionary leadership**
- **Digital-age learning culture**
- **Excellence in professional practice**
- **Systemic improvement**
- **Digital citizenship**

Virginia's Definition of ICT Literacy

The Commonwealth of Virginia has taken a significant step forward by articulating essential ICT literacy elements for all stakeholders (see Appendix A). Based in part on SETDA's definition, Virginia defines ICT literacy as a synergistic blend of cognitive, technical, and social skills that enable students to use technology responsibly (safely and ethically) and effectively to advance learning and develop strong thinking habits in all subject areas. This blend should lead each student toward a lifelong ability to communicate; solve problems; and access, manage, integrate, evaluate, and create information.

Instructional Technology Resource Teachers (ITRT)

In 2005, the Virginia General Assembly began requiring divisions to employ one ITRT per 1,000 students to help integrate technology into classrooms. A study by Virginia Tech's Center for Assessment, Evaluation, and Educational Programming determined that ITRT have become an essential part of educational technology in the Commonwealth (Virginia Department of Education, 2007).

The research found that ITRT are "overwhelmingly qualified for their positions, work consistently on appropriate tasks, and train teachers regularly in the latest technologies. While some teachers still resist incorporating technology, the program has helped many overcome their fears; an increasing number have taken advantage of the ITRT program, particularly through technology integration, software training, and the development of curriculum resources" (p. 2).

The study added that ITRT have contributed to major improvements in 32 percent of the SOL test areas, with the most significant impact occurring in English reading; however, improvements also were observed in eighth-grade English writing and fifth-grade mathematics. The study recommended that the program would achieve even greater success by hiring at least one ITRT per school, clarifying their duties more precisely, and encouraging administrators to work more closely with them (Virginia Department of Education, 2007).

Technology Support Positions

In 2005, the Virginia General Assembly also began requiring divisions to employ a second technology position aimed at providing technology support for schools. School divisions must employ one technology support position per 1,000 students. This position provides support for information networks; software and hardware installation, maintenance, and repair; security management; and other related responsibilities. In the most recent educational technology survey, 93 percent of respondents believe their school's technology is reliable, and 92 percent believe technical support for teachers is adequate (Virginia Department of Education, 2009).

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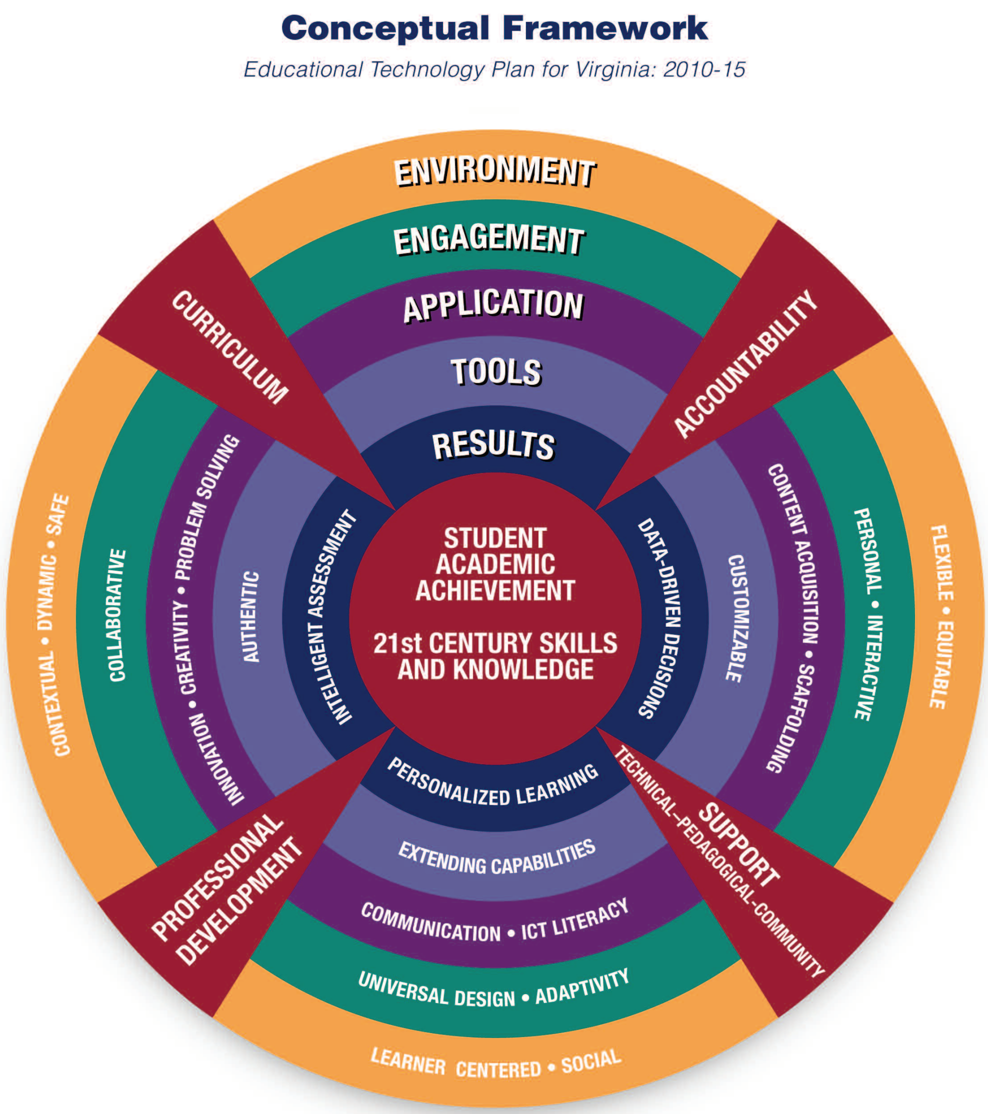
Conceptual Framework

The *Educational Technology Plan for Virginia: 2010-15* builds upon the foundation established by the *Educational Technology Plan for Virginia: 2003-09*, Computer/Technology Standards of Learning, Technology Standards for Instructional Personnel, NETS*S, NETS*T, NETS*A, and the goals for ICT literacy. To foster the development of 21st century skills, the plan relies extensively on factors that support effective technology use:

- **Appropriately and adequately designed environment**
- **Meaningful engagement**
- **Purposeful application of tools for learning**
- **Use of authentic technology tools to extend learning capabilities**
- **Authentic and intelligent assessments**



The conceptual framework shows five focus areas for educational technology in Virginia between 2010 and 2015:

- Schools need to consider physical and virtual **environments** in new and innovative ways to support learning activities.

- Educators must employ multiple ways to engage students in learning through technology. This **engagement** should reflect student learning styles, cultural backgrounds, and personal interests.

- Students need to understand the proper **application** of technology tools (i.e., choosing and applying the most appropriate technology for communicating and problem solving) and to be creative and innovative.

- Students should not use technology **tools** just to replicate paper-and-pencil activities. Tools should extend student capabilities to perform functions that would be difficult, if not impossible, without technology. Tools should be authentic—ones students will encounter in the nonschool environment.

- **Results** are not just a matter of meeting accountability requirements but using data, including real-time assessments, to inform instruction. Teachers addressing 21st century skills and knowledge must employ intelligent assessments.

These five focus areas underlie the plan's goals. Each focus area comprises a number of topics that form the basis for the plan's objectives. Four key educational components cut across these focus areas:

- **Accountability**
- **Support**
- **Professional development**
- **Curriculum**

The goals, objectives, and methods of this plan incorporate the best thinking about ICT literacy and cognitive science. The overarching goal is to craft a flexible framework that allows individual schools and divisions to implement systemic changes that support 21st century learning and greater academic achievement. Just as this plan builds upon national standards, division plans should not only align with the statewide framework but also define specific objectives based upon local-needs assessments. The bottom line is that technology should be an essential means for supporting 21st century learning and academic achievement; it is not, however, an end unto itself.

These four areas are common to education and familiar to educators and those who work with them. Instead of adding another definition of these factors to what we already know, the following example illustrates how one innovative project embodies all of these factors.

Sharing the Skies: Boundless Possibilities

The Conceptual Framework in Practice

In 2007, the Virginia Department of Education Office of Educational Technology developed an innovative project that encompasses all aspects of the conceptual framework. *Share the Skies* is the nation's first statewide initiative that enables students and teachers to

study astronomy in real time during the daytime without leaving the classroom. Virginia students can access and control a research-grade telescope to explore Australia's night skies via the Internet. They use CCD (charge-coupled device) imaging techniques to capture digital images of deep space for further study.

Environment

Share the Skies epitomizes the concept of a rich and multidimensional environment. From their classroom environments, students use a Web browser to control a telescope in Australia and explore deep space. This technology expands classroom walls to a learning environment millions of light years away.

The environment allows students to leverage this tool to explore subjects across the **curriculum**. In addition to the obvious implications for science and mathematics instruction, it also taps into language arts, history, and visual arts by helping learners understand the impact of astronomy on thousands of years of religious customs and cultural beliefs.

Share the Skies provides **accountability** across system and classroom levels. When working in a distributed environment, accountability is essential. The tools must function properly, teachers must provide proper guidance, and students must use the tools correctly. Educators must assess students' roles in terms of their work with the telescope and collaboration with learners in other locations. It is incumbent upon teachers to ascertain each student's individual achievement in an environment where thousands of students are participating.

Technical **support** must be coordinated on many levels and in several locations. Telestra, an Australian telecommunications company, assures the network is operational; Software Bisque of Golden, Colorado, developed and maintains the software; and New Mexico Skies Observatory maintains the remote access and provides operational support. At the Virginia school level, teachers rely on the expertise of ITRT, who have been trained to work with *Share the Skies*. Teachers and ITRT also receive technical and pedagogical support from the Virginia Department of Education.

Professional development is essential for teachers not only to learn details about the project but also to understand how to work in a distributed environment. Since the project involves various places spanning the Earth and multiple time zones, teachers must anticipate potential issues. For instance, learners need to calculate when to schedule telescope usage based on the time of day and year, i.e., during Daylight Savings Time, there is a 12-hour gap between Virginia and Australia.

Engagement

The project offers learners flexibility in what and how students learn. *Share the Skies* incorporates a Web 2.0 platform provided by Oracle Education Foundation. It allows learners to develop collaborative research projects, and the complexity can be scaled to a learner's age level and abilities. Aiming the telescope and taking a photo also steps learners through a series of problem-solving tasks, which range from setting the exposure time to checking the weather; as a result, they develop deeper insight into the entire process. While students can access deep space images on the Web, it does not compare to the level of engagement young learners experience as they take the telescope and camera virtually into their own hands.

The associated **curriculum** helps engage students by expanding their comprehension of deep space and challenging them to achieve at a higher level. While the complexity can be scaled to different age levels, some younger students may be capable of more advanced studies. They are learning science by *doing* real science and must draw on knowledge and skills across the curriculum to solve these authentic research problems. The practical uses of mathematics, for example, become apparent as conceptual learning, rather than rote operations, is emphasized.

In a project that engages students in multiple ways, **accountability** assumes numerous forms. The project's varied opportunities must be assessed continually: Are the learners' individual needs being met? Do they have choices in their learning? Do their experiences reflect their personal experiences, backgrounds, and cultural beliefs? Educators are accountable for assessing what students bring to their learning as much as what they learn.

Students should understand the potentials and limitations of the telescope. For instance, technical **support** can engage students by guiding them toward specific objects that can be imaged while allowing them the flexibility to pursue other possibilities.

Working with students from around the world heightens awareness of cultural differences. **Professional development** can help teachers better appreciate how to design projects that engage students from a variety of backgrounds and experiences in authentic, collaborative research.

Application

The key to selecting the right tool is to understand how it will be used. In this instance, the Virginia telescope is optimal for deep space but not planets, which are typically too bright to image successfully. Early in the project, students learn that different telescopes are necessary for different applications. They compare their optical telescope to other telescopes, such as the massive radio telescope at Green Bank, West Virginia. This demonstrates that they must first determine what they need to accomplish and how a tool should be applied before choosing the tool.

The **curriculum** supports problem solving and knowledge acquisition across disciplines. It allows educators to help improve presentation, communication, writing, and computer skills—all in one assignment. It also encourages learners to formulate and execute inquiry-based projects in a creative manner.

While the telescope and Web browser are simple to use on a basic level, they must be applied in ways that support **accountability** and age-appropriate goals and objectives. This project is flexible enough to support the Standards of Learning (SOL) and challenge advanced learners with opportunities beyond their grade levels. Educators must understand their students' abilities and the project's capabilities. After all, with a research-grade telescope, the potential exists for even young learners to make groundbreaking discoveries.

Based on the various avenues of **support**, educators need to help students apply the tools properly. As mentioned, educators receive technical and pedagogical support from a number of sources including the project partners, ITRT, and a dedicated technical support line. Just-in-time support is critical to ensure that educators feel confident to use this advanced technology with their students.

The telescope is an advanced scientific instrument that can enable teachers to plan complex and authentic activities for students. Teachers must understand how to design and facilitate appropriate experiences for their students. **Professional development**, led by an ITRT, can address these aspects in training sessions with teachers.

