# integrating technology
## with student-centered learning

A REPORT TO THE NELLIE MAE EDUCATION FOUNDATION

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# executive summary

With the intent to expand education beyond traditional boundaries, student-centered learning focuses on educational practices and principles that:

- Provide all students equitable access to the knowledge and skills necessary for college and career readiness in the 21st century,
- Focus on mastery of skills and knowledge, and
- Align with current research on how people learn.

As the principles guiding student-centered learning become more defined, increased attention is being paid to the tools and resources best suited to its successful adoption. On the surface, technology would seem to offer a natural—and accessible—way to advance student-centered learning. After all, in today's public schools, there's an average student to computer ratio of 4:1 and a teacher and student population ready, willing and able to use technology. Yet despite its availability, technology is not widely integrated into the learning experience. A recent survey of more than 1,000 high school teachers, IT staff and students shows that only 8 percent of teachers fully integrate technology into the classroom. Not surprising, 43 percent of students feel unprepared to use technology as they look ahead to higher education or their work life.

To learn more about how technology could enhance student-centered learning, Education Development Center (EDC) examined current research literature as well as practice and policy-related reports. This research was enriched by collaboration with EDC colleagues who have expertise on this subject as well as interviews with educators at selected schools. This report concludes that while technology can provide a powerful teaching and learning tool, it cannot drive reform on its own. To be widely adopted, technology must be part of a comprehensive and systematic effort to change education. This report provides a candid look at the potential technology offers and the steps needed to better understand when technology is most effective in student-centered learning—and for whom.

## THE POTENTIAL TECHNOLOGY OFFERS

Because technology is both highly customizable and intrinsically motivating to students, it is particularly well-suited to expand the learning experience. To date, research on the effectiveness of technology has focused primarily on higher education and professional development, yet it suggests that specific uses of technology can improve K-12 student outcomes as well. Although the findings are general, and not necessarily specific to student-centered learning, they indicate that technology can:

***Help diagnose and address individual needs.*** Technology can equip teachers to assess an individual student's strengths and needs. Two main approaches to technology-supported assessment exist. One is a mastery learning approach tied to accountability systems. This enables teachers to benchmark students as they progress through a standards-based curriculum. The other assesses understanding which produces a picture of student thinking. Both approaches help establish a clear baseline from which teachers can then serve as coaches and advisors, steering students to the right mix of resources and projects that meet curricular requirements.

***Equip students with skills essential for work and life in a 21st century global society.*** Using technology for purposes, such as writing, research and analysis—rather than simply drills and practice—can enhance student competencies that surpass the knowledge and skills typically measured in achievement tests. These competencies include problem solving, creativity, collaboration, data management and communication. Many employers find these skills lacking among today's college graduates. In addition, a number of organizations ranging from the Partnership for 21st Century Skills to the U.S. Department of Education see literacy in digital media as essential for succeeding in a global society.

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***Provide an active experience for students.*** Technology can equip students to independently organize their learning process. So, instead of being passive recipients of information, students using technology become active users. At the same time, technology transfers some responsibility for learning to students. Through online learning (which provides increased access to course content, more scheduling flexibility, and better access to alternative education choices) and alternative media (such as digital games and project-based learning), students have the flexibility to direct their individual progress.

## SOME MODELS ARE ALREADY IN PLACE

Clearly, student-centered learning places new demands on both students and teachers. Appendix 2 describes two examples of school models where technology has been successfully integrated into student-centered learning. These examples are based on two distinct approaches:

***High Tech High (HTH)*** is a network of K-12 charter schools where the program and curriculum are based around personalization with strong student and faculty collaboration; adult world connection emphasizing community service projects and semester-long academic internships; and common intellectual mission based on a "technical" foundation, real-world career skills, and a "college prep" education.

Technology enables many of HTH's innovative practices. For example, to aid classroom learning, schools are equipped with Specialty Labs dedicated to a range of sciences from biotechnology to robotics. Also, throughout their academic careers at HTH, students document their learning by compiling and presenting their work in digital portfolios. Moreover, HTH uses technology to emphasize assessment as an "episode of learning"—not as an endpoint—and offers its own teacher-credentialing program. To date, HTH reports sending 100 percent of its students to college.

***Quest To Learn,*** a new public school in New York, has designed an integrated game-based curriculum that meets state and national standards while focusing on game-design and systems thinking. To achieve this, subject areas such as math, science, language arts, and social studies are blended together into domains. Not only is technology prevalent throughout the curriculum, it also supports other Quest To Learn programs including a specially designed social networking application as well as a program evaluation and assessment lab.

## THE CHALLENGES TO OVERCOME

Integrating technology into educational practices has proven to be a slow and complex process. In fact, it can take four or more years from the time new technologies are first introduced to the point when changes can be observed in students. To date, the most prevalent barriers to successful integration include organizational support, teacher attitudes and expectations, and technology itself.

***School culture and structure don't support specific uses of technology.*** Often, technology is not aligned with a school district's vision, mission and curriculum. As a result, there is no foundation in place to provide consistent access to—and use of—technology throughout the K-12 years. Using technology to support student-centered learning requires leadership, administration and the community to collaborate and set an agenda for technology that reflects local needs, focuses on a common set of learning standards, and connects students to real-world audiences.

***Most teachers lack confidence in technology as well as their technology skills.*** According to a National Center for Education Statistics study, only 23 percent of teachers surveyed feel prepared to integrate technology into their instruction. Those who use technology do so primarily to present information rather than to provide hands-on learning for students. Some are unclear about policies governing the use of technology. Others are uncomfortable with investing instructional time to deal with possible equipment failures or slow Internet access. Clearly, more of an investment in technology training and technical support needs to be factored into K-12 funding and resource allocation.

## CONCLUSION: TECHNOLOGY IS CRITICAL YET MORE TARGETED ANALYSIS IS NEEDED

This report concludes that technology can support key practices of student-centered learning. This includes emerging technology already prevalent in the consumer and business worlds (such as digital books, cloud computing, collaborative environments, and mobile devices). Here's how:

- ↗ Technology (done right) provides an invaluable way to deliver more personalized learning in a cost-effective way.

- ↗ Technology provides high-quality, ongoing feedback to teachers and students that can help guide the learning process. And when technology mirrors how professionals use it in the workplace, it can enhance academic achievement, civic engagement, acquisition of leadership skills, and personal/social development.

- ↗ Technology can be designed to provide adaptive learning and assessment experiences for students. Most important to student-centered learning, technology can enable outcomes that vary based on student strengths, interests, and previous performance.

While studies to-date have examined the effectiveness of specific technology uses on student learning, very few have addressed whether those uses can effectively produce different outcomes for different student subgroups. It's still not clear, for example, which types of learners are most successful using online learning. Or more specifically whether the drop-out rates associated with online learning suggest that the amount of reading works against students with weak literacy skills. This report concludes that deeper analysis of outcomes for different student subgroups is needed before specific technology-enhanced instructional practices can be successful at reducing existing performance gaps.


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# introduction

A key goal for current reform efforts in education is to have students graduate from high school ready for college or a career, regardless of their income, race, ethnic or language background, or disability status *(e.g., U.S. Department of Education, Office of Planning, Evaluation, and Policy, 2010).* But currently too many students leave high school without the knowledge and skills they need for success in further education or the workplace (see sidebar 1 for details). There is a growing consensus among education reformers that improving the preparation of students for the 21st century, including postsecondary education and careers, requires fundamental and systemic changes in how middle and high school education is organized *(e.g., Carnegie Corporation of New York & Institute for Advanced Study, 2009; National Academy of Sciences, National Academy of Engineering, & Institute of Medicine, 2007; NCEE, 2006).*

In particular, there is recognition that the traditional, rigid "one size fits all" design of schools must give way to more personalized, student-centered designs to meet the needs of an increasingly diverse student population *(e.g., Bowler & Siegel, 2009; Christensen, Horn, & Johnson, 2008; KnowledgeWorks Foundation & Institute for the Future, 2008)*. A key idea behind this model of education is that learning should be driven by a focus on students and their proficiency with specific competencies, and not by archaic school structures and arbitrary, age-based benchmarks.

Computer technology and digital media have fundamentally transformed all aspects of our lives, and many education reformers agree that it can and must be an important part of current efforts to personalize education *(e.g., Christensen, 2008; Collins & Halverson, 2009; U.S. Department of Education, 2010; Wellings & Levine, 2009; Woolf, Shute, VanLehn, Burleson, King, Suthers, Bredeweg, Luckin, Baker & Tonkin, 2010).* Use of technology can help to improve and enhance the acquisition of knowledge and skills, and learning with and about technology is essential for students to gain the competencies to function well in a 21st century society and workforce. Moreover, technology can serve as an important tool for districts, schools, and teachers to support reforms. Because technology is intrinsically motivating to many students and also highly customizable, it is particularly well suited to support student-centered learning. Yet in the past, school reform efforts driven by technology have often failed *(e.g., Cuban, 2001; Zhao & Frank, 2003).* In an effort to provide practitioners and policymakers with some guidance about how to use technology to support student-centered learning initiatives, Education Development Center, Inc. (EDC) conducted an extensive review of the research and practice literature. We built on the literature on technology integration as a framework for understanding various uses of technology to personalize learning. This report summarizes the findings from this review and discusses implications for practice, policy, and research.

## WHY INTEGRATE TECHNOLOGY WITH STUDENT-CENTERED REFORM EFFORTS?

There are several reasons cited in the literature as to why technology should be an integral part of student-centered reform efforts.

First, even though the relationship between technology and learning is complex, research indicates that specific uses of technology can improve student outcomes. While the availability of technology in the classroom does not guarantee impact on student outcomes *(e.g., Dynarski, Agodini, Heaviside, Novak, Carey, Campuzano, Means, Murphy, Penuel, Javitz, Emery, & Sussex, 2007; Wenglinsky, 1998),* when used appropriately, it can help to improve students' performance on achievement tests *(e.g., Kulik, 2003; Wenglinsky, 2006).* Using technology for drill and practice generally has

SIDEBAR 01

# by the numbers

### Percent of 12th Grade Students Achieving at or above Basic Level on Most Recent NAEP Assessments

| | Overall | Racial / Ethnic Groups: White | Black | Hispanic | Asian / Pacific Islander | Native American / Alaskan | Students with Disabilities | Students Without Disabilites | English Language Learners | Not English Language Learner |
|---|---|---|---|---|---|---|---|---|---|---|
| Civics[7] | 66% | 74% | 42% | 46% | 68% | 42% | 25% | 69% | 18% | 67% |
| Economics[8] | 79% | 87% | 57% | 64% | 80% | 72% | 43% | 82% | 34% | 81% |
| Mathematics[9] | 61% | 70% | 30% | 40% | 73% | 42% | 17% | 64% | 26% | 62% |
| Reading[10] | 73% | 79% | 54% | 60% | 74% | 67% | 28% | 76% | 31% | 74% |
| Science[11] | 54% | 82% | 38% | 45% | 76% | 52% | 17% | 57% | 12% | 55% |
| U.S. History[12] | 47% | 56% | 20% | 27% | 54% | 32% | 21% | 49% | 8% | 48% |
| Writing[13] | 82% | 86% | 69% | 71% | 86% | 70% | 44% | 85% | 40% | 83% |

The Program for International Student Assessment (PISA) compared the scores of U.S. 15-year-old students in science and mathematics literacy to their peers internationally in 2006. In this comparison, U.S. students ranked 23rd out of 56 countries in science and 32nd out of 54 countries in mathematics *(Baldi, Jin, Skemer, Green, & Herget, 2007).*

On average only about 75 percent of all high school students in the U.S. receive a high school diploma within

been found to be less effective than using technology for more constructivist purposes such as writing, research, collaboration, analysis, and publication *(Warschauer & Matuchniak, 2010).* For instance, based on an analysis of NAEP data, Wenglinsky *(2005)* found that for eighth-grade reading, use of computers for writing activities positively affected test scores, but use of computers for grammar/punctuation, reading drills, or tutorials negatively affected test scores. The educational use of technology also can enhance competencies that go well beyond the knowledge and skills typically measured by these achievement tests *(e.g., Bransford, Brown, Cocking, 1999; Collins & Halverson, 2009).* These competencies include improved understanding of complex concepts, connections between ideas, processes and learning strategies, as well as the development of problem solving, visualization, data management, communication, and collaboration skills, which are among the skills that employers find lacking even in many college graduates *(The Conference Board, Corporate Voices for Working Families, the Partnership for 21st Century Skills, and the Society for Human Resource Management, 2006)[1].*

Second, recently released standards documents emphasize that the use of technology in education is essential in helping students build 21st century skills. The Partnership for 21st Century Skills *(2009)* has identified the skills and expertise that are essential for succeeding in work and life in a 21st century global society. These include information, media, and technology skills; learning and innovation skills; and life and career skills. These three skill sets are both required for and applied through sophisticated uses of new digital media.

1 *This report is based on a 2006 survey of more than 400 businesses and follow-up interviews with a smaller sample of HR and other senior executives.*

four years of entering 9th grade *(Stillwell, 2010).* High school graduation rates vary considerably among different racial and ethnic groups, with 91 percent of Asian/Pacific Islander students graduating within four years, compared to 81 percent of Caucasian students, 64 percent American Indian/Alaska Native students, 64 percent of Hispanic students, and 62 percent of African American students *(Stillwell, 2010).*

Graduation rates for students from low-income families are particularly low. Between 2006 and 2007, students from low-income families were approximately 10 times more likely to drop out of high school than were students living in high-income families *(Cataldi, Laird, & Kewal Ramani, 2009).*

Among those students who graduated high school in 2004 and who entered postsecondary education by 2006, 40 percent of students in four-year colleges and 51 percent of students in two-year colleges took remedial courses *(NCES, 2010).*

Only about 57 percent of full-time, first-time bachelor's or equivalent degree-seekers in 2002 attending 4-year institutions completed a bachelor's or equivalent degree at the institution where they began their studies within 6 years. Graduation rates vary based on students' racial and ethnic background. They are highest for Asian/Pacific Islanders (67 percent) and white students (60 percent), and lowest for Hispanic or Latino students (49 percent), black or African American Students (40 percent), and American Indian or Alaska Native students (38 percent) *(Knapp, Kelly-Reid, & Ginder, 2010).*

7 *Lutkus & Weiss, 2007*
8 *Mead & Sandene, NCES 2007*
9 *Grigg, Donahue, & Dion, 2007*
10 *Grigg, Donahue, & Dion, 2007*
11 *Grigg, Lauko, & Brockway, 2006*
12 *Lee & Weiss, 2007*
13 *Salahu-Din, Persky, & Miller, 2008*

While the Partnership's definition of 21st century skills is not universally accepted, there is considerable overlap between their recommendations and those of professional teacher organizations and the U.S. Department of Education. Specific technology literacy skills that the National Educational Technology Standards *(International Society for Technology in Education, 2007)* encourage teachers to incorporate across content areas include:

1 using technology to demonstrate creative thinking and to develop innovative products,

2 using technology to communicate and work collaboratively,

3 applying digital tools to gather, evaluate, and use information,

4 using critical thinking and problem solving to make informed decisions regarding appropriate digital tools and resources,

5 understanding human cultural and societal issues related to technology and practicing legal and ethical behavior,

6 understanding technology operations and concepts.

Similarly, the recently released National Educational Technology Plan *(U.S. Department of Education, 2010),* emphasizes the importance of enabling students to experience technology in the ways professionals do in their fields (e.g., to conduct experiments, organize information, and communicate) and encourages

2 *Surprisingly, other recently released national standards and policy documents do not explicitly address technology, as discussed in more detail below.*

educators to create learning experiences that mirror students' daily lives and the reality of their futures[2].

Third, students are highly motivated to use technology. Technology and media use is pervasive among children and youth. According to a recent survey of media and technology use by 8-18 year olds conducted by the Kaiser Family Foundation *(Rideout, Foehr, & Roberts, 2010),* young people in this age group spent an average of 7 hours, 38 minutes consuming media per day and through multitasking are able to pack a total of 10 hours, 45 minutes worth of media content into that time, seven days a week. Twenty percent of this media consumption occurs on mobile devices such as cell phones, iPods, or handheld video game players. In 2009, 31 percent of 8-10 year olds, 69 percent of 11-14 year olds, and 85 percent of 15-18 year olds owned their own cell phones. Similarly, 61 percent of 11-14 year olds, 80 percent of 11-14 year olds, and 83 percent of 15-18 year olds owned iPods or MP3 players. Laptops were owned by 17 percent of 8-10 year olds, 27 percent of 11-14 year olds, and 38 percent of 15-18 year olds. A recent survey sponsored by the MacArthur Foundation found that nearly all young people (97 percent) use the Internet by 8th grade. They use the Internet on average almost 14 hours per week, and types of uses include social networking, gaming, and sharing digital resources *(sharing files, blogs, and personal websites; Flanagin & Metzger, 2010).*

Fourth, technology now has a considerable presence in public schools. According to a recent survey conducted by the U.S. Department of Education *(Gray, Thomas, & Lewis, 2010),* 97 percent of teachers had one or more computers located in their classroom every day during the winter and spring of 2009. Internet access was available for 93 percent of computers every day (though school firewalls can limit the extent of Internet access in the classroom). Other technology devices available in the classroom or in the school included liquid crystal display (LCD) or digital light processing projectors (48 and 36 percent, respectively), interactive whiteboards (23 and 28 percent), and digital cameras (14 and 64 percent). Many teachers also reported having access to student data through their school or district network, including grades (94 percent), attendance records (90 percent), and student assessments (75 percent). Ninety-seven percent of teachers reported having remote access to school email and 81 percent had remote access to student data. Teachers thus have at their disposal a powerful set of tools to support teaching and learning.

Sixty percent of teachers reported that they use technology in the classroom, but just 26 percent of the students indicated they are encouraged to use technology themselves.

### FRAMING THE REVIEW: RESEARCH ON TECHNOLOGY INTEGRATION

Despite the ready availability of technology in schools and compelling reasons to use it to enhance teaching and learning, research indicates that it is not widely integrated into classrooms.

According to a recent survey of more than 1,000 high school teachers, IT staff members, and students conducted by CDW Government LLC *(2010)*, only 8 percent of the teachers surveyed fully integrate technology into the classroom. Further, the survey found that teachers use the technology primarily to teach (e.g., to give presentations), while students lack opportunities to use technology hands-on. Sixty percent of teachers reported that they use technology in the classroom, but just 26 percent of the students indicated they are encouraged to use technology themselves. Both teachers and students reported that they use handheld technology (iPods, MP3 players, smart phones) and social media (e.g., online text or video chat, blogs, podcasts) in their private lives, but only about 12 percent or fewer of teachers reported that they use these technologies in the classroom. Not surprisingly, 43 percent of students reported that they felt unprepared or unsure of their level of preparation to use technology in higher education or the workforce.

Project RED *(Greaves, Hayes, Wilson, & Gielniak, 2010)* conducted a survey of nearly 1,000 school principals and technology coordinators[3]. The survey found that 80 percent of the schools surveyed under-utilize technology they have already purchased. Few schools employ practices that their study found to be correlated with improved student performance, such as a 1:1 student computer ratio, daily use of technology in core classes, daily electronic formative assessments, and weekly teacher collaboration in professional learning communities (a professional development practice that has been found to be effective in supporting teachers' technology integration).

Research on technology integration that has been conducted over the past 20 years sheds some light on why technology is not used more. Technology integration is a slow and complex process and is influenced by many factors. These include organizational factors, teacher factors, and factors associated with the technology itself.

***Organizational support.*** Schools naturally resist changes that will put pressure on existing practices *(Collins & Halverson, 2009; Cuban, 2000; Zhao & Frank, 2003).* Unless the culture and structure of a school is compatible with and supportive of specific uses of technology, technology integration is not likely to succeed. Aspects of organizational support for technology integration that have been identified in the literature include the following:

- A school culture that promotes technology use and the adoption of new teaching practices,
- A coherent, shared pedagogical vision for technology use, and support from peers, administration, and the community,
- Availability of technical support,
- Technology policies (e.g., regarding cell phone use and access to Internet resources) that allow teachers to make use of the wealth of technological resources available,
- A culture of collaboration in which teachers work together to explore more effective uses of technology,
- Assessment systems that go beyond multiple-choice tests and that measure changes such as deeper understanding and improved problem solving that result from effective technology use *(Inan & Lowther, 2010; Kopcha, 2010; Lemke et al., 2009; Zhao & Frank, 2003).*

***Teachers.*** Teachers' attitudes towards and expertise with technology have been identified as key factors associated with technology use in the classroom *(e.g., Inan & Lowther, 2010; Sandholtz et al., 1997; Zhao & Frank, 2003).* Teachers need to hold a positive attitude towards technology in order to use it effectively in their teaching. Moreover, their pedagogical beliefs and existing

*3 The sample surveyed in this study was representative of enrollment, geography, poverty level, and ethnicity of the universe of schools in the U.S. (Greaves, Hayes, Wilson, & Gielniak, 2010).*

teaching practices will shape how they incorporate technology in the classroom *(e.g., Honey & Moeller, 1990; Sandholtz et al., 1997).* In order to use technology effectively for educational purposes, teachers must not only be familiar with how to operate equipment, but also understand how these tools are effectively used in the subjects they teach and how to incorporate resources into classroom activities that accomplish important learning goals. While many teachers use technology in their private lives and know how to operate it, they often lack some of the other knowledge and skills required to support teaching and learning. Teachers need ongoing professional development to keep up with how professionals are using technology in the subjects they teach and to better understand the essential role that technology plays in supporting the work and generating knowledge in those subjects. A study conducted by the National Center for Education Statistics revealed that only 23 percent of the teachers surveyed felt well prepared to integrate technology into their instruction *(NCES, 2000).* In another study, more than half of the teachers surveyed did not believe that their pre-service programs prepared them well in either technology or 21st century skills *(Walden University, 2010).* Yet, only 20 percent of states require technology training or testing for recertification or participation in technology-related professional development *(Hightower, 2009).*

***Ease of use of technology.*** Technology itself has been identified as a potential barrier to technology integration *(e.g., Zhao & Frank, 2003; Lemke et al., 2009).* Low-bandwidth technology can be unreliable and break down at any given moment, which can be an obstacle for accessing the Internet. Teachers may not feel comfortable spending valuable instructional time dealing with equipment failures or slow Internet access. Unless they have access to reliable support, they may opt not to use technology in the classroom. Moreover, continual changes and innovations can make it difficult for teachers to keep up with the latest technology.