Tools

A good tool allows people to perform functions they would not be able to perform without it. Put simply, it extends a person's capabilities. This project extends a student's capabilities through essentially two tools: a telescope and a Web browser. Additionally, the main *Share the Skies* tool is authentic; unlike a typical classroom telescope, the telescope is research grade—the same used by professional astronomers.

The *Share the Skies* Web 2.0 tools also allow tremendous **curricular** flexibility, particularly as they promote collaboration, including wikis and other forms of shared communication. A key is that the tools can be personalized for the classroom environment and individual students.

The software generates data that support easy **accountability**. This accountability also works in reverse. Like professional research, regular feedback from users helps improve the product and fix potential problems.

All tools will malfunction at some point. Effective projects must have **support** teams in place to repair the problems as quickly as possible. *Share the Skies* has a technician on site in Australia to fix any problems that cannot be repaired remotely. Additionally, New Mexico Skies and Software Bisque work proactively to anticipate remote-access or software problems before they occur.

As with most educational technology tools, tutorials spell out a step-by-step process for using the telescope and Web browser. In addition, intensive **professional development** sessions convey how to integrate the tool effectively into instruction. The ITRT have been trained in *Share the Skies* and can help educators realize the possibilities.

Results

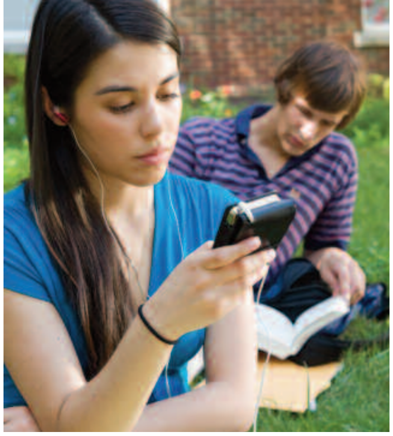
Share the Skies catalogs the work students have done, helping educators interpret achievement or possible problems. It also generates data that show students' activities in each session, which can offer insight into their thought processes.

Share the Skies can be used throughout the **curriculum** and enable students to demonstrate what they know. The tangible products from their work—digital images—could reveal their understanding on many levels. For example, the objects a student chooses to image can demonstrate his or her comprehension of magnitude (brightness of an object).

The possibilities for **accountability** reach far beyond student achievement. By studying how students learn, educators can adapt curricula to meet the changing needs of 21st century skills and knowledge.

The available data are particularly important in shaping the appropriate level of technical and pedagogical **support**. User activity logs can help technical support staff identify problems and make adjustments as needed. Poor images provide an opportunity to explore possible causes and serve as wonderful opportunities to expand teachers' understanding. The explanations could range from an inadequate exposure time to dust from the annual wheat harvest. The complexity of the process and unpredictability of the environment creates new and exciting challenges each day for teachers and students.

As noted, the project generates quantitative results for teachers and administrators. A student's 21st century skill development, however, may be less quantifiable or simple to ascertain. Educators need **professional development** to better assess the 21st century skills that students display. Training helps teachers examine the data, processes, and outcomes to recognize how well students are learning.



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Goals, Objectives, Strategies, and Evaluation Strategies

The *Educational Technology Plan for Virginia: 2010-15* imparts state-level goals and objectives grounded in a foundation of research and based on identified needs (see Appendix B). School divisions must develop locally appropriate strategies and measures that address these statewide goals and objectives while, at the same time, leveraging their unique strengths and minimizing the gaps between promise and practice. Beyond the goals and objectives of the state's plan, division technology committees may create effective plans by adding goals and objectives that support division missions and visions.

Virginia school divisions are practiced in the art and science of good planning procedures. Division technology plans need to follow these procedures, reflect state and local goals, and be useful to all stakeholders. With an increased emphasis on supportive data collection, divisions also must collect appropriate and useful information during the evaluation phase of the planning cycle.

The Virginia Department of Education has generated some tools to help divisions formulate their technology plans. An alignment document focuses on both the planning process and the plan itself (see Appendix C). Additionally, the Department has developed an outline of the educational technology data that must be collected.

Goal 1: Provide a safe, flexible, and effective learning environment for all students

Objective 1.1: Deliver appropriate and challenging curricula through face-to-face, blended, and virtual learning environments.

Strategy 1.1.1: Expand course offerings for students through Virtual Virginia.

Evaluation Strategy: Before and after, analyze the frequency counts of courses offered through Virtual Virginia.

Strategy 1.1.2: Enhance Virtual Virginia courses to promote greater flexibility and engagement for learners.

Evaluation Strategy: Describe the number and types of media enhancements to Virtual Virginia.

Evaluation Strategy: Analyze the user assessments of flexibility and engagement.

Strategy 1.1.3: Provide statewide access to Web-based content, tools, and collaborative spaces.

Evaluation Strategy: Analyze use data to determine frequency of access to Web-based content, tools, and collaborative spaces.

Strategy 1.1.4: Leverage higher education partnerships to assist schools in instructional design and media production.

Evaluation Strategy: Document how the number and types of higher education partnerships differ from previous years.

Evaluation Strategy: Describe the types, quantity, and perceived quality of instructional and technical assistance provided by higher education partnerships.

Evaluation Strategy: Describe the extent to which these partnerships are accessible and useful with regard to delivering appropriate and challenging curricula.

Evaluation Strategy: Document the professional development program attendance and perceived quality.

Objective 1.2: Provide the technical and human infrastructure necessary to support real, blended, and virtual learning environments.

Strategy 1.2.1: Provide resources and support for one instructional technology resource teacher (ITRT) per 1,000 students to assist teachers in integrating technology into teaching and learning.

Evaluation Strategy: Document the resources and support provided by the state to reach this objective.

Evaluation Strategy: Describe the ratio of ITRT to students by school division.

Evaluation Strategy: Describe the extent to which the actual count matches the *one ITRT per 1,000 students* guideline.

Strategy 1.2.2: Provide resources and support for one technical support position per 1,000 students to ensure that technology and infrastructure is operational, secure, and properly maintained.

Evaluation Strategy: Document resources and support provided by the state to reach this objective.

Evaluation Strategy: Describe the ratio of technical support personnel to students by school division.

Evaluation Strategy: Describe the extent to which the actual count matches the *one technical support position per 1,000 students* guideline.

Strategy 1.2.3: Facilitate the implementation of fiber and 100 Mbps to 1 Gbps Ethernet to every school.

Evaluation Strategy: Describe state-level efforts to facilitate this objective.

Evaluation Strategy: Describe the extent to which fiber and 100 Mbps to 1 Gbps Ethernet have been implemented in every school.

Strategy 1.2.4: Facilitate the implementation of wireless access to the Internet in every school.

Evaluation Strategy: Describe state-level efforts to facilitate this objective.

Evaluation Strategy: Describe the extent to which wireless access has been implemented in every school.

Objective 1.3: Provide high-quality professional development to help educators create, maintain, and work in a variety of learner-centered environments.

Strategy 1.3.1: Identify, develop, disseminate, and maintain resources to support the effective use of technology in all curricula by teachers at all levels of integration expertise.

Evaluation Strategy: Examine the extent to which the state identifies, develops, disseminates, and maintains the resources needed to support the effective use of technology across curricula and at varying levels of integration expertise.

Strategy 1.3.2: Leverage public/private/nonprofit partnerships to provide professional development focused on technology integration strategies and the development of teachers' and administrators' 21st century skills.

Evaluation Strategy: Document how the number and types of partnerships differ from previous years.

Evaluation Strategy: Describe the types, quantity, and perceived quality of professional development provided by partnerships.

Evaluation Strategy: Describe the extent to which these partnerships focus on technology integration and 21st century skills.

Evaluation Strategy: Document the professional development program attendance.

Strategy 1.3.3: Support pilot projects to help educators better understand the impact of new and emerging technologies on the learning environment and develop strategies to integrate them effectively into schools.

Evaluation Strategy: Document the state's efforts to support pilot projects.

Evaluation Strategy: Describe the number, types, locations, and scope/extent (breadth and depth) of the pilot projects.

Evaluation Strategy: Document the new and emerging techologies and strategies for technology integration in schools.

Goal 2: Engage students in meaningful curricular content through the purposeful and effective use of technology.

Objective 2.1: Support innovative professional development practices that promote strategic growth for all educators and collaboration with other educators, content experts, and students.

Strategy 2.1.1: Facilitate the development or use and delivery of innovative professional development that promotes collaboration.

Evaluation Strategy: Describe the development of professional development opportunities.

Evaluation Strategy: Describe the types, scope/extent, and accessibility of the professional development offered.

Evaluation Strategy: Describe the extent to which these opportunities facilitate the development or use and delivery of innovative professional development that promotes collaboration.

Evaluation Strategy: Document the professional development program attendance.

Strategy 2.1.2: Facilitate the development and delivery of professional development opportunities that focus on effective technology use in specific core curricular areas.

Evaluation Strategy: Describe how the state facilitates professional development opportunities.

Evaluation Strategy: Describe the development of professional development opportunities for each core curricular content area.

Evaluation Strategy: Describe the types, scope/extent, and accessibility of the professional development offered.

Evaluation Strategy: Document the professional development program attendance.

Objective 2.2: Actualize the ability of technology to individualize learning and provide equitable opportunities for all learners.

Strategy 2.2.1: Provide reasonable access to Internet-connected devices that offer students the flexibility to learn anytime, anywhere.

Evaluation Strategy: Describe the state's role in providing access to Internet-connected devices.

Evaluation Strategy: Tabulate the number of Internet-connected devices per student by division, locality, and grade level.

Evaluation Strategy: Describe access policies.

Evaluation Strategy: Describe student use records.

Strategy 2.2.2: Identify and disseminate information and resources to assist schools in evaluating the interactive and universal design features of hardware, software, and Internet sites.

Evaluation Strategy: Describe ways the state identifies and disseminates hardware, software, and Internet evaluation information.

Strategy 2.2.3: Identify and disseminate information and resources to assist schools in developing and maintaining personal learning plans for all students.

Evaluation Strategy: Describe ways the state assists schools in developing personal learning plans.

Evaluation Strategy: Describe methods of information dissemination.

Objective 2.3: Facilitate the implementation of high-quality Internet safety programs in schools.

Strategy 2.3.1: Identify and disseminate best practices and resources to promote the integration of Internet safety and security throughout the curricula.

Evaluation Strategy: Describe methods of identifying best practices with regard to Internet safety and security.

Evaluation Strategy: Describe the best practices identified and methods of information dissemination.

Strategy 2.3.2: Monitor the implementation of Internet safety policies and programs and provide technical assistance and support to ensure that schools have effective programs and policies.

Evaluation Strategy: Describe monitoring methods.

Evaluation Strategy: Describe the types and availability of technical assistance and support.

Goal 3: Afford students with opportunities to apply technology effectively to gain knowledge, develop skills, and create and distribute artifacts that reflect their understandings.

Objective 3.1: Provide and support professional development that increases the capacity of teachers to design and facilitate meaningful learning experiences, thereby encouraging students to create, problem-solve, communicate, collaborate, and use real-world skills by applying technology purposefully.

Strategy 3.1.1: Identify and disseminate information and resources that help schools provide ongoing, personalized, and just-in-time professional development for teachers implementing technological and pedagogical innovations.

Evaluation Strategy: Describe the identification of resources.

Evaluation Strategy: Describe the dissemination of information.

Evaluation Strategy: Describe the extent to which these information sources are accessible and useful with regard to giving ongoing, personalized, and just-in-time support.

Strategy 3.1.2: Enhance curricula using Internet resources and software that encourage creativity, collaboration, and problem solving.

Evaluation Strategy: Describe curriculum enhancement (list of Web resources and software, including their instructional objectives).

Evaluation Strategy: Describe the availability of resources.

Evaluation Strategy: Describe access to these resources.

Strategy 3.1.3: Promote the safe and responsible use of social media.

Evaluation Strategy: Describe the state's efforts to promote safe and responsible use of social media.

Strategy 3.1.4: Provide opportunities for students to participate in global communication and collaboration.

Evaluation Strategy: Describe the state's efforts to provide students with opportunities to participate in global communication and collaboration.

Strategy 3.1.5: Identify and disseminate resources to help school boards and administrators develop and evaluate technology policies that effectively balance the need for instructional innovation with safety and security.

Evaluation Strategy: Describe the identification and dissemination procedures that help school boards develop and evaluate technology policies.

Objective 3.2: Ensure that students, teachers, and administrators are ICT literate.

Strategy 3.2.1: Identify and disseminate information and resources to ensure that schools can effectively assess and report ICT literacy.

Evaluation Strategy: Describe the identification and dissemination procedures that help school boards develop and evaluate technology policies.

Strategy 3.2.2: Monitor the assessment of ICT literacy in schools and provide technical assistance and support to schools as needed.

Evaluation Strategy: Describe the monitoring processes.

Evaluation Strategy: Describe the technical assistance efforts.

Evaluation Strategy: Describe the support efforts with regard to helping localities find resources to assess ICT literacy.