***Technology integration as a process.*** Research indicates that the integration of technology into instruction occurs over time and follows a pattern *(e.g., Sandholz, Ringstaff, & Dwyer, 1997).* Initially, teachers incorporate new technologies into existing practices. Once they observe changes in their students, such as improvements in engagement, behavior, and learning, teachers gradually begin to experiment with using technology to teach in new ways. It can take four years or more from initial use of technology until changes in student learning can be observed *(Williams, 2002)*. However, teachers may adopt technology at different rates, depending on their beliefs about technology and their individual skills, and different implementation factors interact. For instance, with sufficient technical support, teachers feel more competent and ready to integrate technology. Overall support and positive expectations from the school community and administration also influence teachers' beliefs about and willingness to integrate technology *(Inan & Lowther, 2010).* Zhao and Frank *(2003)* have suggested that the process of technology integration is an evolutionary one, and that teacher's beliefs, pedagogy, and technology skills slowly build upon each other and co-evolve as technology is introduced and assimilated into the school culture.

To summarize, research on the use and integration of technology suggests that technology by itself is not likely to bring about reforms in schools, but can be a powerful tool for educators if it is made part of a comprehensive and systemic effort to change education. Technology is most likely to be widely adopted by teachers and schools if (1) it supports already existing practices and helps to solve problems or address challenges; (2) it is part of a systemic, organization-wide initiative; and (3) teachers have access to ample professional development and ongoing support. Based on these findings, we organized our review of the literature on technology and student-centered learning around the following questions, which we will address in the remainder of this report:

1 How is technology currently being used to help students and teachers meet the demands of student-centered learning practices?

2 How is technology integrated into curriculum-based approaches to student-centered learning?

3 How is technology being used as part of school-wide or district-wide initiatives to personalize learning?

4 What is the potential of emerging technologies to help to broaden/deepen opportunities for student-centered learning?

In student-centered learning environments, students are more engaged, responsible learners.

# technology and student-centered learning[4]

## 1. HOW IS TECHNOLOGY CURRENTLY BEING USED TO HELP STUDENTS AND TEACHERS MEET THE DEMANDS OF STUDENT-CENTERED LEARNING?

Student-centered learning implies significantly changed roles for students and teachers. In student-centered learning environments, students are more engaged, responsible learners. They work to develop and explore their own unique academic and career interests, and produce authentic, professional quality work to demonstrate their learning. To support students in their new roles, teachers act as coaches, advisors, and facilitators of student learning. Instead of lecturing to a whole class as the primary mode of instruction, teachers provide opportunities for students to take charge of their own learning *(Clarke, 2003; Hargreaves, 2005; Keefe & Jenkins, 2008).*

A student-centered school moves away from the current "one-size-fits-all" approach to education towards a more adaptive and flexible approach in which learning opportunities are customized to maximize learning outcomes. At some schools, students may work closely with advisors and subject-area coaches to set and assess learning goals and set up a meaningful schedule of learning activities that best allows them to progress through their courses. Schools may tailor the content, delivery, and learning supports within the curriculum to address the needs and aspirations of individual learners. This type of learning affords a degree of choice about what is learned, when it is learned, and how it is learned. While there is choice, learners typically still have to meet certain targets set by the curriculum.

Student-centered learning thus places new demands on both students and teachers. Students must be clear about their interests, strengths, and needs and be able to communicate these to their teachers and advisors. They have to be self-directed in their learning, be able to relatively independently organize their own learning process, elicit help from teachers, peers, or experts when needed, and be able to reflect on their progress. Teachers need to engage in ongoing assessment to better understand individual students' strengths, needs, and progress and provide students with the resources and guidance to engage them in projects that address their needs and interests, as well as meet curricular requirements. Technology can help students and teachers meet these demands. Below we discuss selected examples of how technology is being used to support student-centered learning practices, such as assessment, flexible scheduling and pacing, advising, collaborative learning communities, independent projects, community involvement, and student-centered curricula. Where available, we describe any research on the effectiveness of these uses.

### ASSESSMENT

In order to meet students where they are, schools must work to figure out where that is. In a student-centered learning environment, teachers collect and use data to better understand students' strengths and needs, as well as to monitor their progress towards acquiring content knowledge and skills. Using a variety of methods, including but not limited to teacher observation, digital diagnostic tools, and developmental knowledge, teachers work to become familiar with students' cognitive and emotional needs, their preferred learning styles, and their prior knowledge and skills. Students' content knowledge and skills are typically measured in a variety of ways, including

*4 Details about the methods used for this review and information about the type of evidence available from the studies we discuss in this section are included in Appendix 1.*

SIDEBAR **02**

# *school of one*

The School of One pilot program, launched during the summer of 2009, focuses its efforts on using technologies to give students instruction that is tailored to their learning style and current proficiency with content and skills. The School of One model is essentially assessment and data-driven. Before the program's launch, students were given a learning diagnostic in order to create a profile of how each student learns best. Students were then given a pre-test to determine what performance indicators they needed to improve. Taken together, those two data sets were used to create students' daily schedules, matching students to both digital and traditional resources designed to help them fill in the gaps in their content learning (in mathematics for the pilot phase). In the School of One model, students work on a variety of computer-assisted instruction programs, and take daily assessments the results of which are fed back into the system in order to formulate each student's schedule for the next day of instruction.

The foundation of the School of One model is its use of student data and assessment outcomes to provide students with appropriate content, at appropriate levels, and in a way that appeals to students' individual learning styles. The assessment program at School of One is tied to its database. Students take daily assessments, and results from those assessments are used to inform instruction for the next day. The assessments are constructed by the database based on the activities the student worked on that day, and consist of up to six multiple-choice questions and two long-answer questions. The multiple-choice answers are fed back into the system and are used to generate the next day's schedule. In this model, teachers do not examine students' assessments, thus there are few opportunities for the teachers to diagnose student misconceptions based on the assessments.

The School of One model is very popular with New York policymakers: it is almost completely data-driven, it utilizes cutting edge, data-base technologies, and purports to provide students with exactly what they need. During the pilot however, some issues came up concerning the value of the data being generated through the School of One model *(Light, Cerrone, & Reitzes, 2009).* While the model generates lots of student performance data, there are limitations in the data around conceptual understanding. While beta-testing showed that students who participated in School of One showed substantial improvements in standardized-test scores, it is not clear to what extent this model contributes to the development of deep conceptual understanding and complex problem solving that mathematics standards call for and that are typically not measured by multiple-choice tests.

SIDEBAR **03**

# *accelerated mathematics (AM)*

In classrooms using AM, students take a 15-minute, computer-adaptive pretest, the results of which are used to assign them to an instructional level. At that point, the computer generates at-level practice exercises for each student. As the student completes these exercises, the computer sends immediate feedback to both student and teacher, and provides the teacher with summary data on all students in the class. Ideally, the teacher uses that data to further adapt and individualize instruction. The research shows increased student achievement on standardized math tests in classrooms in which teachers used continuous technology-supported progress monitoring to track student work and differentiate instruction *(Ysseldyke & Bolt, 2007).* One of the problems that researchers found, however, concerns fidelity. While the student scores went up in classrooms where teachers were diligent about their use of AM, those scores from students in classrooms with less consistent use of AM did not show significant improvement.

standardized tests and naturalistic, performance-based, or portfolio-based assessments. This ongoing assessment allows teachers to guide students to appropriate learning activities.

An advantage of technology-enabled assessment systems is their capability for customization. Many of the systems offer teachers the opportunity to review assessment items and to select a subset of items that they deem most relevant. Some systems also allow teachers to modify test items or add their own. In addition, technology-based assessment systems can perform complex analyses of patterns of student responses that would be difficult to perform otherwise. However, the accuracy of instructional diagnoses performed by the current generation of artificial intelligence programs is still an issue of debate in the learning sciences and many researchers would argue that human observers still do a better job. Nevertheless, technology can still play an important role in presenting problems and making thinking processes visible in ways that teachers can use to make instructional diagnoses.

Means *(2006)* distinguishes between two visions of technology-supported assessment: assessment tied to accountability systems, which results in a system of benchmarking students as they progress through a standards-based curriculum, and assessment of understanding, which produces a picture of student thinking described in detail below.

***Mastery learning approach.*** In this type of assessment, knowledge is broken down into skills, which are worked on until they are mastered. The goal of such assessments is to identify specific standards for which a student has not yet attained proficiency in order for that student to receive additional instruction on that content. In the mastery learning approach, instruction and learning are measured based on exposure to material and time on task, and there is generally little attention given to the quality and/or nature of student interaction with material *(Means, 2006).* In practice, these assessments take the form of frequent multiple choice tests or quizzes intended to provide data about the areas in which students are not performing well and where teachers need to focus instruction. Technology can support this kind of assessment by delivering online or software-based tests to students and the results of these tests to teachers. Some of the assessment systems also include instructional components, while others only provide teachers and administrators with the results of the assessments and leave it up to them to provide the appropriate instruction. Examples of this type of technology-supported assessment include Pearson Progress Assessment Series and Pinnacle Plus. One of the more highly publicized content mastery models is the School of One (see sidebar 2). A related approach to assessment is progress monitoring. Progress monitoring comes out of the tradition of programs designed to be used frequently to determine what students do and do not know, to inform need-based instruction, and to show students' progress through the curriculum. Conceptually, progress monitoring systems are designed to keep teachers up to date on the performance and progress of every student in their class and enable them to make changes in instruction for students experiencing difficulty *(Ysseldyke & Bolt, 2007).* Technology-supported progress monitoring is exemplified by Renaissance's™ Accelerated Math program (see sidebar 3).

***Assessment of understanding.*** The other major category of technology-supported assessments is designed to provide insights into students' understanding and reasoning, rather than level of performance. These formative assessments draw on learning sciences research that suggests that there are different ways of not knowing something; understanding how and why someone is not understanding is key to addressing misconceptions *(Means, 2006)*. Two students may both lack understanding of a topic or phenomenon, but may think about it in very different ways. In order to offer appropriate, personalized learning experiences, teachers need to understand how individual students are thinking. One example of this type of assessment for understanding is Diagnoser, developed by Facet Innovations. Diagnoser is a web-based assessment tool based on educational and psychological theory, designed by a team of science teachers and computer programmers. It is founded on the theoretical framework of Facet-based instruction, which contends that student responses are diagnostic of underlying reasoning about content areas *(Thissen-Roe, Hunt, & Minstrell, 2004).* The goal of Diagnoser is to elicit responses that reveal the underlying thinking, or knowledge facets, of each student. The system is programmed with facets, or frequently held conceptions and misconceptions in a certain content area, and sets of problems designed to unearth the facets that students are working with.

Among other technologies used for assessment of understanding, the Automated Response System (ARS) of "clickers," is gaining popularity. A 2006 study of ARS use in K-12 classrooms found that teachers use clickers as a tool for checking for student understanding in real time, diagnosing misconceptions, displaying responses to trigger

SIDEBAR **04**

## *diagnosing student thinking with diagnoser*

The program consists of computer-administered and graded, low-stakes, in-class quizzes, aligned to state standards, that grade in a standard way across one state and that deliver immediate feedback to both the teacher and the student about how well the student is learning. From a teacher page, teachers assign students question sets on relevant content. Students then log in to their individual student pages and proceed through their question sets. Question sets are made up of mostly multiple choice questions—with answer choices based on frequent student responses—using some fill-in, and some long-answer questions. After a student solves a problem, the system will either provide feedback to the student or ask the student to solve a question in order to confirm the facets that student is employing in that problem series. In that respect, the idea is to make the assessment itself into a learning experience: taking a student response (correct or incorrect) and providing pointed feedback that helps the student understand why that response was correct or incorrect on a conceptual level *(Thissen-Roe, et al; 2004).*

Diagnoser is designed as a complement to the teacher. It is intended to help provide the means for a qualitative discussion of student understanding of content, and to go beyond assessing content mastery. To achieve this, the program provides an integrated package of resources, including the assessment tool itself, an administrative tool, and a teacher guide. The teacher guide provides teachers with descriptions of content area facets, and instructional practices and activities proven to address particular facets (misconceptions).