Strategy 3.2.3: Provide and support high-quality professional development focused on the acquisition and application of ICT skills for teaching, learning, and school management.

Evaluation Strategy: Describe the development of ICT-related professional development for teaching, learning, and school management.

Evaluation Strategy: Describe the types, scope/extent, accessibility, and perceived quality of the professional development offered.

Evaluation Strategy: Document the professional development program attendance.

Strategy 3.2.4: Provide opportunities for teachers and students to learn to deconstruct and construct media messages.

Evaluation Strategy: Describe the opportunities provided to teachers and students to deconstruct/construct media messages.

Evaluation Strategy: Document the state-recommended media literacy guides.

Objective 3.3: Implement technology-based formative assessments that produce further growth in content knowledge and skills development.

Strategy 3.3.1: Identify and disseminate information about technology tools and systems to help schools implement cognitively-based assessments.

Evaluation Strategy: Describe the identification and dissemination process for technology tools and systems that facilitate cognitively-based assessments in schools.

Strategy 3.3.2: Design and implement pilot projects to explore technology-based assessment models that tightly integrate curricula, instruction, and assessment.

Evaluation Strategy: Describe the processes of designing the pilot programs.

Evaluation Strategy: Describe the number, types, locations, and scope/extent (breadth and depth) of the pilot projects.

Evaluation Strategy: Document the projects' strategies for integrating curricula, instruction, and assessment into schools.

Goal 4: Provide students with access to authentic and appropriate tools to gain knowledge, develop skills, extend capabilities, and create and disseminate artifacts that demonstrate their understandings.

Objective 4.1: Provide resources and support to ensure that every student has access to a personal computing device.

Strategy 4.1.1: Provide tools that extend students' capabilities, can be customized to meet individual needs and preferences, and support learning.

Evaluation Strategy: Determine the frequencies of personal computing device distribution, specifically (a) how personal computing devices are customized and (b) how the options for customization support learning.

Strategy 4.1.2: Provide opportunities for students to learn and apply ICT skills in local and community settings using a variety of authentic tools.

Evaluation Strategy: Describe how and the extent to which the state provides students with opportunities to learn and apply ICT skills; describe the programs designed to teach students about ICT skills.

Objective 4.2: Provide technical and pedagogical support to ensure that students, teachers, and administrators can effectively access and use technology tools.

Strategy 4.2.1: Provide and support high-quality professional development to assist educators in evaluating and integrating technology tools in ways that foster effective student use.

Evaluation Strategy: Describe the state's role in providing professional development opportunities.

Evaluation Strategy: Describe the types, scope/extent, and accessibility of the professional development offered.

Evaluation Strategy: Describe how the professional development assists educators in evaluating and integrating technology tools in ways that benefit student learning.

Evaluation Strategy: Document the professional development program attendance.

Strategy 4.2.2: Provide ongoing just-in-time support to assist teachers in effectively integrating a variety of technology-based tools into teaching and learning.

Evaluation Strategy: Describe the state's role in providing ongoing and just-in-time support.

Evaluation Strategy: Describe the types of ongoing and just-in-time support and how they assist educators in evaluating and integrating technology tools in ways that benefit student learning.

Strategy 4.2.3: Provide timely and effective technical support to ensure that all tools and the network that supports them are installed and maintained properly.

Evaluation Strategy: Describe the state's role in providing technical support.

Evaluation Strategy: Describe the types of technical support available.

Evaluation Strategy: Describe the extent to which technical support is timely and effective with regard to technology installation and maintenance.

Objective 4.3: Identify and disseminate information and resources that assist educators in selecting authentic and appropriate tools for all grade levels and curricular areas.

Strategy 4.3.1: Identify and disseminate information about new and emerging technologies.

Evaluation Strategy: Describe methods of identifying and disseminating information about new and emerging technologies.

Strategy 4.3.2: Design and implement pilot projects to evaluate a variety of personal computing devices.

Evaluation Strategy: Document the state's efforts to support pilot projects.

Evaluation Strategy: Document the processes of designing and implementing the pilot projects.

Evaluation Strategy: Describe the number, types, locations, and scope/extent (breadth and depth) of the pilot projects.

Evaluation Strategy: Describe the methods of the pilot projects for evaluating personal computing devices.

Goal 5: Use technology to support a culture of data-driven decision making that relies upon data to evaluate and improve teaching and learning.

Objective 5.1: Use data to inform and adjust technical, pedagogical, and financial support.

Strategy 5.1.1: Model the use of data to inform strategic plans and purchases.

Evaluation Strategy: Describe how the state uses data to inform strategic plans and purchases.

Evaluation Strategy: Describe how the state models data use to divisions and locales to inform strategic plans and purchases.

Strategy 5.1.2: Conduct an annual survey and provide local education agencies with an annual statewide technology status report.

Evaluation Strategy: Document when, where, and how the survey is conducted.

Evaluation Strategy: Document the dissemination of survey results.

Objective 5.2: Provide support to help teachers disaggregate, interpret, and use data to plan, improve, and differentiate instruction.

Strategy 5.2.1: Provide training and support to help ITRT interpret data and assist teachers in using technology effectively to address data-supported needs.

Evaluation Strategy: Describe the state's role in providing ITRT training.

Evaluation Strategy: Describe the types, scope/extent, and accessibility of the professional development offered.

Evaluation Strategy: Describe how professional development enables ITRT to use student achievement data to help teachers use technology in ways that optimize student learning.

Strategy 5.2.2: Identify and disseminate resources to assist ITRT in training teachers to disaggregate, interpret, and use data for instructional improvement.

Evaluation Strategy: Describe the types of resources disseminated.

Evaluation Strategy: Describe the dissemination processes.

Evaluation Strategy: Document how these resources help ITRT use student achievement data to inform teachers about ways to improve instructional technology to enhance student learning.

Objective 5.3: Promote the use of technology to inform the design and implementation of next-generation standardized assessments.

Strategy 5.3.1: Design and implement pilot projects that support technology-based assessments, including simulations and game environments, innovative delivery platforms, and multiple ways for students to demonstrate understanding.

Evaluation Strategy: Describe the processes of designing the pilot programs.

Evaluation Strategy: Describe the number, types, locations, and scope/extent (breadth and depth) of the pilot projects.

Evaluation Strategy: Describe the technology-based assessments that are developed.

"A learning environment has to be structured to achieve the ultimate goal of education: the educated person."

—Ibrahim Hefzallah

2010-15

Grounding the Framework in Research

Environment

The first step in supporting student learning is establishing an effective learning environment. The identification of 21st century skills and the rapidly changing nature of technology—which demand and support these skills—require schools to adapt their traditional approaches to environments.

In the recent past, the student environment often consisted of traditional school desks, cheerful classrooms with bright (but static) bulletin boards, and group spaces—like cafeterias and auditoriums—where the whole school could gather. Such environments supported monolithic methods of instruction, as teachers led students step-by-step through each subject area and grade level.

The term *environment* now addresses much more than classrooms; it refers to the extended classroom, which can range from museums, to local ponds, to virtual reality, to blended environments that combine physical spaces with the virtual world. Sharon Smaldino, Deborah Lowther, and James Russell (2008) define a learning environment as the "learning setting," comprising "physical surroundings in which learning is expected to take place"; this can include "the classroom . . . the laboratory (computer lab, science lab, or language lab), library, media center, playground, field trip site, theatre, study hall, and at home" (p. 16).

In the National Research Council's report, *How People Learn*, an effective learning environment is described as learner-centered, assessment-centered, knowledge-centered, and community-centered. Learner-centered environments consider the knowledge, skills, and attitudes that students bring to the classroom. A knowledge-centered environment considers what is taught, why it is taught, and what mastery looks like. In the assessment-centered environment teachers employ ongoing formative assessments to monitor and demonstrate student progress, enable students to revise and improve their thinking, and help them identify problems that need to be addressed. Finally, the community-centered environment establishes norms for the classroom and makes connections to the world beyond the classroom to support core-learning values (Bransford, Brown, & Cocking, 2000). Technology, when used effectively, can help create and support this type of learning environment.

Technology integration has required educators to look at nontraditional physical space issues, such as organizing desks in computer labs to maximize learning, installing proper chairs and monitors to reduce back and eye strain, and instructing students to take regular breaks to avoid repetitive stress syndrome. Technology integration, with its emphasis on teamwork and multiple activities, also has encouraged the use of classroom stations and areas where students can collaborate. These concepts have been important leaps forward for classrooms, which have been laid out based on essentially the same approach since the days of one-room schoolhouses.

To support technology use in learning 21st century skills, the physical environment definition must be extended to address infrastructure, including wires, connections, computers, and displays. Infrastructure comprises everything from physical equipment to human resources, the availability of outlets to timely technical support. To be robust, this environment must be adequately flexible to adapt as technology changes. Additionally, environments must be safe; this includes hardware and software interventions, teacher monitoring of activity, and student education on healthy behavior.

Technology also extends teaching and learning beyond the structured hours of the school day, providing a 24-hour-a-day opportunity to access resources and information (Harwood & Asal, 2007). This unprecedented blending of technology and the learning environment is, in the broadest sense of the term, multidimensional—spanning both space and time; yet, each school-based environment must reflect the values, mores, and characteristics of a particular community in a particular historic time. Proper policies and procedures provide needed grounding for students.

Flexible and Equitable

To state the obvious, the future of technology is exponentially unpredictable. Technology resources in school buildings must be adequately *flexible* to adapt easily to changes. Students currently have access (not exclusively in schools) to innumerable technologies that allow them to acquire knowledge and generate products. These technological possibilities will increase dramatically in number and variety over the next six years.

In the world of technology, the term *learning environments* holds nearly limitless possibilities. Physical spaces can be reconfigured temporarily depending on the changing needs of students, such as when they need to work individually or collaboratively (Brodersen & Iversen, 2005). Even the physical walls are no longer limited to being static surfaces; special *paint* can convert them into projection surfaces, and increasingly thinner and larger displays and televisions are transforming surfaces that define physical spaces.

K-12 schools are beginning to look at *smart spaces*—open environments that intuitively provide appropriate tools depending on the students' demonstrated skills and specific tasks. Such flexibility is possible because miniscule technological equipment now can contain exponentially more computation capability than super computers of the recent past. As Bill Mark (2001) notes, this makes decision making about computation "more about spaces than devices" (p. 52).

Wireless devices—particularly handheld and laptop computers—and small devices, such as tiny palm-sized projectors, make it easier to reconfigure spaces. Mobile learning offers tremendous flexibility (Li, Lau, Shih, & Li, 2008). GPS receivers and other sensors can factor a learner's location and enable the learning environment to respond to a command or request. Relevant information or activities can be delivered to the student's relative position within that physical environment.

Cognitive scientists and 21st century skills experts have called for technologically supported environments that enable students to learn—underscoring the importance of technology availability and access. The gap between students and access to technology-based resources, called the *digital divide*, has been a concern since the launch of technology in schools (Davis, Fuller, Jackson, Pittman, & Sweet, 2007). Technology generates new levels of inequality among students outside of school; those from a higher-income family or with a higher achievement level have more opportunities to interact with technology than students from a lower economic status (Brown-L'Bahy, 2005; Davis, Fuller, Jackson, Pittman, & Sweet, 2007).

The issue, however, is not merely one of access but how the technology is used (McGrath, 2004). Placing students in technologically rich learning environments fosters additional use of such tools and helps level the playing field (Schroeder & Zarinnia, 2007). The flexibility of technology provides a learning environment in which students can select the tools most appropriate to their needs and comfortable to their learning styles (Kelly, 2008).

Project *ROAR*: *Opening New Worlds of Learning*

Project *ROAR*, a Radford University initiative, develops augmented reality learning simulations that enhance middle school science teaching and learning in southwestern Virginia. The project effectively blends the real and virtual environments. It uses handheld computers and GPS receivers to correlate students' real-world locations to their virtual locations in the simulation's digital world. As students move around a physical location, such as playgrounds or sports fields, maps on their handheld devices superimpose digital objects and virtual people from the augmented reality on real space. When students come within approximately 10 feet of these digital artifacts, video, audio, and text files provide narrative, navigation, and collaboration cues as well as academic challenges. This technology helps students break down classroom walls and expand their learning environment as far as their minds can take them.

Most importantly, the environment should be developed around the needs of the school, the subject and content to be taught, and specific goals and objectives (Hefzallah, 2004; Kelly, 2008; Price, 2007). Schools need to become empowered to design and develop such learning environments.

Learner Centered and Social

Howard Gardner (1993, 1999) posits that students have multiple intelligences, though they generally do not excel in more than a few. Within these intelligences, they possess different *learning styles*. In the past, some of these students, such as visual learners or kinesthetic learners, have found it more difficult to adapt to conventional classroom settings. Technology allows students to use tools that best suit their learning styles and interests and that prepare them to continue their learning beyond school.

This characteristic of a technology-enabled environment supports a learner-centered approach to education, validated by 21st century skills scholars and cognitive science researchers (Bransford et al., 2000; Gee, 2003; Hefzallah, 2004). Learner-centered environments facilitate connections between students' existing knowledge, skills, and attitudes and the current learning situation (Bransford et al., 2000). Technology can help create an environment where students can solve real-world problems that are meaningful to them. Other aspects of the learner-centered approach are pace and timing. Technology again allows students to determine the pace that best suits their learning styles and access learning at any time and in any place. Placing the responsibility for learning on students and providing them with the proper tools, they will learn how to learn for the rest of their lives.

Ironically, in a student-centered environment, the teacher is more important than ever. Lejeane Thomas and Don Knezek (2002) state, "The key individual in helping students develop [technology] capabilities is the classroom teacher. . . . The teacher is responsible for establishing the classroom environment and preparing the learning opportunities that facilitate student use of technology to learn, communicate, and develop knowledge products" (p. 16). Teachers who know how to leverage the learning power of technology are essential to student-centered learning.

While textbooks can be valuable resources, they clearly have limitations. "Few resources are more prevalent in schools in textbooks; yet in many cases, textbooks inadequately address the needs of students and teachers. Outdated information is common due to the nature of textbook adoption cycles, and the information is often ill-suited to curricula and assessments. Printed textbooks containing inaccuracies often remain in use for six to eight years and literally pages of corrections are being posted to publishers' Web sites." (McGraw & Ross, 2001, p. 5). Furthermore, many textbooks do not support the learning of 21st century skills. Virginia is currently exploring traditional textbook alternatives such as the *flexbook*, a free and open-source textbook platform where one can build and edit collaborative textbooks as a means to address these issues.

ICT allows students to learn foundational knowledge and high-level skills in ways that help them the most. Intangible characteristics of an ICT environment are based on a pedagogy that supports 21st century learning. It includes the environment's ability to enable learner-centered activity (focusing on individuals with reasonable physical and virtual access to technology) and community interaction (focusing on social groups that gain physical and virtual space for using ICT). Effective technology integration "transforms the learning environment so that it is student-centered, problem and project centered, collaborative, communicative, customized and productive" (CEO Forum, 2001, p. 5).

The social aspects of learning have not been universally emphasized in current educational practice. However, research shows that "(m)uch of what humans learn is acquired through discourse and interactions with others. For example, science, mathematics, and other domains are often shaped by collaborative work among peers. Through such interactions, individuals build communities of practice, test their own theories, and build on the learning of others." (Pellegrino, Chudowsky, & Glaser, 2001, p. 5). By creating environments that encourage and enable these social dimensions, technology provides for deeper learning.

Contextual, Dynamic, and Safe

A flexible environment allows teachers to respond more adroitly to individual student needs. Since technology can connect students to a world outside their classrooms, it can foster learning in the *context* of real-world situations and opportunities. A lesson may be grounded in local political issues or a worldwide environmental crisis. Mobile technology allows students to move out into their community to investigate, gather data, test hypotheses, and deliver conclusions to concerned parties. Videoconferencing capabilities allow students to interact in real time with scientists studying the desertification of equatorial countries or with archaeologists at an excavation site in Jamestown.

Students learn within the context of the local mores and standards. The community and school must influence the environment in which students are learning. The community's standards should influence the rules and regulations around the use, or misuse, of technology. A school's specific learning goals and objectives strengthen the technology environment, which, in turn, reinforce the curriculum.

Technology-enhanced environments must also remain *dynamic*—open to change and the influx of new enabling technologies. These newer technologies can motivate students to learn more and push themselves harder. In this area, technology environments can learn from areas such as gaming. The Learning Federation (2003) identified five components in its *Learning Science and Technology R&D Roadmap*. Among the components related to instructional design for new technology-enabled approaches to learning is "understanding how features of games can be used to improve learning" (p. 9). James Paul Gee (2003) suggests, "When kids play video games they experience a much more powerful form of learning than when they're in the classroom. . . . The secret of a video game as a teaching machine isn't its immersive 3-D graphics, but its underlying architecture. Each level dances around the outer limits of the player's abilities, seeking at every point to be hard enough to be just doable" (p. 68).

Just as student *safety* is important in the physical learning environment, it is equally essential in any virtual learning environment. Educators must regularly emphasize responsible technology use, going beyond the obvious use of filters and restrictive policies to achieve student self-awareness and self-control. In physical and virtual environments, educators are responsible for protecting students; in upper grade levels, this responsibility should gradually shift to the students. Technology that connects people from all over the world requires students to work sensitively with others and become aware of their own vulnerabilities.

Ultimately, learning environments are much different than they were 25 years ago. The increased emphasis on collaboration, student responsibility for learning, communication, access to higher levels of information, and critical thinking has permanently changed the traditional learning environment (Niess, Lee, & Kajder, 2008). The environment must take these factors into account and allow room for change while providing students with real-world contexts.

A dynamic, flexible, and authentic environment is essential to student learning in the 21st century. Ibrahim Hefzallah (2004) states, "We learn to drive a car by being behind the wheel and driving the car, not by reading about it. We learn to speak a foreign language by speaking the language. . . . We learn by taking an active role in life situations" (p. 47). To accomplish this, technology can help make the instruction environment flexible, dynamic, learner centered, contextual, social, and intelligent.

"The first object of any act of learning, over and beyond the pleasure it may give, is that it should serve us in the future. Learning should not only take us somewhere; it should allow us later to go further more easily."

—Jerome S. Bruner

2010-15

Grounding the Framework in Research

Engagement

E*ngaging students* is one of the most frequently stated and vaguely understood phrases in education. It is used variously in reference to capturing students' attention, sparking their interest in a topic, or connecting with them on an important point. In reality, *engagement* can refer to any of these definitions; but, most importantly, engagement means helping students find relevance in a lesson in their everyday lives. To this end, teachers must help students understand how to tackle an assignment and discriminate—in short, how to learn.

Through his school-reform center, Phil Schlechty (2000) has shown that students become more engaged in their learning when it is more personal and meaningful. He has identified five levels of engagement:

1. Engagement—high attention and high commitment
2. Strategic compliance—high attention but low commitment
3. Ritual compliance—low attention and low commitment
4. Retreatism—no attention and no commitment
5. Rebellion—diverted attention

While students may arrive in the classroom with a pre-defined or preconceived level of engagement, Schlechty has found that an attention-grabbing lesson can increase this level. In fact, he has identified a direct correlation between an effectively designed activity and a student's engagement level.

Although ICT may be used somewhat passively to teach foundational knowledge, its interactive capabilities support 21st century skills most effectively. Most ICT—but especially new tools—facilitate engagement or interaction between humans and technology and between humans and humans.

Culturally Situated Design Tools

This program helps students learn standards-based mathematics in the context of various cultures, including African, African American, Native American, Latino, and a general youth subculture. Students use mathematics to simulate original artifacts from these cultures and develop their own creations. For example, the Cornrow Curves software lets students use the geometric principles of translation, rotation, reflection, and dilation while creating African American cornrow hair designs on the computer. Another software helps students learn about Cartesian coordinates while designing traditional Alaskan baskets. Contextual programs like this help engage learners by personalizing and making the experiences relevant.

Neomillennial students are no longer satisfied with obtaining all their information from textbooks or instructors; rather, these "*digital* students learn in classrooms where the technology is a seamless component of learning that expands the educational environment beyond the classroom walls and beyond the existing capabilities of learners" (Smaldino, Lowther, & Russell, 2008, p. 335).

Any technology plan must offer support for student equipment use. Schools and surrounding communities increasingly support student engagement with technology by extending opportunities for equipment use. They have attempted to bridge the digital divide by allowing after-school access to computers; partnering with public libraries and other facilities to provide computer access; or collaborating with local higher education institutions to gather and use equipment, services, and support (Cuban & Cuban, 2007). These types of opportunities cultivate personal and meaningful learning as students gain self-reliance and problem-solving skills.

A significant challenge is that children all too frequently accept any information fed to them. In this media-intensive world, that information can be extremely unreliable and, in some instances, potentially harmful. As part of learning to engage, students must learn how to examine material and deduce good from biased information. They also must be engaged in authentic learning, allowing them to become partners in the teaching process.

The literature on 21st century skills makes several points clear. First, learners must be prepared to collaborate and communicate successfully with others. Second, they should be capable of using their resources and engage in problem solving with all available resources. Third, beyond learning mere content, learners must be able to interact with and transfer knowledge in multiple situations (Conference Board et al., 2006; CEO Forum, 2001; Partnership for 21st Century Skills, 2007).

Personal and Interactive

A key aspect of engagement is that teachers must choose the appropriate technology to fit each student's life and learning style. This *personal* approach must be geared to how students want to learn. The learning process for each student is unique. Students should be allowed to help craft the learning experience to make it their own.

Web 2.0 technologies, in particular, enable students to personalize the content and media to reflect their preferences. Students are no longer just content consumers; they now have become content producers through podcasts, digital videos, etc. *YouTube* is the most high-profile example of this shift.

Personalizing the learning experience connects naturally with interdisciplinary teaching, in which educators can approach the same basic knowledge or skill set through various subjects. For instance, students can learn about basic mathematics principles through a work of art or one of their favorite songs. The students' personal interests can be a learning portal.

As noted in the Environment section, ICT has expanded the learning environment beyond physical walls. This fundamentally changes the environment into an interactive factor rather than a passive factor and opens a vast assortment of engagement opportunities, including virtual worlds for project collaboration, touch-sensitive screens, flexible projection surfaces, and works of art with attached radio transmitters that send information directly to students' handheld devices. Teachers and students now have access to more informational resources, learning communities, multimedia presentations, and other content and communications tools through the Internet and other ICT.

The addition of technology to learning environments contributes an added element of student engagement and becomes critical in the development of higher-order thinking skills. Technology and media present different characteristics (beyond traditional teaching tools) and allow students to learn according to their preferences (Hefzallah, 2004). This generation is more aware of what it wants from education. Educators must ensure that each student has an equal opportunity to learn (U.S. Department of Education & Office of Educational Technology, 2004).

Universal Design and Adaptivity

Universal design has existed in architecture and city planning for years, advanced significantly by the Americans with Disabilities Act. Universal design generally refers to construction (e.g., buildings, sidewalks) that accommodates people of all abilities (e.g., wider doorways for wheelchairs, standardized placement of signage). It has the same definition in education; although, accommodating a diverse student population requires numerous approaches in the same classroom. Total equity largely was impossible in the past. Educational technology, however, allows teachers literally to program a different lesson for each student based on individual learning needs, cultural backgrounds, and personal interests. In short, universal design for learning is not limited to special education; it is about differentiating instruction for all students. That being said, careful consideration should be given to the importance of assistive and learning technologies for students with special needs. To address this topic more fully, there is a companion document to present solutions that maximize communication, instruction, learning, and convenience for users across the lifespan. This document is available at www.ttaconline.org.

In 1998, Congress amended the Rehabilitation Act to make electronic and information technology more accessible to people with disabilities. Section 508 of the Rehabilitation Act requires federal agencies to eliminate accessibility barriers and utilize technologies that help individuals with disabilities use the Internet and other electronic resources. In 2004, Congress revised the Individuals with Disabilities Education Act (IDEA), further strengthening the rights of people with disabilities. The Commonwealth of Virginia is committed to making all educational resources—electronic and printed—accessible to the entire student population.

The essence of Section 508 and IDEA is that individuals with disabilities should have equitable learning experiences. In this sense, technology can play a critical role. One piece of equipment can meet the diverse needs of multiple students, thus providing choices (Hefzallah, 2004). This is a key feature of most assistive technologies. For example, tangible user interfaces can be effective with younger children or children with special needs. These interfaces permit direct physical manipulation and are much different than graphical user interfaces on desktop systems, which rely primarily on the keyboard and mouse. Other recent developments are touch and gesture-based interfaces such as those found on the iPhone and iPod touch.

Another benefit of technology is its *adaptivity*. Unlike textbooks, most educational technology is not a one-way communication medium. Technology typically is interactive in the sense that students do not just receive information but also can adapt, interpret, or improve upon it. This interactivity can occur in real time, so students learn when and where they are ready.

Collaborative

The ultimate purpose of education is to prepare students for life and work, which means education requires more team-based opportunities. In the past, team-based activities were limited and generally restricted to classrooms or schools; the *collaborative* possibilities now are unlimited.

Cognitive science research (Bransford et al., 2000) shows that students learn better when they participate in group-learning activities. Technology provides a means by which students—whether they are classmates or students from different countries—may work in groups. Many tools can be used collectively to brainstorm, create, edit, and share artifacts, expertise, and knowledge.

The Internet allows students to team with individuals from around the world, ranging from other young people to experts on various topics. Environments that include collaborative teaching strategies, such as cooperative learning groups, encourage students to engage with other students and the learning materials. Students increasingly are learning from one another in teams facilitated by a guiding teacher and an intermediary technology.

Web-based tools allow students to collaborate beyond their classrooms or schools. Web and videoconferencing tools support communication, while tools such as *Zoho* enable students to produce and share documents—and even edit collaboratively in real time. Oracle has developed Thinkquest.org to connect students from all over the world in short- and long-term projects; these powerful collaboration tools are based on real-life models used by scholars and scientists. With technology, students need not occupy the same space, or even the same time zone, to work with one another to increase their learning.