An evaluation of Diagnoser found that there were two key reasons leading to its promising implementation with 6,000 students in Washington state. The first was the package of integrated resources (Diagnoser, its administrative tool, and teacher guide), which make it easy for teachers to understand and make use of the student and class data they receive. The second is that Diagnoser was purposefully designed to be technologically simple: it has a good user interface, but, equally important, it can run on most existing hardware in school systems. The same evaluation found that students who used Diagnoser in their classrooms on multiple occasions scored an average of 14 points higher on state tests than those students who did not *(Thissen-Roe, 2004).*

discussion, providing formative data to guide instruction, and efficiently administering and scoring quizzes *(Penuel, Boscardin, Masyn, & Crawford, 2006).* ARSs are especially valuable for teachers of classes with large numbers of students. The teacher can present a problem with multiple-choice answers to the class, and have students solve the problem on their own and input their answers into their own ARS clickers. Those answers are gathered by the computer and can be instantly displayed to the class. The teacher then might ask the class to look at how other students are answering the question, convene in small groups, and come to a consensus about which is the right answer *(Caldwell, 2007)*. Research shows that AR systems result in a distinct rise in student engagement. However, increases in student achievement were mostly found in classrooms where teachers had a significant amount of professional development around using AR systems in their classroom, as well as those classrooms with veteran teachers *(Penuel et al., 2006).*

Technology-enabled performance-based assessment is another way for teachers to gain insights into student understanding. Digital portfolios are a collection of student work in electronic format and can include text, images, audio recordings, multimedia, blog entries, and links to resources on the web. They have become a way for students to keep track of their work as they grow as learners. Digital portfolios are more suited than other types of assessment tools to document higher order thinking skills and performance skills that are necessary for students to graduate from high school both college- and career-ready for the 21st century. Engaging teachers in the development and scoring of these assessments can strengthen curriculum and instruction and can support more diagnostic teaching practices *(e.g., U.S. Department of Education, 2010.)* Though there exists little research on the efficacy of digital portfolios on student achievement, they are being used in programs such as New Tech Network, Boston Arts Academy, High Tech High, and the Science Leadership Academy in Philadelphia. Digital portfolio programs vary at different schools, but the example from Camino Nuevo High School serves as an illustration of one way they can be implemented (see sidebar 5).

For teachers, the most valuable assessment tools are those that are designed to reveal specifics about students' thinking in ways that can inform further instruction *(Means, 2006; Black & William, 1998).* Many of the assessment systems designed to support classroom assessments that are linked to standards and accountability systems lack this capacity to inform instructional decisions. They provide information about whether a student has achieved mastery, but do not provide insight into the way the student is thinking. Given the multiple-choice format of these assessment systems, they tend to stress facts, name recognition, and discrete procedures, rather than deeper understanding or the relationships among concepts. Assessments that show teachers how students think are more helpful in guiding selection of appropriate learning experiences that are matched to a student's specific strengths and needs. Nevertheless, both forms of assessments are likely to co-exist in the classroom. And either approach puts heavy demands on teachers to bring to bear expertise in the subjects they teach and the ways that students think about and problem solve in those content areas in order to design instruction to support further learning. Appropriate professional development is key for these assessments to be used effectively.

### FLEXIBLE CONTENT, SCHEDULING, AND PACING

In a student-centered learning environment, students and teachers have input into the use of their time. Student-centered learning offers opportunities to expand education beyond the traditional boundaries of schools by making it available during afterschool hours and year-round. Technology can be an important vehicle for providing flexible scheduling and pacing through online learning. It takes place in the form of online courses that are provided either through traditional brick-and-mortar schools or through virtual schools. In online courses teachers and students are physically separated, with the majority of content and instruction delivered via the Internet. There are many

SIDEBAR 05

## portfolio assessment at camino nuevo

At Camino Nuevo, students are trained in web design and tasked with building and maintaining their own personal digital portfolio. The portfolios live on the school's server, and serve as an "authentic and public way for students to display their work while demonstrating a mastery of some basic new media skills" *(Cramer, 2009).* At the end of the 10th, 11th, and 12th grades, students are required to present their portfolio, which contains work demonstrating the skills and concepts developed during each year across disciplines. Often, students will go back over their work and reflect, or perhaps even improve upon it, e.g. reediting an essay, or rethinking the results of a science experiment.

Teachers at Camino Nuevo cite many benefits of their digital portfolio program, including a positive impact on student achievement, parent and community access to student work, and preparing students to present themselves professionally in the real world *(Cramer, 2009).*

different approaches, which can range from delivering all content and instruction online to more blended courses, which supplement a majority online course with significant face-to-face instruction. As the field of online learning evolves, educators are embracing a mix of online and face-to-face instruction, referred to as either blended or hybrid models *(Means et al, 2009; Watson, 2009).* Researchers have described a number of advantages of hybrid models. As Dziuban, Hartma, & Moskal *(2004)* point out, blended models combine the effectiveness and socialization opportunities of the classroom with the technologically-enhanced active learning possibilities of the online environment. Because online learning environments provide an additional lens on students' performance (e.g., how they communicate in the online medium, how they participate in group discussion) and more opportunities to engage in one-on-one communication with students, they help can help teachers to get a more comprehensive understanding of individual students' strengths and needs *(Davis, 2010).*

A virtual school is an organization that offers online K-12 courses. While there are a number of diploma-granting virtual schools where students enroll as full-time students, the majority of virtual school programs provide expanded learning opportunities in the form of online courses to already established educational institutions. Clark *(2008),* distinguishes between three different types of virtual schools:

1. ***State-led virtual schools.*** These schools generally provide supplemental courses for already existing educational institutions, supplementing and complementing existing local curricula. The Florida and New Hampshire Virtual Schools are examples of a state-led virtual school program.

2. ***Virtual Charter Schools.*** Operating under state charter law, these schools offer tuition-free, full-time online programs. They generally serve K-8 student populations, and the majority of these programs serve students with extraordinary circumstances, such as medical conditions.

3. ***Privately Operated Virtual Schools.*** These tuition-based programs offer full-time or supplemental learning opportunities. They may be schools of record, but are often contracted by established educational institutions to provide online learning opportunities.

There exists a fairly extensive literature describing how online learning has been used in K-12 education. Online learning is being used to provide increased access to course content, increased scheduling flexibility and geographic flexibility, and increased access to alternative educational choices for students *(Barbour & Reeves, 2008; Means, Toyama, Murphy, Bakia, & Jones, 2009)*. Smaller schools and schools in rural areas utilize online programming in order to offer courses that they would otherwise not have the resources to teach, including higher-level mathematics and science courses and Advanced Placement courses. Further, schools use university- sponsored online learning programs, such as Project Advance from Syracuse University and the Clipper Project from Lehigh University, to give students the opportunity to earn college credit while still in high school *(Barbour & Reeves, 2008; Clark, 2008).* Online learning is also used to provide students with access to remedial courses (offered by online curriculum companies, such as Apex Learning Inc. and Plato Learning Inc., as well as nonprofit providers such as the Orlando-based Florida Virtual School and Georgia Virtual School), or online tutoring and homework help services such as e-tutor or Tutor.com *(Trotter, 2010).*

Delivering content and instruction online can also allow students at brick-and-mortar schools to fit additional courses into an otherwise busy schedule, and it can allow students who are unable to attend brick-and-mortar schools, for whatever reasons (e.g., extended illness), the chance to keep up with their coursework *(Barbour & Reeves, 2008; Clark, 2008; Wood, 2005).* Online learning also offers students a different type of flexibility. Depending on the structure of the online course, a student may have the opportunity to spend as much or as little time going through course content and activities as needed. For advanced students, this means that they can move through courses without having to stop and wait for their classmates, and struggling students can take the extra time they need to become comfortable with course content and work through course activities.

Computer-based delivery of education is one of the fastest growing trends in educational uses of technology.

Computer-based delivery of education is one of the fastest growing trends in educational uses of technology. Christensen et al. *(2007)* predict that by 2019, 50 percent of all high school classes will be taught over the Internet. However, while providers of online education believe that it is effective in reaching and serving a wide range of students, little research has been performed to date to examine its effectiveness compared to face-to-face instruction in elementary and secondary settings. Much of the existing evidence on the effectiveness of online learning comes from research that has focused on higher education and professional development contexts *(Barbour & Reeves, 2008; Means et al., 2009; Smith, Clark, & Blomeyer, 2005).* A meta-analysis of the available research (primarily conducted in post-secondary settings) showed that on average, students in online learning conditions performed better than those receiving face-to-face instruction. Students who participated in blended online learning experiences outperformed students in face-to-face settings by a larger degree than students who participated in online courses that were conducted entirely online *(Means et al., 2009)*. It should be noted, though, that blended courses often include additional learning time and instructional elements not included in traditional face-to-face settings, so the difference in performance cannot entirely be attributed to the online delivery medium alone.

Five of the research articles included in the meta-analysis conducted by Means et al *(2009)* reported on studies conducted in K-12 settings. These studies compared blended conditions with face-to-face learning. One of the studies was a randomized control trial *(Long & Jennings, 2005)* and the others were quasi-experiments *(Rockman, 2007; O'Dwyer, Carey & Kleiman, 2007; Sun, Lin & Yu, 2008; Englert, Zhao, Dunsmore, Collings, & Wolbers, 2007)*. One of the quasi-experimental studies *(Rockman et al., 2007)* favored face-to-face learning, while the other studies favored online learning.

In addition to the research on effectiveness, there exists some research on the conditions under which online learning is effective. Based on their synthesis of the research literature, Means et al. *(2009)* found that few of the variations in which online learning is being implemented in different contexts (e.g., synchronous versus asynchronous interaction; see sidebar 6) made a difference in student outcomes, except for the use of a blended, rather than a purely online approach, and the expansion of time on task for online learners. These two online learning practice variables significantly improved student learning. Further, elements of online learning such as video and quizzes did not influence the amount that students learned in online classes. However, the research suggests that online learning can be enhanced by giving learners control of their interactions with media and prompting learner reflection. Moreover, DiPietro, Ferdig, Black, & Preston *(2008)* found that the most important factor related to student perceptions and outcomes in online learning courses is the role of the teacher. Stronger teachers result in more engaged and more confident students. In online instruction, as in face-to-face instruction, having a more involved teacher does not necessarily mean having a teacher who dominates instructional time with lectures. Rather, in online learning environments strong teachers must be able to connect pedagogy, content, and technology in order to facilitate communication between students, and design informative and engaging learning experiences, all while keeping pace with and integrating effective Internet technologies to support their teaching practices.

Despite the availability of some research, many questions about the integration of online learning into student-centered learning environments remain. For instance, which types of learners are most successful using online learning? Online courses often have substantial dropout rates, suggesting that not all students may do well in this type of learning environment. Online courses often require a lot of reading, which raises the question of how students with weak literacy skills fare in these environments.

***Advising***

Schools that provide students with a student-centered learning model allot a significant amount of time for teacher-student advisement. Our review found very little research discussing the role of technology in advisory programs such as those in student-centered high schools like High Tech High and Science Leadership Academy (see sidebar 7). In those student-centered models, groups of no more than twenty students are paired with an advisor for their entire four-year high school experience. Students meet in their advisories anywhere from twice to ten times a week for varying amounts of time. In many of these schools, most adults in the school building are advisors, including teachers, administrators, and counselors *(Keefe & Jenkins, 2008)*. In these models, advisors become adult advocates for their advisees, developing strong relationships with their parents or caregivers, and communicating with their teachers to help them grow socially, personally, and academically.