Wikipedia is another good example of collaboration. A wiki allows students to contribute to the collective intelligence by collaborating with others to refine content and information on a continual basis. Rather than resist Wikipedia due to possible inaccuracies, schools can use this tool to teach students how to review information critically and disseminate their own research and writing.

Web 2.0 technologies can support proven teaching strategies that encourage student engagement and interaction. These strategies include problem-based and cooperative learning, which promote personal connections, student responsibility, and social interaction (Herrington & Kervin, 2007; Jonassen, Howland, Moore, & Marra, 2003; Smaldino, Lowther, & Russell, 2008).

Social networking tools can allow students to identify, interact, and collaborate with one another. While most reporting focuses on the negative aspects of social networking, schools need to embrace these outlets and find meaningful ways to incorporate them. One possibility is online portfolios, which mirror the way students use sites like *MySpace* and *Facebook*—in other words, these sites present students' interests and profiles, identify people with similar interests, and allow them to interact with one another. Online portfolios take the same approach but present students' academic profiles.

Some educators have misinterpreted the concept of integrating technology as merely using e-mail to communicate with parents, developing a class Web page, maintaining grades electronically, or using PowerPoint in a classroom presentation. While these tasks are important, they neither constitute technology integration nor student engagement (Smith, Bichelmeyer, Monson, & Horvitz, 2007). True engagement requires students and teachers to apply appropriate technology to learning situations. It requires technology that can be personalized and adapted to individual students and that provides interactive and collaborative experiences.

"All our steps in creating or absorbing material of the record proceed through one of the senses—the tactile when we touch keys, the oral when we speak or listen, the visual when we read. Is it not possible that some day the path may be established more directly?"

—Vannevar Bush, 1945

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Grounding the Framework in Research

Application

In the context of the six-year plan, the term *application* does not refer to software specifically but how the software is *applied*. A typical problem is that people often become familiar with a certain software title and try to apply it to every situation. Students need to learn how to analyze a problem and then select the proper tool (see Tools section). For example, although it would function, Microsoft Word is not the most appropriate program for designing a multimedia project with photographs. Likewise, students do not need PhotoShop just to generate a basic text document.

Under the goals of the previous six-year technology plan, teachers and students became familiar with the characteristics of different software programs. Current technology, however, offers a much wider array of choices to students. For instance, wikis provide word-processing capabilities that rival the basics of Microsoft Word, but the document is stored online and can be coedited by others.

As teachers become familiar with the capabilities of equipment, they must employ knowledge of human learning to make informed pedagogical decisions about the application and use of the tools (Hefzallah, 2004). Mark Warschauer states, "What is more important about [technology] is not so much the availability . . . but rather people's ability to make use of that device . . . to engage in meaningful social practices" (Harwood & Asal, 2007, p. 82).

This shift in roles requires continual professional development to keep teachers up-to-date and adequately prepared. Maggie Niess, John Lee, and Sara Kajder (2008) argue that continual learning and preparation are the "keys for assuring educational reform that adequately prepares students to meet the challenges of the twenty-first century" (p. xiv). As such, teachers "must consistently engage in learning about new and emerging technologies . . . how to teach both *about* and *with* the new and emerging technologies" (p. xiv). The message is that teachers can no longer teach in the manner they were taught; they must remain as flexible and dynamic as the technology itself (Mehlinger & Powers, 2002).

Students increasingly use ICT to research any topic of interest to them, providing more opportunities to learn foundational knowledge. Armed with ICT literacy skills, students can evaluate the accuracy and value of information they discover on the Internet.

Fresh Fish on Sacred Soil: Engaging Learners on Virginia's Civil War Battlefields

A project initiated by the Virginia Department of Education Office of Educational Technology creates an environment where learners of all ages can experience Virginia's Civil War battlefields in an innovative and authentic way. It leverages GPS-enabled mobile devices, digitized primary source materials, and social media tools to promote a deep and shared understanding of the Civil War. The project allows battlefield visitors to use a variety of digital tools and media to access, contribute to, and distribute historical narratives about the Civil War. Learners can access and share text, new and historic images, audio, and video artifacts. Applying common technology tools (e.g., iPhones, GPS devices) to learning helps make the subject—in this case, the Civil War—more relevant to students. It also helps learners better understand the capabilities of everyday technology devices and how to choose the right tool for the intended purpose.

Most significantly, ICT can emulate authentic 21st century practices, such as problem solving, communication, innovation, and creativity. These skills are increasingly important in the business world. M. B. Eisenberg (2003) states that as students use technology for problem solving, they gradually will learn more about its application and potential rather than just developing isolated, discrete skills; this will help them "perform better in classroom curriculum," which is "essential if we are to put students in a position to succeed in an increasingly complex and changing world" (pp. 13-15).

Content Acquisition and Scaffolding

Some scholars assert that learning can be enhanced and even accelerated with the use of graphically-baed interactive models and simulations (Bransford, Brown, & Cocking, 2000). Learners also tend to develop deeper understandings of subjects when they participate in inquiry-based investigations of authentic problems. This presents hope and challenges since all students learn and progress in a unique manner.

Although technology is most effective in nurturing students' 21st century skills, it also can help with *content acquisition*. Not all drill-and-practice programs are mere electronic worksheets. Some software programs can respond intelligently to the users' progress and assist them in learning a concept or skill.

Regardless of the use, good ICT helps teachers provide *scaffolding* between what students already know and the acquisition of new knowledge. Eisenberg (2003) states, "Students need to be able to use technology for a purpose, flexibly and creatively"; he adds, "helping students learn to apply technology in these ways requires a major change in the way computing and technology are often taught in school" (p. 13). This means moving from teaching about isolated skills and focusing more on application.

Tools should help students move from level to level in technology learning. This scaffolding can help ease students' transitions into more advanced technology. Educators should provide this scaffolding for each student based on individual learning styles. According to Dr. Zheng Yan (2007), "The scaffolding needs to be adjusted continually to meet individual needs, which vary based on children's physical, social, and cognitive stages as well as personalities" (p. 1).

Students' reliance on a teacher diminishes as they become increasingly comfortable with making decisions, using appropriate tools, and relying on other students to complete tasks. By offering extensive resources and collaborative opportunities, teachers can scaffold student learning experiences to "incorporate collaborative work with multiple paths to exploring ideas" (Niess, Lee, & Kajder, 2008, p. 49). As students respond to these learning situations, they will "learn to use technology as a tool for learning" (Price, 2007, p. 49), where the tool becomes *part* of the learning process, not what the learning process is *about*.

Communication and ICT Literacy

The growth of distance education is a prime example of applying ICT effectively for learning. Online and virtual courses dramatically are changing the ways students learn and interact (Smaldino, Lowther, & Russell, 2008). Distance education can accomplish a number of purposes, from solving overcrowding problems, to providing students in rural areas with more complex and challenging coursework, to educating incarcerated students (Price, 2007).

Today's students engage in national and international learning communities, using technology to break through geographical and cultural barriers, such as distance (Price, 2007). Distance education and virtual learning environments also benefit educators, who use Web 2.0 tools (e.g., webinars, blogs, discussion boards) to participate in professional development opportunities (Price, 2007; Wyatt, 2007). Betsy Price (2007) adds that technology such as the Internet provides teachers with a way to network nationally with peers. She states, "The Internet addressed this problem of isolation by bringing communities of like-minded teachers together" (p. 13).

New responsibilities come along with these new opportunities. A large part of ICT literacy is learning how to use these valuable technologies in effective, safe, and ethical ways. Students can learn to use technology on their own (as they often have), but they need the guidance and wisdom of their parents, teachers, and administrators to learn and apply the mores of their local community to their technology use.

Innovation, Creativity, and Problem Solving

Students who use technology for learning typically find that these tools help them become more innovative and better problem solvers. Technology not only enables students to learn creativity and innovation skills but also challenges them to be more inventive. For instance, a Tablet PC facilitates simple changes and edits, which can assist students who may be hesitant to draw illustrations due to the fear of making a mistake. Students who want copyright-free music for a podcast can use GarageBand to write and record their own original compositions or find loops or other royalty-free musical artifacts online that can be combined to create unique compositions. Writers looking for innovative ways to express their ideas can turn to Thinkmap's Visual Thesaurus to map related words. Students answering a probing question posed by a peer from India can use Inspiration visual mapping software to connect ideas. These technologies are easy to learn and adapt to various ends, freeing the students' energy to tap their creativity.

Some schools actively integrate games into teaching and learning plans. Games, though often met with skepticism, allow students to take control of their learning and interact with content (Hefzallah, 2004). James Paul Gee (2005) suggests that many good principles of learning are built into video games and can empower learners, promote problem solving, and lead to deeper understanding. In addition, the navigation and decision-making opportunities engage students and increase their sense of responsibility, which fosters a more learner-centered environment. Educational simulations provide excellent hands-on practice of certain skills, just as they do in professional settings. While not all games are beneficial to learning, many mirror real-life situations and offer another medium for presenting authentic materials and opportunities to students. The decision making required in such situations can be transferred to other learning and work environments, thus increasing the chances of student success and achievement (Hefzallah, 2004; Smaldino, Lowther, & Russell, 2008).

Classroom instruction traditionally has addressed problem-solving skills but typically in an inauthentic manner, i.e., two trains leaving Cleveland at different speeds. Technology, on the other hand, allows students to address real-world problems, such as climate change or world hunger, in a collaborative and participatory manner. An excellent example is the GLOBE Program, which challenges learners through inquiry-based investigations of the environment. As John Bransford, Ann Brown, and Rodney Cocking (2000) observe, "This approach to learning is very different from the typical school classrooms, in which students spend most of their time learning facts from a lecture or text and doing the problems at the end of the chapter" (p. 195).

In helping students apply technology, educators need to consider how technology changes. The key to understanding this topic is that teachers and students must analyze a situation carefully to determine what they want the technology to accomplish, choose the right tool, and then complete the task—adapting when needed. The 21st century skills of communication, ICT literacy, innovation, creativity, and problem solving are all enhanced by the right technology applications.

"We shape our tools and afterwards our tools shape us."

—Marshall McLuhan

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Grounding the Framework in Research

Tools

Like engagement, the term *tool* is used vaguely in the education world. In the context of this six-year plan, tool does not refer to specific hardware; rather, it is a matter of selecting the most useful means with the most appropriate characteristics to perform a particular function.

Specific technology tools often are at the forefront of major decisions, such as planning for technology purchases, dissemination, and use. Niess, Lee, and Kajder (2008) state, "Educators must continually examine the potentials of the new technologies" and decide whether the "current curriculum [will] stay the same or shift with the impact of the newer technologies" (p. 234). The latest and greatest technology tools may not fit the needs of the school, teachers, or students. In addition, since these tools change so rapidly, new purchases can become a constant drain on any school division budget.

To save time, money, and resources, it is just as important to examine existing tools and determine what can and cannot be done with them. It is important to select tools for meaningful and necessary purposes, not just because they are available (Price, 2007).

As newer technologies are brought into schools, educators often expect the new equipment automatically to perform the same or better as the old tools; however, teachers must consider several factors, such as the specificity, stability, and function of the equipment (Koehler & Mishra, 2008). As with any instruction, teaching with technology requires meticulous planning (Smaldino, Lowther, & Russell, 2008). Teachers should recognize the aptitude of their audience (students), the objective of the lesson, capabilities of the available technology, and the properties of the learning environment. In some cases, older technologies may work just as well or be more reliable. As a first step, educators should examine and try to adapt the existing tools.

While selecting the proper equipment is crucial, tools are meaningless without proper training and application (see the Application section). Training for teachers and students should support multiple levels of need. As previously stated, learning discrete and isolated skills may have significant self-efficacy purposes, but it is just as important to be trained properly on function and capability. Teacher training should focus on pedagogy and classroom application and not address issues such as maintenance and repair (Thomas & Knezek, 2002).

Educational technology plans should include tools that engage students in ways that foster 21st century skills. Such tools will adapt to different circumstances and users by changing dynamically based on needs and inputs. Tools for 21st century learners should be sufficiently intelligent to provide learners with information and experiences that fit the pace of the student rather than a predetermined program. They also should incorporate features consistent with the premise of universal design for learning which encourages the equitable use of ICT for the widest number of students possible regardless of their physical, cognitive, or emotional needs as they relate to learning.

Customizable

A tool should be *customizable*, but that does not mean adapting the wrong tool for the intended purpose, i.e., using a spreadsheet as a database. Students need to learn the benefits and limitations of a variety of tools, keeping in mind that nearly all software titles—or at least software versions—eventually become obsolete.

Hefzallah (2004) warns educators about technology fads. While certain tools may come and go with time, it is vital to consider the tool's characteristics, which are not a fad. In other words, tools may change, but the concepts behind their design and development will remain constant and transferable across time. As a result, the capabilities built into each tool can, when performed appropriately, extend the capabilities of teaching and learning.

Along this line, *mashups*—Web sites or applications that combine content from multiple sources—allow students to interact with data and information. One example is *Google Planimeter*, which computes the areas of specific places (e.g., Roanoke, Blacksburg). Another example is *Earthquakes in the Last Week*, which compiles U.S. Geological Survey data and information from *Google Maps* to show recent earthquakes measuring 2.5 or greater on the Richter Scale.

Additionally, Gee (2005) suggests that good video games achieve customizability by enabling players to shape the game play to suit their learning and playing styles. This principle is essential to empowering learners to be responsible for their own learning.

Extending Capabilities

Through the development of environments and understanding student engagement with technology, tools clearly can help *extend learning capabilities* (Price, 2007). Technology can generate added elements of functionality, access, and capabilities. According to Eisenberg (2003), when properly integrated, technology tools can help "extend knowledge and individualize learning" (p. 15). Tools manipulated at a distance, such as remote instrumentation controlled over the Internet, can empower a learner as he or she manipulates these tools to extend the area of effectiveness (Gee, 2005).

Virtual environments, games, and simulations provide students with engaging opportunities that ultimately extend their capabilities. Virtual environments can allow students to visit places or perform tasks that would be impossible or perhaps too dangerous to visit in real life. Visualization technologies can enable students to manipulate molecular structures in their hands. In short, good learning technologies enable students to extend their capabilities in myriad ways—from analyzing, manipulating, and presenting data to accessing and exploring remote parts of the Earth.

Authentic

As educators prepare students to participate in the workforce, it is important to provide them with meaningful and realistic learning opportunities and tools (Jonassen, Howland, Moore, & Marra, 2003). Much of the available technology is equivalent or similar to equipment used in modern workplaces. Most importantly, creating opportunities for students to use and apply ICT tools to solve authentic problems will help prepare them to succeed in the 21st century workplace (Harwood & Asal, 2007; Price, 2007; Smaldino, Lowther, & Russell, 2008; Wyatt, 2007).

Technology can add several dimensions to a learning environment. These capabilities allow teachers and students to engage in authentic learning environments by having access to real-life information and realistic tools found in surrounding environments (Herrington & Kervin, 2007; Jonassen, Howland, Moore, & Marra, 2003). As students engage in authentic learning environments, they use the available tools to become active members in the authentic activities. The mere task of selecting an appropriate tool introduces students to such higher-order thinking skills as analysis, evaluation, and application (Jonassen, Howland, Moore, & Marra, 2003). In addition, student engagement in authentic learning environments encourages independence and self-reliance as well as providing practice for learning good thinking skills.

iPod touch

Effective tools should adapt dynamically to user needs and inputs. One of the best examples is the Apple iPod touch, which daily adds new educational uses—ranging from foreign languages to trigonometry—as new applications are added. These applications expand the capabilities of this versatile tool by leveraging the multitouch interface, accelerometer, Wi-Fi access, real-time 3D graphics, and other integrated features. Collectively, ordinary users and professional programmers alike have created nearly 100,000 applications for the device, many of which can be downloaded for free from the App Store. In the first 18 months of the App Store launch, more than two billion apps were downloaded. This versatile and intuitive device—coupled with an enormous collection of useful and, in many cases, user-created applications—has become an extremely popular and multipurpose learning technology.

Technology should not be used for technology's sake. Even if it is available, technology that does not fit seamlessly into a teacher's instructional plan or goals should not be used. The integration of technology must always be purpose driven and employed to enhance and extend teaching and learning capabilities. Technology should be evaluated for its ability to be customized and its authenticity. It is vital to weigh the potential *affordance* and constraints of technology in relation to goals and objectives (Koehler & Mishra, 2008). Once again, understanding the capabilities and potential of available tools is essential before planning for or integrating technology into the curriculum.

*"I have not failed.
I've just found 10,000 ways
that won't work."*

—Thomas Edison

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Grounding the Framework in Research

Results

The first four framework components lead naturally to *results*, which can be more informal and less time consuming than traditional assessments. The goal is to produce constant improvement by determining what works and what does not, thus increasing student achievement and fostering improved accountability. The key to real improvement, however, is not just assessing *what* students know but *how* they know. As stated by the U.S. Department of Education and Office of Educational Technology (2004), "Having good data to guide decisions in schools and for instruction is critical to ensuring that all the nation's children achieve. New technological solutions have the potential to generate actionable data about school performance" (p. 58).

The previous six-year technology plan focused, by necessity, on traditional assessments; however, as the need for 21st century skills has become more obvious, methods for assessing these skills must also be addressed. Technology may provide the only practical avenue for assessing these skills. As James Pellegrino, Naomi Chudowsky, and Robert Glaser (2001) write, "Technology removes some of the constraints that previously made high-quality formative assessment difficult or impractical for a classroom teacher" (p. 272).

Data-Driven Decisions

Accountability is a pressing reality for every educator. In education technology, results go beyond formal accountability systems, program evaluation, and state and federal accountability requirements and compliance. Results are rooted in *data-driven decisions*, which consist of using concrete data—increasingly acquired in real time—to inform the teaching process.

Technology can enable schools and divisions to collect higher-quality data to help educators track students from kindergarten through postsecondary education, measure student transitions between grade levels and schools, and transfer student information to other school systems and states. A U.S. Department of Education report (2008b) states, "High-quality data is the underpinning for robust accountability systems at the state level and for differentiated instruction inside the classroom. Longitudinal data systems, by following students across grades and schools, help make it possible to

Instant Results: Data-Driven Decision Making

Data-driven decision making is an essential element as educators try to assess student achievement and craft lessons to meet individual learners' needs. Virginia has developed the Educational Information Management System (EIMS) to address these issues. This Web-based system collects required data and stores assessment results to inform decision making based on accurate and timely data. While the information is entered only once, the data can be used in multiple ways. For instance, educators can disaggregate and track data about at-risk students over their entire school careers. Classroom teachers can pull up test scores, drill down to see which students struggled with certain topics, and then formulate remediation for individual students; they also can examine students' strengths and weaknesses longitudinally over several years to determine possible curricular weakness. The EIMS provides instant data to inform instructional decisions and defines instructional gaps by explaining *how*, not just *what*, students learn.

determine which programs are working. These same data systems also are needed for more ambitious reforms, such as pay for performance. At a minimum, such tools as online assessments help to identify which students need extra assistance. They also save teachers' time, and provide them with information that can be acted on immediately versus waiting for the next school year" (p. 6).

The first step for teachers is to recognize how students perform and determine actions that can be taken to make necessary changes. The use of technology to analyze data can be invaluable in assessing student achievement.

Tools can help gather, organize, analyze, and report on schoolwide student achievement. The *No Child Left Behind Act of 2001* (NCLB) has made schools more responsible for reporting on student academic progress. Neil Mercurius (2005) states, "As a result of NCLB, the teaching community is establishing data repositories to analyze information to improve teaching and learning within the school environment" (p. 33). Schools rely increasingly on technology to help establish and maintain student records. Selecting the appropriate tool will minimize and improve the reliability of reporting on student outcomes and achievement (USDOE & OET, 2004).

As Thomas & Knezek (2002) observe, data obtained from assessment should "ensure that the vision for technology use maintains the appropriate direction" (p. 20). It is equally important to assess teaching and student outcomes. Through careful evaluation of the technology, schools can easily assess if tools are being used effectively to meet goals and objectives.

A second level of assessment becomes more localized as technology provides teachers with access to student information. This access allows educators to monitor individual student and whole-classroom progress. As teachers become better equipped with richer data on individual students, they can individualize instruction and differentiate for student needs (Robertson, 2005).

Some technology tools combine several elements of student data. For example, tools can "gather and synthesize diagnostic information about everything [students] do" (Robertson, 2005, p. 31). The teacher can use this data to guide further planning and quickly recognize student needs. In other instances, tools can suggest instructional resources based on the identified needs of the student (Brown & Lemke, 2007). This type of output can assist teachers in generating more individualized instruction to meet student needs. The ease and timeliness of educational reporting through technology "enables teachers to adjust instructional practices to meet varying student needs" (Brown & Lemke, 2007, p. 4).

A third level of assessment is sustainability of outcomes. A goal of educational reporting and data collection is to make informed decisions about future school efforts, including changes in policies and instructional practices or the selection of tools and resources (Thomas & Knezek, 2002). The focus on standardized test scores forces schools to look for additional information to guide these decisions and "sustain student achievement over the long term" (Robertson, 2005, p. 31). When used properly, technology provides schools with extensive resources and a faster way to gather additional data, keep track of student achievement, and connect decisions with achievement levels. Thomas and Knezek (2002) state, "Changes made over time due to technology innovation should exemplify informed decision-making" (p. 20). When data are collected and analyzed appropriately, decisions regarding teaching and learning strategies will be well-informed, reliable, and valid, thus strengthening educational practices and increasing student achievement.

Personalized Learning

Assessment systems must identify what works for each individual student via *personalized learning*. Technology allows educators to ascertain instant detailed assessment information about each student and adapt their teaching accordingly. It also is important to track each point of a student's decision making; otherwise, assessments provide little more than old-fashioned grading of checkmarks and X's for right and wrong.

Using technology for assessment also can address different learning styles and the specific needs of individual special needs students. For instance, some students might find it easier to use graphic elements rather than text for a test. Technology that supports both methods allows teachers to focus on the learning goals for a particular assessment rather than compensating for the barriers.

Technology-based tools in the classroom can lead to an increase in collaborative projects. Sophisticated evaluation tools built into some of these collaborative endeavors help teachers evaluate the performance not only of the group but also of each individual contributor, highlighting particular strengths and challenges. Such evaluation tools encourage the inclusion of powerful group experiences while meeting the necessity of providing individual evaluations.

Intelligent Assessment

Mary Axelson, Tammy McGraw, and Sheila McEntee (2003) write, "New technologies are making it possible as never before to gather, store, and analyze data on student achievement, and thus to develop assessments that capture rich, multidimensional information" (p. 3). Intelligent assessment systems, enabled by these technologies, reflect the depth and complexity of students' understanding and, to the extent possible, serve both formative and summative needs. At the core of these systems are cognitively-based teaching and assessment methods such as those put forward in *Knowing What Students Know: The Science and Design of Educational Assessment* (Pellegrino, Chudowsky, & Glaser, 2001). Technology can document what students know, indicate how they acquire knowledge, and teach them how to learn. It also can demonstrate that students ultimately are personally responsible for their own learning.

Intelligent tutors use current research in cognitive science to create tools that respond to each student based on his or her demonstrated knowledge and skill level, helping them immediately to analyze and remediate their own errors. Other tools use scientific analyses of expert approaches to problem solving to help students learn how to improve their thinking skills.

Over the next six years, assessments will increasingly combine all of these elements to adapt to the needs of each student. *Intelligent assessments* personalize the testing experience, maximize students' strengths, and help them address weaknesses. Intelligent assessments can respond to current needs and adapt to changes in technology, economic conditions, and curricula. Teachers and students will continue to learn how to use the data provided by such assessments more effectively. At the same time, schools need to be aware of the challenges these new technologies pose to student privacy and system security.

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Conclusion

The five components of this technology plan conceptually stand alone on the framework graph. In reality, however, their planning and execution must be seamless. When technology is used effectively, it is difficult to discern the differences among environment, engagement, application, tools, and results. As such, each school and division must enact education plans that implement all five components collectively.

The demands of the 21st century compel schools to incorporate technology in ways that open worlds that were never before possible. Technology "can help the nation's schools deliver a world class education that will improve student achievement and develop 21st century skills" (CEO Forum, 2001, p. 5).

The success of students and schools is not completely dependent on technology alone. Several factors are important to fostering a technology-rich environment:

1. **Create a learning environment that supports 21st century learning and that opens limitless possibilities for students.**

2. **Engage students in ways that personalize learning and encourage collaboration.**

3. **Ensure proper application of technology to encourage acquisition of content and engage students in real-life learning situations.**

4. **Understand the capabilities of the technology tools and identify authentic tools that prepare students for the 21st century world.**

5. **Use technology to gauge results and make decisions about further planning and purchasing.**

As educators think more deeply about these factors, schools will begin to realize the potential technology offers for teaching and learning.

Perhaps the most important message in creating a successful learning environment through technology is the context, needs, and characteristics of the school. There is no perfect solution for integrating technology into schools; rather, technology should be custom-designed to meet the needs of each individual classroom (Koehler & Mishra, 2008). This customization should empower schools to recognize the true potential of technology for each student. Flexibility allows technology to be manipulated and adapted to meet the varying needs of teachers and students. It is important for schools to recognize and outline clear teaching goals and objectives and then plan to incorporate technology into those objectives.

The North Central Regional Educational Laboratory (NCREL) surveyed various schools to determine their individual contributions to academic success. The study revealed that high-performing schools use technology appropriately to meet their goals and that "educational technology . . . can help create and maintain" a successful learning environment (NCREL, 2004, p. 5). In addition, teachers in the participating schools "use technology as a tool . . . but do not regard technology as sufficient in itself to ensure academic success" (p. 5).

The clear message here is that while technology can bring new and innovative opportunities to the classroom, the more important consideration is its value and applicability to meeting each school's goals and objectives. This occurs through understanding these goals and objectives, learning about the capabilities of the technology, and carefully planning for technology use and application in the educational environment. By understanding these factors thoroughly, schools will use time and resources efficiently and effectively while creating opportunities for student academic success.