SIDEBAR **06**

# *synchronous and asynchronous online learning*

Typically, communication in online learning environments is broken down into either synchronous or asynchronous. Often, online courses will use a combination of asynchronous and synchronous communication tools. It is important to consider the benefits of each approach and to be aware of ways of incorporating both approaches when possible (e.g., by making a live, synchronous chat available asynchronously by archiving it) *(Quillen, 2010).*

Synchronous instruction refers to online teaching and learning that happens in real time via the Internet. Synchronous instruction methods afford life interactions between teachers and students, and student with each other, similar to face-to-face interactions. For example, using a synchronous communication tool, a teacher might deliver a lecture or facilitate a class discussion, or share online media or data. Synchronous communication tools also allow teachers to deliver immediate feedback to students in an online environment *(Barbour & Reeves, 2009; Watson, 2009).* For example, online tutors in the School of One pilot were able to work with students one-on-one via audio chat and a shared computer screen. Sharing the screen allowed the student and tutor to better communicate their ideas to one another without a time lag. There are a variety of synchronous communication tools, including: live chat, audio and video conferencing, shared screens, and virtual hand-raising. Students can interject questions in order to request clarification or ask for more in-depth coverage of relevant topics. Virtual hand-raising makes it possible to adjust the pace and content of a class to match the skills and goals of the students.

Asynchronous instruction refers to online teaching and learning that utilizes Internet-based, time-delayed communication tools. Typically, students log in to a course website (often this will be a pre-packaged customizable course management system (CMS), such as Blackboard) that contains a course syllabus, course calendar, assignments, content resources, and communication tools such as message boards and file sharing utilities. Based on the syllabus and calendar, the student will use the available online resources, as well as, perhaps, supplementary texts and other media to complete weekly assignments, which he or she will hand in to the teacher through the CMS. Assignments may vary and include written reports, posting on the class message board twice a week, or posting a weekly synopsis of course-relevant news articles, for example. Teachers provide feedback about written work to individual students, and monitor activity on the message boards to ensure that students are participating in group discussions *(Barbour & Reeves, 2009; Watson, 2009).* One of the benefits of asynchronous teaching and learning is that it allows students to work at their own pace to a greater degree. For instance, a student who is struggling with the course material can take more time to work through a problem set or a difficult assignment, while a more advanced student can complete assignments at a faster pace and move ahead in the syllabus without having to wait for the rest of the class. Asynchronous communication tools include e-mail, threaded discussion, newsgroups, bulletin boards, and file attachments.

SIDEBAR **07**

# *technology for advisement at the science leadership academy*

In order to better understand the different roles that technology can play in these models, we spoke with the head guidance counselor at the Science Leadership Academy (SLA) in Philadelphia. The school's advisory program begins when students come in as freshmen and are matched with an advisor. Advisory groups are 18 students per advisor, and meet two days a week for 50-minute periods at the end of the school day. The focus of advisory programming at SLA changes as students move through their high school career: in 9th grade working on their transition into high school; in tenth and eleventh grades engaging in career planning, and in twelfth grade working on college prep and the application process. Throughout all four years, advisory is also a place where students discuss prevalent issues—from school policies to global affairs—and sometimes just hang out and chat with each other *(Z.F.S., Counselor, personal interview, May 23, 2010).*

At SLA, a school where technology use is ubiquitous (all students have laptops and use them frequently, and technology is well-integrated into the curriculum), advisory is where technology is used the least because of the one-to-one human interaction that the school is trying to foster. However, technology is not absent from SLA's advisory program. The main uses of technology in the program are for communication and for organizing students' college application process.

SLA is piloting a new Internet communication platform called School Tool. While School Tool has many functions for schools, including collecting, coding, and disseminating assessment data, the counseling team at SLA praises the program for how easy it has made communication among stakeholders. According to the counselor at SLA, one of the advantages of School Tool is that teachers and administrators can log in and see a record of the messages in a student's folder (e.g., "Student A was late handing in her benchmark assignment in Math. Her parents were contacted on 5/23/2010, and an e-mail was sent to the student's e-mail address.") The program acts as a "digital folder" in which a record of correspondences regarding each student is maintained and easily accessible for teachers to see. The program has also made it easier for the school's counselors to integrate student support programs through the district (e.g., "documenting when teachers call home, that parent contact was made on such and such date"). Though there are glitches to the system, such as an inability to cut and paste from a Word document, the communication affordances that it provides have been a welcome addition to the SLA program. As one counselor put it: "For me it's awesome... especially as a one-to-one student-laptop ratio makes documentation so much easier."

At SLA, Naviance is used to help track where students are applying to college, to cut down on paper work by enabling high schools to transmit documents to college admissions offices electronically, and to streamline the application process. One of the potential benefits of using Naviance is the abundance of statistics that the program can provide to a school, including data on acceptance rates, financial aid, alumni records, etc. Accessible data on alumni acceptances and financial aid has helped counselors at SLA guide current students to the programs that best suit their interests and needs.

Communication plays a key role in the advisement process. Technology can facilitate more streamlined and regular communication between teachers, advisors, administrators, students, and parents or caregivers. A Harvard Family Research Project study has concluded that ongoing, two-way communication is associated with students' academic success, and that Internet technology represents an opportunity for increasing communication between families and schools *(Bouffard, 2008).* School Tool is an example of a documentation and communication tool that allows teachers and advisors to send messages to students, parents/caregivers, and other teachers either regarding a particular student (e.g., perhaps a student has not yet turned in a major assignment, or has been dealing with personal issues that teachers should be aware of). Messages to parents/caregivers and students are sent to their e-mail addresses, while messages to other teachers and administrators are sent through the School Tool system. These messages are saved and kept in each student's digital School Tool folder, which can only be accessed by teachers and administrators. Published research on School Tool or similar programs is not yet available. An important question for future research to investigate is how digital divide issues (e.g., what happens with families that do not have access to a computer at home or that are not adept with technology) affect the effectiveness of these communication tools. Such research could help schools to prioritize their use of technology for specific purposes, and to weigh the cost of implementing a particular technology solution against other costs.

The college application process can be complicated and trying for students, as well as high school guidance counselors. Technology can help to scaffold and streamline much of the process. Naviance is an example of a Web-based, college-planning program. The program provides students and families with online access to information about colleges and scholarships, and provides innovative search tools, graphs, and statistics that offer insight into the application process. It can be used to create detailed reports that reveal data about college application, enrollment, and completion. Schools also can extract information essential to adjusting academic offerings and programs. No published research provides direct evidence about the effectiveness of Naviance, or how this program is being used in schools. However, a 2009 What Works Clearing House report, "Helping Students Navigate the Path to College: What High Schools Can Do," outlines a number of research-based recommendations that support the use of a tool like Naviance. Those recommendations include helping students through each of the multiple steps needed to complete the college application process and providing information about financial aid opportunities and how best to take advantage of them *(Tierney, Bailey, Constantine, Finkelstein, & Hurd, 2009).*

In summary, existing tools hold some promise to support advisement functions such as communication and the college application process, but little research has been done on the use and effectiveness of these tools.

## PRESENTING CONTENT IN ALTERNATIVE WAYS

Student-centered learning models acknowledge that content can and must be presented in multiple ways in order to provide access for students who learn best in particular ways, as well as to deepen learning for all students. Universal Design for Learning is an approach to curriculum design that aims to address the needs of the broadest range of learners by highlighting the importance of providing multiple means of representation, expression, and engagement. According to Rose and Meyer (2006) universally designed learning environments are built on the following three key principles:

1. They provide multiple means of representation, to give diverse learners options for acquiring information and knowledge.

2. They provide multiple means of action and expression, to provide learners with options for demonstrating what they know.

SIDEBAR **08**

# civilization

Civilization is a computer game in which a player can lead his or her chosen nation from the beginning of time through the Space Age and become the greatest ruler the world has ever known. A player's tasks include making decisions about resource allocation, diplomacy, and knowledge advancements for society. Researchers report that Civilization can be a good way for kids to learn about history, specifically including vocabulary and geography, as well as generally increase their interest in the topic itself. Researchers at Games Learning Society at the University of Wisconsin and the Education Arcade at MIT have been looking at how teachers are using Civilization in classrooms and the resulting effects on students' content knowledge and thinking skills. These studies found that students were able to use historical concepts to interpret and analyze the game; to ask questions about historical events; and to consider alternate possibilities to history. While Civilization is a tool in helping students engage with, interpret, and analyze history; teachers still need to provide context and scaffolding through class discussions.

Digital games can be computer-, game console- (XBox, PS3), or handheld-based (Nintendo DS, iPhone), and are defined by two key elements: an interactive virtual playing environment and the player pursuing a win-state *(Salen & Zimmerman, 2003).* Games are virtual worlds in which learners "play at" some role as they solve problems and make connections by learning to "think like" scientists, historians, journalists, soldiers, diplomats, or any other group that employs systematic methods of inquiry and problem framing in order to investigate the world. Games also provide a way for teachers to meet students where they are. A 2006 study reports that, on average, eighth-grade boys play 23 hours of video games per week, and girls play 12 hours per week *(Dawley, 2006).* Young people know how to interact with games. However, games are not designed to teach without some human intervention.

3 They provide multiple means of engagement to tap into learners' interests, offer appropriate challenges, and increase motivation.

Technology has long been known to offer options for teachers to present information in multiple media and modalities and for students to express and demonstrate what they know through multiple means (e.g., text, images, audio, animations, video) *(e.g., Bransford et al., 2000).* Recently, researchers and educators have devoted more attention to how technology can be used to engage students in alternative ways. Specifically, a number of studies have examined how digital games can be used to present content in new and engaging ways. In the remainder of this section, we summarize emerging research in this area.

Researchers and game developers largely agree that games do not necessarily teach content. However, Gee *(2005a)* has proposed that games can provide kids with experiences that teach them valuable higher order thinking skills and some habits of mind that are very valuable in today's post-industrial society. Groff, Haas, Klopfer, & Osterweil *(2009)* have observed teachers using games to get students to take on the role of scientist, engineer, mathematician, journalist, etc., and found that students developed the higher order thinking skills associated with those professions. Gee *(2005b)* has demonstrated that game playing can help to develop users' thinking skills, such as the ability to quickly process information, to review information and decide what is relevant and irrelevant, to process information concurrently from a variety of sources, to explore content in non-linear fashion, to become familiar with digital collaboration networks, to take a relaxed approach to play and problem solve by exploring, to form hypotheses, and to experiment.

When researchers discuss games in terms of education, they split them into COTS (commercial, off-the-shelf) games, and games that are designed explicitly for education. Both types of games have been used in classrooms. An example of a COTS game that researchers have examined is Civilization. An example of a game that has been explicitly designed for educational purposes is Conspiracy Code (see sidebars 8 and 9).

SIDEBAR 09

## conspiracy code

An example of a game that has been explicitly designed for educational purposes is Conspiracy Code. The game is part of an online course on American history offered by the Florida Virtual School. The course revolves around students playing an espionage adventure game that requires players to acquire knowledge of American history to solve problems and ultimately stop a conspiracy.

The aim of Conspiracy Code is to strengthen higher-order thinking skills, written communication, problem-solving, and collaborative skills through playing engaging concept-practice games, responding to a variety of question types, writing assignments and essays, completing authentic game-based assessments, and participating in discussion-based assessments. In order to ensure student understanding as the course progresses, teachers of this course review students' mission assessments and peer collaboration, check student log books, and facilitate discussions.