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References

All Web sites were available as of 13 August 2009.

Axelson, M., McGraw, T., & McEntee, S. (Eds.). (2003). *Toward a national research agenda for improving the intelligence of assessment through technology: Conference summary*. Charleston, WV: AEL. http://www.edvantia.org/products/pdf/ConferenceProceedings2.pdf.

Bransford, J. D., Brown, A. L., & Cocking, R. (2000). *How people learn: Brain, mind, experience, and school*. Washington, DC: National Academy Press.

Brodersen, C., & Iversen, O. S. (2005). eCell - Spatial IT Design for Group Collaboration in School Environments. In *Proceedings of the 2005 International ACM SIGGROUP Conference on Supporting Group Work (GROUP'05)* (pp. 227-35). New York: ACM.

Brown, J. S. (2006). New learning environments for the 21st century: Exploring the edge. *Change, 38*(5): 18-24.

Brown, R., & Lemke, C. (2007). Informed decision making and higher academic achievement. Culver City, CA: Metiri Group. http://www.metiri.com/PDFs/MetiriSDP.pdf.

Brown-L'Bahy, T. (2005). Within and beyond the K-12 classroom: The social contexts of students' technology use. In C. Vrasidas & G. V. Glass (Eds.), *Preparing teachers to teach with technology* (Vol. 3, pp. 23-44). Charlotte, NC: Information Age.

CEO Forum. (2001). *School technology and readiness report, year 4: Key building blocks for student achievement in the 21st century*. Washington, DC: Author. http://www.ceoforum.org/downloads/report4.pdf.

Conference Board, Corporate Voices for Working Families, Partnership for 21st Century Skills, & Society for Human Resource Management. (2006). *Are they really ready to work? Employers' perspectives on the basic knowledge and applied skills of new entrants to the 21st century U.S. workforce*. N.p.: Author. http://www.21stcenturyskills.org/documents/FINAL_REPORT_PDF09-29-06.pdf.

Cuban, S., & Cuban, L. (2007). *Partners in literacy: Schools and libraries building communities through technology*. New York: Teachers College Press.

Davis, T., Fuller, M., Jackson, S., Pittman, J., & Sweet, J. (2007). *A national consideration of digital equity*. Washington, DC: International Society for Technology in Education.

Dede, C. (2007). Reinventing the role of information and communications technologies in education. *NSSE Yearbook 2007 106*(2): 11-38.

Eisenberg, M. B. (2003). Technology for a purpose: Technology for information problem-solving with the Big6. *TechTrends, 47*(1): 13-17.

Gardner, H. (1993). *Multiple intelligences: The theory in practice*. New York: Basic Books.

Gardner, H. (1999). *Intelligence reframed: Multiple intelligences for the 21st century*. New York: Basic Books.

Gee, J. P. (2003). High score education: Games, not schools, are teaching kids to think. *Wired, 11*(5): 68.

Gee, J. P. (2005). Learning by design: Good video games as learning machines. *E-Learning, 2*(1): 7.

Harwood, P. G., & Asal, V. (2007). *Educating the first digital generation*. Westport: Praeger.

Hefzallah, I. M. (2004). *The new educational technologies and learning* (2nd ed.). Springfield: Charles C. Thomas.

Herrington, J., & Kervin, L. (2007). Authentic learning supported by technology: Ten suggestions and cases of integration in classrooms. *Educational Media International, 44*(3): 219-36.

International Information and Communication Technologies (ICT) Literacy Panel. (2002). *Digital transformation: A framework for ICT literacy*. Princeton, NJ: Educational Testing Services. http://www.ets.org/Media/Research/pdf/ICTREPORT.pdf.

Jonassen, D. H., Howland, J., Moore, J., & Marra, R. M. (2003). *Learning to solve problems with technology: A constructivist perspective* (2nd ed.). Upper Saddle River, NJ: Merrill/Prentice Hall.

Kelly, M. A. (2008). Bridging digital and cultural divides: TPCK for equity of access to technology. In AACTE Committee on Innovation and Technology (Ed.), *Handbook of technological pedagogical content knowledge (TPCK) for educators*. New York: Routledge.

Koehler, M. J., & Mishra, P. (2008). Introducing TCPK. In AACTE Committee on Innovation and Technology (Ed.), *Handbook of technological pedagogical content knowledge (TPCK) for educators*. New York: Routledge.

Learning Federation. (2003). *Learning science and technology R&D roadmap*. Washington, DC: Author. http://www.fas.org/gamesummit/Resources/LST%20Roadmap.pdf.

Li, Q., Lau, R. W., Shih, T. K., & Li, F. W. (2008). Technology supports for distributed and collaborative learning over the Internet. *ACM Transactions on Internet Technology, 8*(2): 1-24.

Mark, B. (2001). Pervasive computing: Enhancing learning in the classroom and beyond. *Insight 1*: 43-60.

McGrath, D. (2004). Equity revisited: PBL and the digital divide. *Learning and leading with technology, 32*(2): 36-39.

McGraw, T., & Ross, J. (2001). Paper and pixels: In search of the ultimate textbook. *Insight 1:* 5-17.

Mehlinger, H. D., & Powers, S. M. (2002). *Technology & teacher education: A guide for educators and policymakers*. New York: Houghton Mifflin.

Mercurius, N. (2005). Scrubbing data for D3M. *T.H.E. Journal, 33*(3): 15-18.

Metiri Group. (2003). *enGauge 21st century skills: Literacy in the digital age*. Los Angeles: Author. http://www.metiri.com/21/21%20Century%20Skills%20Final.doc.

North Central Regional Educational Laboratory. (NCREL). (2004). *Educational Technology News, 4*(2). Naperville, IL: Learning Point Associates/North Central Regional Educational Laboratory.

Niess, M., Lee, J., & Kajder, S. (2008). *Guiding learning with technology*. Hoboken, NJ: John Wiley & Sons.

Partnership for 21st Century Skills. (2003). *Learning for the 21st century: A report and mile guide for 21st century skills*. Tucson, AZ: Author. http://www.21stcenturyskills.org/images/stories/otherdocs/p21up_Report.pdf.

Partnership for 21st Century Skills. (2007). *Framework for 21st century learning*. (Rev. ed.). Tucson, AZ: Author.

Pellegrino, J. W., Chudowsky, N., & Glaser, R. (Eds.). (2001). *Knowing what students know: The science and design of educational assessment*. Washington, DC: National Research Council.

Price, B. (2007). *Managing technology in our schools: Establishing goals and creating a plan*. New York: Rowman & Littlefield Education.

Robertson, P. (2005). Results matter: NCLS's focus on results could save instructional technology. *Technology & Learning, 26*(2): 31.

Schlechty, P. (2000). *Shaking up the school house: How to support and sustain educational innovation*. San Francisco: Jossey-Bass.

Schroeder, E. E., & Zarinnia, E. A. (2007). Documenting the impact of school library media programs. In M. Orey, V. J. McClendon, & R. M. Branch (Eds.), *Educational media and technology yearbook* (pp. 98-127). Westport, CT: Greenwood.

Smaldino, S. E., Lowther, D. L., & Russell, J. D. (2008). *Instructional technology and media for learning* (9th ed.). Upper Saddle River, NJ: Merrill/Prentice Hall.

Smith, K. M., Bichelmeyer, B. A., Monson, J. A., & Horvitz, B. S. (2007). Integrating computers in the schools: A review of criticisms. In M. Orey, V. J. McClendon, & R. M. Branch (Eds.), *Educational media and technology yearbook* (pp. 3-19). Westport, CT: Greenwood.

State Educational Technology Directors Association. (2002). *Technology literacy assessment*. Arlington, VA: Author. http://www.setda.org/toolkit/nlitoolkit/tla/index.htm.

Thomas, L. C., & Knezek, D. G. (2002). Standards for technology-supported learning environments. *The State Education Standard, 3*(3): 14-20.

U.S. Department of Education (USDOE). (1983). *A nation at risk*. Washington, DC: Author. http://www.ed.gov/pubs/NatAtRisk/risk.html.

U.S. Department of Education (USDOE). (2008a). *A nation accountable: Twenty-five years after a nation at risk*. Washington, DC: Author. http://www.ed.gov/rschstat/research/pubs/accountable/index.html.

U.S. Department of Education (USDOE). (2008b). *Harnessing innovation to support student success: Using technology to personalize education*. Washington, DC: Author. http://www.ed.gov/about/offices/list/os/technology/reports/harnessing-innovation.pdf.

U.S. Department of Education (USDOE) & Office of Educational Technology (OET). (2004). *Toward a new golden age in American education: How the Internet, the law and today's students are revolutionizing expectations*. Washington, DC: Office of Educational Technology.

U.S. Department of Labor, 21st Century Workforce Commission. (2000). *A nation of opportunity: Building America's 21st century workforce*. Washington, DC: Author. http://digitalcommons.ilr.cornell.edu/cgi/viewcontent.cgi?article=1003&context=key_workplace.

Virginia Department of Education. (2007, January). *An analysis of the instructional technology resource teacher (ITRT) program in Virginia*. Information Brief. Richmond: Author. http://www.doe.virginia.gov/VDOE/Technology/OET/info_brief_itrt.pdf.

Virginia Department of Education, Office of Educational Technology. (2009). [Survey of technology use in Virginia schools]. Unpublished raw data.

Wyatt, E. D. (2007). Student learning: Documenting the impact of school library media programs. In M. Orey, V. J. McClendon, & R. M. Branch (Eds.), *Educational media and technology yearbook* (pp. 98-127). Westport, CT: Greenwood.

Yan, Z. (2007, June). *Children and the Internet*. Information Brief. Richmond: Virginia Department of Education. http://www.doe.virginia.gov/VDOE/Technology/OET/information-brief.pdf.

APPENDIX A

Essential Elements of ICT Literacy

What Students Need to Know about ICT Literacy

Choose appropriate technologies to complete particular tasks and learn new technologies when needed:

- Become familiar with the strengths and weaknesses of various technologies for supporting different tasks (e.g., writing, research, presentations, creating artwork).
- Have a working knowledge of locally available technologies.
- When completing educational tasks, consider which technologies may help and use those that are available.
- Incorporate appropriate new technologies as they become available.

Use technologies to develop strong thinking skills and extend capabilities:

- Use built-in assessments, or self-assessment tools, to increase skills and understanding of their learning processes (metacognition).
- Effectively and rapidly evaluate information to make decisions.
- Approach authentic tasks with flexibility and persistence; adapt technologies to make them useful.
- Use technology to seek out diverse perspectives and develop multiple solutions.

Use technologies ethically and safely:

- Comply with current copyright laws.
- Use borrowed technology with respect and care.
- Never use technology to bully, coerce, or harass any other person; be accountable for conduct when using technology.
- Be aware of safety issues related to all technologies, but specifically communication technologies.
- Follow the division's current guidelines for ethics and safety (identified in each division's acceptable use policy).

Understand the nature of information in a global world and the characteristics of various media:

- Become informed about other cultures so all global communication can be made respectfully.
- Recognize when information is needed and determine where to locate the appropriate information.
- Evaluate information based on accuracy, relevance to a task or question, and appropriateness.

- Be aware of the strengths and weaknesses of various types of media and how media (including one's own creations) can influence people.
- Be able to deconstruct and construct media messages.

Use technologies to facilitate collaboration and teamwork:

- Show respect and care for others at all times, even when technology makes them seem *not real.*
- Actively pursue collaborations with both local community members and people in other communities.
- Be flexible in taking different roles (e.g., leader/follower, orator/listener) on teams as the situations require.

What Parents, Grandparents, and Caregivers Need to Know about ICT Literacy

Technology is just one tool for learning:

- Children should not learn everything through technology; there must be time for real-life play, activity, and interaction.
- Time spent with technology should be limited in a child's earliest years, with increasing use allowed as the child matures.
- Participate in technology interactions with young children, allowing more and more autonomy as the child matures and learns norms of behavior.

Technology, by itself, is neutral but can be used for both good and bad things:

- Provide good role models for acceptable behavior and respect for others.
- Learn how to identify safety or ethical problems encountered by children and have a plan for handling these issues before they arise.
- The content of some media is objectionable. Establish rules about what is acceptable. Ratings systems are not reliable indicators.
- Be aware of state and federal laws governing technology and its misuse and communicate problems with school personnel.

Children may be more conversant with technology than their parents, but parents have more practical experience in real-life situations:

- Help children understand that all media messages are constructed and promote deconstruction and construction of media messages.

- Help children learn how to evaluate the motives of various media messages.

- Be aware of the strengths and weaknesses of various media and point these out to children as situations arise.

Good thinking skills enable students to use technology as a powerful learning tool:

- Help students learn how to think critically and creatively.
- Support student collaboration and teamwork.
- Encourage persistence and flexibility in problem-solving tasks.