For teachers, using games in the classroom either online or face-to-face is not necessarily easy. As with any instructional tool, there are a variety of different strategies for implementation, for instance students play alone, in pairs, or as a whole class led by the teacher. Successful implementation of digital games in the classroom must overcome a number of barriers, including school culture, pedagogical and technical support, teacher's proficiency with technology and pedagogy, students technical proficiency, and resources. In order to work through those barriers, the Education Arcade, an MIT-based research and development center, suggests for teachers to explore games themselves. Teachers should spend time becoming familiar with digital games, especially the ones they want to use in their classroom, and collaborating with a colleague, either in person or online. Collaborating with another teacher who is interested in similar teaching methods is a good way to generate ideas and troubleshoot *(Groff et al., 2009).*

While teachers can use games like Civilization to offer students a different approach to historical content, it is important to note that the research concedes that games can be powerful educational tools when they are used as a springboard for engaging in critical thought and play. However, Groff et al. *(2009)* suggests that class discussions are needed to help students develop critical perspectives on game play and to understand where games fail to represent reality.

### PROJECT-BASED LEARNING

Project-based learning is an instructional approach that builds on students' interests to engage them in learning essential knowledge and skills through an extended, student-driven, and often collaborative inquiry process structured around complex, authentic questions and carefully designed products and tasks *(e.g., Ravitz, 2009).* A qualitative synthesis of meta analyses comparing project based learning to more traditional instruction conducted by Strobel & van

Barneveld, 2009 found that project-based learning was superior when it comes to long-term retention, skill development and satisfaction of students and teachers, while traditional approaches were more effective for short-term retention as measured by standardized board exams.

Technology can serve an important role in project-based learning by scaffolding component processes such as accessing information, collecting data, analyzing information, collaborating with others, and sharing and presenting the outcomes of a project. ThinkQuest is an example of a program that uses technology to support both teachers and students in carrying out projects (see sidebar 10). Other examples include the Adobe Youth Voices and Scratch programs, which focus on teaching students new technology tools to support their presentation of projects and ideas both in school and in afterschool settings (see sidebars 11 and 12).

In order for students to have authentic influence over their own learning, student-centered learning programs often provide a set of structured learning activities for all content areas, as well as the opportunity for students to work with teachers

SIDEBAR **10**

# *thinkquest*

To support teachers in the development and implementation of learning projects, the Oracle Education Foundation has developed and hosts an online environment called ThinkQuest. The environment is flexible so that teachers can design projects to meet their specific teaching and learning goals. ThinkQuest is available only to teachers and students at accredited schools to create a safe space for interaction. ThinkQuest also allows teachers to control whether their materials are limited to their classrooms only or open to all ThinkQuest members globally. ThinkQuest is available free of charge to primary and secondary schools around the world. It currently supports more than 400,000 students and teachers in 43 countries *(SRI International, 2009).* Components of ThinkQuest include:

- A shared online space for designing learning projects that can include an essential question and ties to the curriculum
- Publishing and collaboration tools that support a variety of project activities such as authoring content, conducting online discussions, and sharing digital objects such as photos, charts, and presentations
- A global community of teachers and students to draw from for cross-cultural collaboration opportunities and to serve as an audience for presentation of project results
- A competition space in which students can submit their projects to international contests
- A library of past student projects to use as references or as sources of inspiration
- A professional development program, which trains teachers to integrate project learning and 21st century skills into their curriculum.

Anecdotal evidence from case studies of classrooms using ThinkQuest suggests that the use of this online learning environment can result in improved outcomes for students *(SRI International, 2009).* These include critical thinking, creativity, teamwork, cross-cultural understanding, communication, technology skills, and self-direction.

to create new learning activities. Activities might range from short-term guided independent study to long-term work culminating in the production of a collaborative project, such as a short film, and will contain sufficient scaffolding such that key content and skill areas are addressed and assessed.

Research conducted on ThinkQuest and Adobe Youth Voices *(SRI International, 2009; Education Development Center, 2010b,c,d)* suggests that these programs can fit into a variety of content areas across the curriculum, as well as into different learning contexts (in school and afterschool settings). They enable educators to facilitate projects that are meaningful to the specific populations they serve. Opportunities for students to engage deeply in questions and issues they care about and to express their knowledge and opinions can support the development of their skills and contribute to their sense of themselves. For instance, evidence from case studies of classrooms using ThinkQuest suggests that the use of this online learning environment can result in improved outcomes for students in areas including critical thinking, creativity, teamwork, cross-cultural understanding, communication, technology skills, and self-direction *(SRI International, 2009).* Similiarly, case studies conducted in conjunction with

SIDEBAR **11**

# *scratch*

Scratch, created by a partnership between the Lifelong Kindergarten group at MIT Media Lab and Yasmin Kafai's group at UCLA, is a graphic programming environment that emphasizes media manipulation and supports programming activities that build on the interests of youth, such as creating animated stories, games, and interactive presentations *(Maloney, Peppler, Kafai, Resnick, Rusk; 2008).* Scratch projects can be uploaded and shared with a growing Scratch community via the Scratch website.

Scratch has been used in a variety of afterschool programs. Maloney et al. *(2008)* report on participants in an urban computer clubhouse afterschool program using Scratch on their own, with very little teaching, except when assistance from program staff was requested. Other programs, such as one afterschool program run by the Museum of the Moving Image in New York City, hired media arts professionals to teach semester-long curricula around Scratch *(Maloney et al., 2008; Peppler & Kafai, 2007).*

Peppler and Kafai *(2007)* identify three main benefits for youth participating in creative media production in informal spaces:

1. Using programs like Scratch helps to increase youth flexibility and fluency when moving between platforms.

2. Engaging in creative production affords young people opportunities to question traditional media conventions and designs, such as turning a critical eye towads video games and television.

3. These programs allow users a space for personal expression, creativity, and the appropriation of new media, which allows youth to connect to their prior knowledge and personal interests.

the implementation of the Adobe Youth program in a small number of school and afterschool settings suggest that this program can contribute to increasing students' engagement, acquisition of 21st century skills, and self-confidence and pride in their abilities. However, adequate teacher professional development and support is key. Both the ThinkQuest and Adobe Youth Voices programs have teacher professional development as a central component.

### COMMUNITY INVOLVEMENT

Student-centered learning environments give students opportunities to learn in a variety of ways, as well as in a variety of settings. When they are well developed and supervised, internships and other community-based learning opportunities play a very important role in connecting learning to the real world, providing genuine experiences and promoting thoughtful reflection *(Billig, 2007).* An example of an internship program that makes linkages to the community by introducing students to careers in the emerging field of sustainable technologies is the GreenFab academic enrichment program (see sidebar 13). A number of technology-based programs currently under development (see sidebar 14) also link to the community in a variety of ways, including the following:

- Enabling students to share their ideas about proposed urban development designs with developers and planners,
- Connecting students to real-world mentors and experts,
- Involving students in data collection that can be shared with research institutions for citizen-science projects,
- Sharing student-produced videos with commuters to provide them with information about different neighborhoods,
- Supporting students to collaborate globally on real-world problems.

In these programs, technology is being used to support communication, to provide students with access to experts and real-world audiences for their work, and to engage them in authentic problem solving and research activities. Since these programs are still under development, research on their effectiveness is not yet available. However, they align well with promising practices that have been identified by research on service learning. Billig *(2007)* has identified service-learning practices that emerged as predictive of student learning outcomes, such as academic achievement, civic engagement, acquisition of leadership skills, and personal/social development. Among others, these practices include:

- Planning and implementing service learning with specific learning objectives in mind,
- Engaging students in ongoing, cognitively challenging reflection activities,
- Giving students a say in every phase of a service-learning project,
- Teaching students respect for diversity,
- Selecting service-learning opportunities that students perceive as valuable, useful, relevant, and interesting,
- Building reciprocal partnerships with community organizations.

## 2. HOW IS TECHNOLOGY INTEGRATED INTO CURRICULUM-BASED APPROACHES TO STUDENT-CENTERED LEARNING?

There is little focus on curriculum in the literature on student-centered learning. This does not mean it is not an important element to consider. On the contrary, a well-designed curriculum is vitally important for personalizing learning. A curriculum is a coherent plan that links goals for learning, informed by national and state standards, and the work that happens in the classroom. The curriculum provides guidance on what to teach, how to teach, and how to assess student learning. Well-designed curricula can embody the student-centered learning approach and tie together the various elements described above *(Kantrov, 2009).* Technology can be integrated into such curricula

SIDEBAR **12**

## adobe youth voices

The Adobe Youth Voices program trains educators in both technical and pedagogical strategies for working with youth and digital media technologies. The program trains educators to work with youth ages 13 to 18 to create digital media projects designed to contribute the essential perspectives of youth to critical topics and inspire new solutions to long-standing problems, following the program's motto: "creating with purpose" *(Adobe Youth Voices, 2010).* Participants are encouraged to go out and interview members of their communities and capture images and ideas to communicate the stories they want to tell. Through the programs' partnership with various media outlets, participants can display their work to a global audience.

Program participants have shown deepened engagement in education and career development, as well as the acquisition of relevant 21st century skills and increased self-confidence and pride in their abilities. Educators who have gone through the Adobe Youth Voices program have gained skills in effectively using digital tools with youth, increasing the use of digital tools to teach across content areas, and capitalizing on the learning opportunities presented when youth use media to express themselves *(Education Development Center, 2010b,c,d).*

SIDEBAR **13**

## greenfab

Students participate in afterschool sessions and summer fellowships designed to introduce sustainable practices, industrial design, and prototyping. This program is designed to teach STEM concepts through hands-on, project-based learning activities that emphasize career development in the emerging field of sustainable technologies. Although Green Technology is one of the fastest growing industries, there is a dearth of qualified professionals in the field. GreenFab seeks to increase participants' technological and engineering fluency while providing a community and framework for students to explore "Green Collar" jobs. GreenFab provides its participants with classroom instruction in mechanical and electrical engineering, 3D modeling, computer programming, sustainable design engineering, and community advocacy. Students take one course per semester, either Green Technology (focused on engineering) or Sustainable Design (focused on design). At the completion of each semester, students present their final projects in an expo. An external evaluation of the GreenFab program is being conducted by EDC's Center for Children and Technology. So far, the evaluation, which is still underway, has shown that the program has been very rewarding for the students who enjoy science, design, hands-on projects, and the connections to the outside world. An integral part of the success is the relationship that develops between students and instructors, who provide a lot of individualized help.

SIDEBAR **14**

# programs that support community involvement

The following programs are currently under development with funding from the Digital Media and Learning program of the MacArthur Foundation.

***Participatory Chinatown*** is an immersive game where players take on the role of one of 15 virtual residents of Boston's Chinatown, and attempt to complete quests, such as finding a job or renting an apartment. In the game, players have to overcome real-life challenges like language barriers and income levels to succeed in their quests. After playing the game, players are then asked to walk their characters through proposed urban development designs and share their reactions and ideas. These comments are seen by developers and planners working on developing Boston's Chinatown.

***Talkers and Doers,*** due out in Fall 2010, is a new game franchise for at-risk teens and young adults from eLine Media (Gamestar Mechanic). Talkers and Doers focuses on entrepreneurship in areas of interest to youth. The first installment in the series, Talkers and Doers: Gear will use a social networking platform for a game to inspire kids to design clothes and other apparel, and craft ways to market and sell their ideas. Each game will unlock tools and missions where players can make real money and connect with real-world mentors and community-based resources.

***WildLab*** sets up students to use mobile devices to become citizen scientists. They walk around and use iPhones set up with the WildLab app to identify and photograph birds that they see within a specified area. The data they collect can be shared and analyzed in the classroom, and/or sent out via the Internet to research institutions. WildLab has developed a curriculum for kids to use the data they collect in order to develop their own questions about ecology and the environment, and to foster the habits of mind of being a citizen scientist.

***History Game Canada.*** Using a platform similar to Civilization, this game presents players with game scenarios taken directly from Canadian history. Players can play the game as different historical characters, giving them different perspectives on historical events. Players' choices throughout the game affect the outcome of each scenario, giving players a chance to not only think about, but also play out "what was," as well as "what might have been," and why. Players share their game experiences in online discussion forums, and can discuss current events with experts.

***Metrovoice: About/In/By Los Angeles.*** Students collaborate to create, write and produce videos exploring aspects of their communities, families, and neighborhoods. The videos are geo-coded, and are shown on the TV screens on the 2200 city buses running through Los Angeles. The videos are envisioned to transform the buses into "mobile learning labs" that connect program participants to the city at large.

***Global Challenge*** is an online, collaborative, problem-solving competition that engages teens throughout the world. The competition groups students into teams of four and presents them with real-world climate and environmental problems to solve. Using a wide variety of digital media and social networking tools, teams can take on problems from a number of approaches with varying levels of difficulty, from exploration of ideas to developing a working global solution business plan. All levels of projects are judged by project staff, peers, and experts, and winners receive awards such as merit scholarships.

both as a means to support students' acquisition of knowledge and skills and as an object of study. *The Ford Partnership for Advanced Studies (Ford PAS)* curriculum serves as an example.

*Ford PAS,* developed by Ford Motor Company Fund in partnership with EDC, is an interdisciplinary, career-focused, academic curriculum. Based on extensive research on project-based learning *(Ravitz, 2009)* and the integration of career and technical education in academic programs *(Stone, Alfeld, Pearson, Lewis, & Jensen 2006),* it is designed to provide high school students the knowledge and skills necessary to succeed in college and in the 21st century workforce. *Ford PAS* is made up of 20 standards-based modules that focus on content with realistic applications in areas such as design and product development, information systems, environmental sustainability, global economics, business planning, personal finance, and marketing. The curriculum encourages the establishment of partnerships with local businesses and higher education institutions to provide students with real world learning experiences. Focusing student learning on career areas and participating in real-world learning experiences requires that the students become familiar with and develop skills in appropriate technologies, for example computer-assisted design (CAD) for product development or database design for information systems. All learning is designed to be project-based in an effort to let students follow their personal academic and career interests. Performance assessments provide evidence of critical thinking, conceptual connections, and mastery of knowledge and skills.

Preliminary findings from research on *Ford PAS* curriculum implementation suggest its potential to impact teaching and learning. A 2005 CNA Corporation study showed that even where implementation was limited or relatively new, students were enthusiastically engaged and were developing important 21st century skills and knowledge. The study reported that *Ford PAS* classes differed substantially from other classes and provided learning experiences not otherwise available. There was also evidence that learning from *Ford PAS* classes carried over into other classes. Evaluators noted that *Ford PAS* students were noticeably better communicators, more inquisitive, more likely to be self-starters, and more capable of working alone and in groups. A 2006 SPEC Associates case study of an urban school with a high-need student population noted the potential of *Ford PAS* to prepare students for postsecondary education and refine career aspirations, as well as improve cognitive skills such as research, problem-solving, and interpersonal skills. The case study also provided cautionary evidence that contextual factors make a significant difference in effect: It stressed the need for professional development and coaching around the *Ford PAS* curriculum as well as buy-in from school administration and the community. Finally, in an implementation survey conducted by MPR, teachers and site coordinators indicated the program is having a strong impact on the 21st century skills the program is designed to advance; in particular, teachers reported a very strong positive effect on communication and problem solving *(MPR Associates, 2009).*

The flexible, modular design of the *Ford PAS* curriculum offers schools flexibility in how to implement it. Some schools use it as a framework for an entire school program, while others use a subset of modules on selected themes, or modules that can be used as units in traditional academic courses or electives. The curriculum also can be used in a formal program of study; an informal setting, such as summer, after-school, or weekend programs; or a combination of these two options.

The design of the *Ford PAS* curriculum can serve as a useful model for the development of student-centered curricula in other content areas. Essential features of the curriculum include:

- Project-based learning experiences that help students master concepts and connect classroom learning to personal interests and career exploration,

- Performance assessments that provide evidence of critical thinking, conceptual connections, and mastery of knowledge and skills,

- Technology being used as a tool to support learning and as an object of study as well,

- Partnerships with local businesses and higher education institutions to provide students with real-world learning experiences.

### 3. HOW IS TECHNOLOGY BEING USED AS PART OF SCHOOL- OR DISTRICT-WIDE INITIATIVES TO PERSONALIZE LEARNING?

Over the past two decades, a number of schools have been created that use student-centered learning approaches. Some of these schools have made technology an integral part of their mission. Appendix 1 includes detailed descriptions of two of these schools (High Tech High and Quest to Learn) to illustrate school-wide approaches for implementing and supporting the use of technology for student-centered learning. Other examples of schools that deeply integrate technology into student-centered learning include iSchool, the Science Leadership Academy, School of One, Opportunity High School, School for the Future, and New Tech Network (URLs to websites for these schools are included below).

These schools use technology in similar ways:

- Technology is deeply integrated into the overall vision, mission, and curriculum of the schools.

- It is used flexibly across the curriculum as tools for project-based learning and to support the pursuit of academic goals.

- Technology is also an object of study through courses such as video production, multimedia design or computer science.

- The curricula in these schools are explicitly designed to foster the development of 21st century skills.

- There is an emphasis on using technology in authentic ways (e.g., using digital probes to collect scientific data, using computer-assisted design tools for creating blueprints) that mirror how professionals in the workplace use digital tools.

- Students are active users and shapers of digital tools, rather than passive recipients of information delivered online.

- The schools utilize performance-based assessments that include technology as a tool and allow teachers to measure, among other things, students' competence with technology and 21st century skills.

- Teachers receive extensive professional development on using technology to support learning and have access to ongoing assistance during the school year.

The technology-using, student-centered schools that we reviewed have met with considerable success; they show low dropout rates, strong academic achievement, and high college enrollment for graduates. For instance, High Tech High schools report sending 100 percent of their students to college, with 80 percent to four-year schools, and 27 percent earning technical degrees in math, science, or engineering (the national average is 15 percent). Similarly, New Tech schools report that in the 2008-2009 school year, 85 percent of their seniors applied to college, 98 percent of whom were accepted to at least one post-secondary institution. The drop-out rate at two-thirds of the schools in the network is 0 percent. The School for the Future reports a four-year high school graduation rate of 91 percent (compared to 75% nationally) and an attendance rate of 91 percent for the 2008-2009 school year. While this success cannot be attributed to technology use alone, the educational approaches of these schools, which are supported by technology, can serve as a powerful model for other schools that seek to use technology in support of student-centered learning.

### 4. WHAT IS THE POTENTIAL OF EMERGING TECHNOLOGIES TO HELP TO BROADEN/DEEPEN OPPORTUNITIES FOR STUDENT-CENTERED LEARNING?

In planning for future technology use in schools, it is important to consider trends and resources that are not yet widely used in education, but that demonstrate considerable potential for supporting teaching and learning. Below we describe a number of technologies that entered the market in the consumer or business worlds and discuss the potential of these technologies to support student-centered learning.

#### DIGITAL BOOKS

Laptop computers and eReaders, such as the Kindle and the iPad, allow students to access digital textbooks and library books anytime and anywhere. Further, as more and more books are transferred to digital platforms, they are redesigned to include more multimedia content to complement the text, or sometimes serve in lieu of text. Multimedia-enhanced digital books provide accessible content for learners who might be less comfortable with text-heavy materials. In addition, eBooks allow readers to annotate content and then share and archive their comments online. Websites such as CAST's UDL book builder allow teachers and students to create their own digital books, which can be customized to meet the needs of individual readers. Digital books are becoming more and more popular on college campuses as universities attempt to cut down their use of paper, as well as cut publishing costs, but have not yet been used widely in K-12 settings *(Johnson, Levine, Smith, & Stone, 2010).*

#### CLOUD COMPUTING

Cloud computing refers to digital programs and storage that live in networked computers (rather than a local server), and that can be accessed anywhere using personal computers or mobile devices. Many applications that people use every day, such as gmail or GoogleDocs, are cloud applications. Cloud computing can bring otherwise out of reach resources into classrooms and into students' hands. For example, iLab Central makes authentic experimental laboratories accessible for students to use and access through the Internet. And because they live on the network, applications in the cloud make it easy to share documents, collaboratively edit, and effectively manage versions, both locally and at a distance.

#### COLLABORATIVE ENVIRONMENTS

Digital collaborative environments range from small single-purpose tools (e.g., GoogleDocs and wikispaces) to comprehensive collaborative virtual learning environments (e.g., Blackboard, Moodle, Schoology, Edmodo). These tools can facilitate synchronous and asynchronous collaboration on anything from small assignments to semester-long

In planning for future technology use in schools, it is important to consider trends and resources that are not yet widely used in education…

projects between classmates, students at different schools, students and teachers, and teachers and teachers, via the Internet. Social networking platforms also fall into this category. These sites allow users to share their interests with their peers, find other users with common interests, and participate in online collaboration *(Johnson et al., 2010).* While the use of collaborative environments in education has not yet been systematically studied, teachers have begun to explore the use of this technology in the classroom. An example is the Networked Newsroom project. Networked Newsroom is an online participatory learning news platform for high school or college journalism classes. It allows users to post story ideas, leads, photos, videos and other information directly from their computers or mobile phones. Editing is done collaboratively in the virtual newsroom, where diverse users supplement one another's work to develop more meaningful and robust stories. Final stories are published on a public wiki.

## MOBILE DEVICES

Newly released, large-screen mobile devices, or tablets, such as the Apple iPad, Google Tablet, and HP Slate, along with cell phones, iPods, and mp3 players that students are already using, offer a variety of educational affordances. In addition to mobile capabilities that might be used in the classroom—such as Twitter to facilitate in-class discussions, Poll Anywhere (pollanywhere.com) to turn a mobile device into an automated response system, or Internet browsing—this new generation of mobile devices can store digital textbooks and library books for students to access anywhere and at anytime, run augmented reality programs, and allow students to more easily take notes and share digital resources *(Johnson et al., 2010).*

Teachers have also used handheld devices (such as PDAs or smartphones) as progress monitoring tools. Wireless Generation has implemented a handheld progress monitoring system, mCLASS:DIBELS, in early childhood classrooms with positive results. Briefly, the system works as follows: Teachers use handheld computers to help manage and organize the administration of assessments and as a data input device to keep records of students' errors as they read passages that are provided to them in print. The system indicates which assessment subtests are appropriate for a given student based on grade level and time of year; it also monitors individual progress by keeping track of which passages have already been administered to which students. Though results from evaluations of the mCLASS:DIBELS have shown gains in student achievement and benefits for teachers (Hupert, Heinze, Gunn, Stewart & Honey, 2006 ), it should be noted that this body of work and subsequent research has focused only on early childhood education. However, similar use of handhelds might be interesting to pursue at the high school level.