What Teachers, Instructional Technology Resource Teachers, and Library Media Specialists Need to Know about ICT Literacy

Technology is best used to support curricular goals:

- Make students aware about which types of technologies are available for their use in school and which of their own technologies may be used for schoolwork.
- Engage in professional development to learn how to use available technologies in their own instructional and day-to-day activities.
- Assign authentic tasks that use authentic technology to prepare students for working effectively and living responsibly in the 21st century.

Responsible use of technology must be taught and emphasized during regular school work:

- Be thoroughly familiar with the division's acceptable use policy and ensure students are also.
- Teach technology ethics and safety continuously, both in school and in other areas of students' lives.
- Be good role models for acceptable behavior.
- Learn how to identify ethical or safety errors and know the procedures for addressing these situations before they arise.

Use technologies to develop strong thinking skills and extend capabilities:

- Model critical-thinking and evaluation skills for students.
- Use built-in assessments, or self-assessment tools, to monitor one's own thinking strategies and to increase skills.
- Provide opportunities for students to evaluate information effectively and rapidly in order to make decisions.
- Encourage students to approach authentic tasks with flexibility and persistence.

- Provide a balance between direct instruction and authentic learning experiences.

Provide opportunities for students to experience both the nature of information in a global world and the characteristics of various media:

- Seek opportunities for students to work as teams and collaborate with others from their community and around the world.
- Ensure students are informed about other cultures so communication technology exchanges can be made respectfully with people around the globe.
- Help students discern when information is needed for a task and how to locate the appropriate information that can be evaluated based on accuracy, relevance to a task or question, and appropriateness.
- Be aware of the strengths and weaknesses of various media and make these transparent when involving media resources in instruction.
- Help students understand that all media messages are constructed and teach them to deconstruct and construct media messages effectively.

Technology enables a variety of measures that can be used to support both formative and summative ends:

- Ongoing formative assessments both support and are supported by the use of educational technology.
- Technology can help provide students with useful and immediate feedback to improve their performance.
- Remain up-to-date on new methods of assessment that support the evaluation of complex learning made possible through technology.

What School Administrators Need to Know about ICT Literacy

Technology, as an educational tool, provides opportunities for learning beyond current capabilities:

- Learning skills that use authentic work technologies help keep students motivated and prepare them for lives after school.
- Technology provides an opportunity for students to learn and practice strong thinking and teamwork skills.
- Using technology, students can learn individualized topics in new ways and in unique settings.
- Because technology can provide opportunities for real change in the way students learn, school leaders should allow teachers the flexibility to try new tools and methods.

- When new technologies are deemed useful, barriers to adoption need to be addressed.

Technology enables a variety of measures that can support both formative and summative ends:

- Ongoing, formative assessments both support and are supported by educational technology.
- Technology can help provide students with useful and immediate feedback to improve their performance.
- Stay up-to-date on new methods of assessment that support the evaluation of complex learning made possible through technology.
- Learn how to evaluate and support teachers' uses of technology as effective learning tools.

Leaders provide inspiration and support for teachers and students who use technology for learning:

- School leaders should be good role models for acceptable and safe behavior.
- Reaching out with information and guidance can help parents and other community members understand and support educational uses of technology.
- Administrators must engage in professional development to enable them to be effective users of technology.
- Be aware of current legal and ethical implications of technologies in education and determine procedures to deal with situations before they arise.
- Develop technology plans by encouraging a strong vision among all stakeholders and practical, innovative methods for implementing the vision.

Budgets that provide ongoing support for technology (e.g., infrastructure, personnel, training) are imperative:

- Be aware of the practical implications of existing and new technologies and hire people who can provide good guidance.
- Develop professional development plans that focus on the ICT skills that students need.
- Provide support and incentives to teachers who take risks with new approaches.

What Superintendents and School Boards Need to Know about ICT Literacy

Technology is a tool that supports learning in new ways:

- New technologies, with new capabilities, must be evaluated for their usefulness to a division's educational goals.

- Because technology can provide opportunities for real change in the way students learn, policies should allow flexibility for trying new tools and methods.

When new technologies are deemed useful, barriers to adoption need to be addressed.

Leaders provide inspiration and support for teachers and students who use technology for learning:

- Be good role models for acceptable behavior.
- Reaching out with information and guidance can help parents and other community members understand and support educational uses of technology.
- Be aware of current legal and ethical implications of technologies in education.

Schools are one place where students have equitable access to both technology and the learning of skills that enable them to use technology effectively:

- Technology-rich environments provide support for students with varying needs.
- Budgets that provide ongoing support for technology (e.g., infrastructure, personnel, training) are imperative.
- Encourage schools to use diverse means of evaluation so that 21st century skills may be appropriately measured just as content knowledge is measured.

APPENDIX B

Status of Technology Use in Virginia Schools

Status of Technology Use in Virginia Schools

In spring 2009, the Virginia Department of Education (2009) conducted a survey of all public school divisions in the state regarding educational technology. Nearly 1,244 public schools and 97 divisions responded. The respondents consisted of building administrators or other key building personnel involved with integrating technology for instructional purposes and division technology directors responsible for designing, developing, and implementing efforts to integrate technology into instruction.

Technology in Virginia School Buildings

The technologies students use most commonly include the Internet, desktop computers, Internet search tools, word-processing software, and printers; the least used are statistical-analysis software, videoconferencing tools, Web-page-creation software, management and organization software, and wikis/blogs. In general, a high percentage of students do not have access to personal digital devices, Web-conferencing and videoconferencing tools, e-mail for communications, or wikis/blogs stored on an intranet or the Internet.

Students most frequently use technology to practice or review topics in various subjects, prepare for standardized tests, or extend learning with enrichment activities. They are far less likely to engage in formal distance learning via the Internet or other interactive media; use modeling and simulations to explore complex systems and issues; communicate electronically about academic content with experts, peers, or others; create products for real-world audiences; or solve real-world problems.

Among teachers or administrators, the most widely used technologies include e-mail, the Internet and Internet search tools, a desktop or laptop computer, printers and data projectors, the school division's intranet, and presentation software; the least used are videoconferencing and Web-conferencing tools, multimedia editing or authoring tools, statistical-analysis software, and wikis/blogs stored on the Internet or an intranet.

The survey also addressed technology tools that foster collaboration. More than half the schools do not have videoconferencing equipment; just less than half do not use a Web-conferencing tool. The most commonly available videoconferencing tool is a desktop computer equipped with a camera, speakers, and a microphone.

In terms of technology support, the majority of respondents named the following as the top services provided by library media centers: digital reference/virtual reference services; licensed databases; video content; audio, digital-imaging, or video-production equipment; and instructional television. A vast majority of the respondents believe that their school's technology is reliable, that the technical support is adequate, and that teachers have adequate support to help them integrate technology into the classroom.

With regard to hardware and connectivity, an average of 253 computers per school are available to students; one-third of these are laptops. On average, each school has two handheld computers with Internet access. About three-fourths of the schools use fiber-optic connections to access the Internet. Most schools have a network connection speed greater than 10 Mbps and use one of the major Internet service providers (e.g., Cox, Verizon, Sprint). Most schools provide wireless access to the majority of instructional areas and other public areas in the building; few provide open wireless access outside the building for the general public. Most respondents consider the school's bandwidth to be at least *usually sufficient* for instructional needs.

Technology in Virginia School Divisions

More than two-thirds of the reporting school divisions noted that their students are computer literate. Nearly all teachers are technologically literate based upon the Technology Standards for Instructional Personnel. Observation and performance-based assessments are the most commonly used methods for assessing technology literacy among students and teachers; although, portfolios increasingly are being used to assess teachers. Just more than one percent of the surveyed teachers are NETS*T certified; about 8.5 percent of the instructional technology resource teachers (ITRT) in the responding divisions are NETS*T certified.

Among division employees, ITRT receive the largest amount of professional development specific to technology (approximately 36.5 hours per school year); teachers are the next highest group with about 15 hours per school year. The most popular technology trainings include multimedia digital content (e.g., digital audio or video) for instruction, Internet resources and communication tools for instruction (e.g., accessing education materials, online discussion forums, virtual field trips), content-specific software tools for instruction (e.g., graphic organizers, interactive mathematics programs, graphing tools), and computers (e.g., word processing, creating spreadsheets, creating Web pages) to enhance student learning The most common types of technology professional development are traditional workshops and conference sessions that last less than three hours; however, 90 percent of the divisions deliver portions of professional development online or through other Web-based resources; 76 percent use one-on-one mentoring.

For teachers and administrators, the most common collaboration tools are e-mail, Web conferencing, and blogs; instant messaging and social networking Web sites are the least used. Students most frequently use blogs or wikis as collaboration tools; they use instant messaging and social networking Web sites the least. In terms of productivity tools, teachers and administrators most commonly use client-server tools (e.g., Mircosoft Office, iWork) and Web-based tools, such as Google Docs. Moodle is the most frequently used course-management tool.

With regard to hardware and policies, 28 percent of the reporting divisions use computers more than four years old; a significant number (33 percent), however, use computers that are less than two years old. A majority have archiving and disaster-recovery plans for electronic records. Of the responding divisions, most have written policies either restricting use or specifying acceptable use by students for MP3 players/iPods, cell phones, e-mail, and wikis/blogs. Fewer address social networking sites directly.

APPENDIX C

Division Plan Alignment
2010-15

Division Plan Alignment • 2010-15

The state's technology plan provides a framework for new division technology plans, suggesting potential courses of action for local strategies. Each focus area (identified by the descriptors in each ring) is a factor that encourages effective technology use. The four key educational components that cross through the focus areas are where technology affects the educational process. The "Goals, Objectives, Strategies, and Evaluation Strategies" move the education system toward more efficacious technology use to support the end goals of teaching and learning.

Each division plan should clearly illustrate the **process** that was followed in developing the plan and the particular **actions** the division intends to take regarding educational technology (e.g., goals, objectives, strategies). The statewide framework serves as a guideline for how division technology planning committees should examine educational technology and develop their plans. It can help them organize their research and the factors that should be considered, including *prompts* for specific facets. The framework demonstrates how all the various focus areas interrelate with one another and with the school system as a whole.

Each division plan must include the following:

I. Cover Page (identify division, effective dates of plan, URL)
II. Table of Contents
III. Executive Summary
IV. Process
   A. Summary of connections to the division's mission, vision, etc.
   B. Summary of work of the planning committee and its benchmarks
   C. Summary of the evaluation process and planned update cycle
   D. Conclusions from Needs Assessment
V. Actions (goals, objectives, strategies, and evaluation strategies)
   A. State goals and objectives with local strategies and measures
   B. Any additional local goals, objectives, strategies, and measures tied to division mission, vision, etc.
VI. Appendix 1: Timetable and Budget for goals, objectives, strategies, and measures (at a minimum, Appendix 1 must be updated after three years, even if the plan covers six years)
VII. Appendix 2: Division AUP (with most recent date it was amended): As required by law, it must include all elements.
VIII. Appendix 3: Summary of Internet safety program for 2008-10 (including process for adjusting program based on evaluation)

Alignment Checklist

Each division must complete and submit this checklist with its plan for the Virginia Department of Education to review.

Planning Process

1. Planning committee group includes all stakeholders (including parents and other elements of community).	
Evidence: List of planners includes wide variety of stakeholders and/or other ways of receiving input.	Note page numbers:

2. Planning committee collaborates regularly.	
Evidence: Dates of planning meetings (face-to-face or electronic) and benchmarks are included in the plan or posted on division Web site.	Note page numbers or URL:

3. Division's mission and vision—and its comprehensive plan's goals and objectives—have been reviewed to inform priorities in relation to its technology plan's goals, objectives, and strategies.	
Evidence: Introduction to plan references specific divisionwide priorities.	Note page numbers:

4. Needs assessment has been conducted.	
Evidence: The plan includes a summary of the needs assessment findings (no need to include the complete findings). The needs assessment must be done before or during the planning process and within the last year. The needs assessment must include staffing, infrastructure, training (including pedagogical approaches), and tools. Resources (i.e., budget, partnerships, and other supporting mechanisms) should be identified to help realistically frame the plan's goals, objectives, and strategies.	Note page numbers:

5. Evaluation is planned as a yearly process.	
Evidence: The evaluation must also include a process by which results of the evaluation are incorporated into the plan over time.	Note page numbers:

Actions

1. State goals and objectives are included as part of the division plan; planning committee develops local strategies.

Evidence: List of goals and objectives, along with strategies and measures, meets this requirement.	Note page numbers:

2. Division may include other goals and objectives as determined by planning committee, but these must be tied to divisionwide priorities.

Evidence: List of goals and objectives, along with strategies and measures, meets this option.	Note page numbers (or N/A):

3. Plan includes a reasonable timetable for implementation as well as a reasonable budget.

Evidence: Timetable and budget are included.	Note page numbers:

4. Plan is available on the division's Web site.

Evidence: URL is provided on cover sheet of plan.	

5. The evaluation of the plan looks at both the "big picture" and at the specifics. The end goal is not to use more technology but to use technology more effectively to meet educational goals.

Evidence: The evaluation of the effectiveness of the plan focuses on this question: "Did we help meet statewide and divisionwide priorities as stated in our plan?" Each strategy should have at least one defined measure as well.	Note page numbers:

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