## AUGMENTED REALITY

Augmented reality (AR) is emerging as a popular technology for learning. It involves the use of smart phones or GPS-equipped devices to explore real-world spaces, such as historical sites, artifacts in a museum, or different trees in a local park, while receiving text, video, images, or other input that are associated with their location. At MIT, the Education Arcade and Teacher Education program created Environmental Detectives, an AR game where players use GPS-guided handheld computers to try to uncover the source of a toxic spill by interviewing virtual characters and conducting large-scale simulated environmental measurements and analyzing data. AR lends itself well to students working in teams and solving problems in a real-world environment. As teams of students explore a location, they are provided with different clues in a jigsaw-puzzle style in order to promote collaboration and critical thinking skills necessary to problem solve in a group setting *(Lemke, Coughlin, & Reifsneider, 2009).* Research has shown that AR experiences can successfully engage students in scientific argumentation and collaborative investigation not often achieved through typical classroom activities *(Johnson et al., 2010).*

## GESTURE-BASED COMPUTING

Human-computer interactions are moving away from the standard keyboard and mouse, and towards more intuitive gesture-based communication systems that adapt to, or are even designed for interpreting natural human movements. For example, the iPhone responds to the gliding of fingers across its screen, as well as the tilting and shaking of the device itself. Larger displays allow multiple users to collaborate on the computer at one time. One such display, the Microsoft Surface, has been installed into school study areas, with schools reporting that students appear to enjoy using them to collaborate on projects. Researchers and designers believe that the move away from keyboards and mice to gesture-based controls will provide opportunities for kinesthetic learning: learners move through learning activities using their whole bodies, and receive haptic feedback (touch or motion based) letting them know how well they are doing *(Johnson et al., 2010).*

## VISUAL DATA ANALYSIS

Tools for collecting, analyzing, and visualizing complex data sets are becoming more readily available. Websites like Gapminder.org allow people to upload, visualize, and manipulate their own data. Researchers and educators see great potential in the eventual ability of such tools to allow students to see and manipulate complex processes, leading to deeper understanding of complex relationships and concepts *(Edelson, Brown, Gordin & Griffin, 1999; Johnson et al., 2010; Kali & Linn, 2009; Lemke et al., 2009).*

Educators have a key role to play in ensuring that technology supports student-centered learning.

# implications for practice, policy and research

While the research on technology and student-centered learning is limited, the existing knowledge base does suggest some implications for practice, policy, and research, which we will discuss in turn.

## IMPLICATION FOR PRACTICE

Educators have a key role to play in ensuring that technology supports student-centered learning. Teachers, in collaboration with other stakeholders (e.g., administrators, parents, students, colleges, employers, community members), need to think carefully about how to use technology well. Decisions about particular uses of technology should be informed by consideration of the following questions:

- How can technology be used to help narrow performance gaps between student subgroups and to ensure that all students achieve high quality, standards-based learning outcomes?
- How do specific uses of technology fit with the school's vision for student-centered learning?
- How can technology be used to add breadth and depth to educational experiences, and not just to replicate things that can be done without it?
- How can technology be used to enhance both content area competencies and 21st century skills?
- How can students experience technology in the ways that professionals use it in their fields?
- How can students experience technology in ways that will increase their awareness of and prepare them for a variety of career paths?
- How does technology use in the classroom relate to technology use for educational purposes outside of the classroom (e.g., for homework, afterschool activities, independent studies, internships)?
- What data needs to be collected on an ongoing basis to formatively assess whether and how specific uses of technology result in the desired learning outcomes?

In addition, administrators need to provide leadership and support the use of technology for student-centered learning. Key questions for them to consider include:

- What are the needs of different constituencies within and outside of the school (students, teachers, IT staff, colleges, employers) concerning technology use?
- What professional development do teachers need to use technology effectively for student-centered learning?
- What ongoing investments in infrastructure and human resources are necessary to support the use of the technology?
- What kinds of technology-use policies need to be in place (e.g., cell phone access, use of Internet filters) to support effective uses of technology?
- How can students receive credit for technology-enabled learning experiences such as online courses or internships?

↗ What assessments need to be developed and put in place to enable the measurement of higher-order, 21st century skills?

## IMPLICATIONS FOR POLICY

Policymakers at the district, state, and national levels have multiple levers to provide leadership and guide practice towards the use of technology for student-centered learning. These include:

***1. Policies Related to the Use of Educational Technology for Learning.*** While the recently released draft of the National Educational Technology Plan (NETP) *(U.S. Department of Education, 2010)* puts a strong emphasis on 21st century skills and on using technology to personalize learning, other recently released national standards and policy documents (such as the common core standards in Mathematics and English Language Arts, and the blueprint for the reauthorization of the Elementary and Secondary Education Act) do not explicitly address technology. The responsibility to integrate the recommendations from the NETP with the common core standards and other reforms falls on states and local leaders. To effectively guide practice, states should articulate technology standards aligned with the NETP and related standards *(Partnership for 21st Century Skills, 2009; International Society for Technology in Education, 2007).* In addition to separate technology standards, states should also embed an explicit focus on technology in specific academic content standards. Along with the articulation of the standards will come the need to test students' knowledge of and skill with technology. This will require the development of new assessments that are well aligned with the standards. Existing high school tests, which traditionally require memorizing facts, often have very little to do with what it takes do well in college or in the workplace (such as writing and problem solving). There is a need for assessments that measure complex 21st century competencies and that incorporate the use of technology. The Assessment and Teaching of the 21st Century Skills Initiative by Cisco, Intel, and Microsoft at the University of Melbourne is undertaking some initial work in this area.

It is important to emphasize that research generally does not tell educators exactly how they should use technology, but it can inform their decision-making about its use in particular circumstances.

States also play a key role in supporting online learning. By establishing and financing virtual schools that offer courses aligned with their standards, states can contribute to broadening available educational experiences that are attuned to individual students' interests and needs.

***2. Policies Related to the Training of Educators***
Standards for teachers and school administrators and requirements for initial teacher and administrator licensure and recertification should include the demonstration of competencies related to using technology to personalize learning experiences.

***3. Monitor Access Using Data.*** In order to insure equitable access to technology, districts and states need to monitor access to, use of, and capacity with technology. Data gathering needs to go beyond the counting of tools and take into consideration how technology is being used and by whom, as well as the capacity of educators to use technology to personalize learning.

***4. Statewide Longitudinal Data Systems.*** One of the four key funding priorities of the U.S. Department of Education is to support states in developing and implementing powerful technology-based longitudinal data systems. These systems are intended to help states and districts manage and analyze the growing wealth of student and teacher data, including individual student records. Once implemented, these systems have the potential to help policy makers and educators make data-driven decisions and facilitate research in the field. Teachers could benefit from the availability of longitudinal data about individual students, but will need professional development and support to be able to access and use the data.

***5. Funding Priorities.*** States should make the use of technology to support student-centered learning a priority in funding initiatives that support school districts' efforts to integrate technology. Technology funding is available through the Enhancing Education Through Technology program, stimulus money for statewide longitudinal data systems, Title 1, and the Individuals with Disabilities Education Act.

## IMPLICATIONS FOR RESEARCH

The existing research on technology and student-centered learning is limited and there are many unanswered questions that future research potentially can address. However, given limited funding resources, it is not likely that all questions can be researched in depth. For instance, as Tom Carroll *(2000)* pointed out, there is no research that shows the effectiveness of telephones, yet that doesn't stop many of us from using this technology every day, and few people would deny that telephones have a fundamental impact on how we communicate. On the other hand, sometimes questions relating to technology use are over-studied. The federal government recently invested six million dollars to support two large-scale studies that showed that texting and driving is dangerous (Richtel, 2009), a finding that few people would have questioned without any data. A key task for the field is to determine which questions are the most important, relevant, and useful to pursue.

There is growing consensus that making research relevant for policy and practice requires collaboration between researchers, practitioners, and policymakers at all levels in the research endeavor, including when research is being planned and conducted, not just when findings are being disseminated (Easton, 2010). So decisions about what research questions are most important to pursue should be made with input from all stakeholders. Collaborative research that accompanies schools' or districts' efforts to integrate technology with student-centered learning initiatives would support practitioners' efforts to continually inquire into and reflect on how technology can be used to support student-centered learning (i.e., as a method for self-improvement) and would also yield lessons learned for the field. In addition, researchers could play an important role in helping to aggregate data and synthesize lessons learned across different reform efforts.

It is important to emphasize that research generally does not tell educators exactly how they should use technology, but it can inform their decision-making about its use in particular circumstances. Research has an important role to play in helping us to better understand the circumstances under which technology is effective and for whom. In particular, we need more research on how technology can personalize learning, which requires analyses of which uses produced what outcomes for different students, not just data that shows that particular technology uses have an impact on the average student population. In addition, more research is needed about the roles of classrooms, schools, and social contexts in mediating the effects of policies and practices, and the ways in which organizational factors contribute to the success of efforts to use technology in support of student-centered learning.

...while technology can support student-centered learning, technology alone it is not likely to transform traditional learning environments into student-centered ones.

# conclusions

Research suggests that technology *can* support key practices of student-centered learning, such as assessing individual students' strengths and needs, flexible scheduling and pacing, advising, presenting content in alternative ways, project-based learning, and involving the community. Technology also has been successfully integrated in curriculum-based and school-based approaches to personalize learning. However, while technology can support student-centered learning, technology alone it is not likely to transform traditional learning environments into student-centered ones. Research on the use and integration of technology suggests that teachers and schools are most likely to use technology to personalize learning if (1) it supports already existing, student-centered practices and helps to solve problems or address challenges; (2) it is part of a systemic, organization-wide initiative to implement student-centered learning; and (3) teachers have access to ample professional development and ongoing support. While the research on technology and student-centered learning is limited, the existing knowledge base does suggest some implications for practice, policy, and research.

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# websites

***Professional Organizations***

International Society for Technology in Education
http://www.iste.org

Consortium for School Networking (CoSN)
http://www.cosn.org

State Education Technology Directors Association (SETDA)
http://www.setda.org

***Research and Policy Centers***

Center for Implementing Technology in Education (CITEd)
http://www.cited.org/index.aspx

National Center for Technology Innovation (NCTI)
http://www.nationaltechcenter.org

Regional Educational Laboratory Northeast and Islands (REL-NEI)
http://www.relnei.org/home.php

***Research and Development Organizations***

CAST
http://www.cast.org

Concord Consortium
http://www.concord.org

EDC/Center for Children and Technology
http://cct.edc.org

ITEST Learning Resource Center
http://itestlrc.edc.org

TERC
http://www.terc.org

***Advocacy Organizations***

Assessment and Teaching of 21st Century Skills
http://www.atc21s.org

Common Sense Media
http://www.commonsensemedia.org

Digital Media and Learning Research Hub
http://www.dmlcentral.net

Games Learning Society
http://www.gameslearningsociety.org

New Media Consortium
http://www.nmc.org

Next Generation Learning
http://www.nextgenlearning.com

Partnership for 21st Century Skills
http://www.p21.org

Project RED
http://www.projectred.org

***Think Tanks/Operating Foundations***

The Carnegie Corporation for the Advancement of Teaching
http://www.carnegiefoundation.org

Kaiser Family Foundation
http://www.kff.org

Knowledge Works Foundation
http://knowledgeworks.org

The Stupski Foundation
http://www.stupski.org

George Lucas Educational Foundation (Edutopia)
http://www.edutopia.org

***Federal Agencies***
National Science Foundation
http://www.nsf.gov

U.S. Department of Education,
Office of Educational Technology
http://www2.ed.gov/about/offices/list/os/technology/index.html

***Private Foundations***
MacArthur Foundation
http://www.macfound.org

Bill & Melinda Gates Foundation
http://www.gatesfoundation.org/Pages/home.aspx

Carnegie Corporation of New York
http://carnegie.org

W.T. Grant Foundation
http://www.wtgrantfoundation.org

***Educational Resources***
Apex Learning Inc.
http://www.apexlearning.com/Solutions/Credit_Recovery.htm

Clipper Project
http://clipper.lehigh.edu

Curriki
http://www.curriki.org

Digital Media Arts
http://dma.edc.org

Education Arcade
http://educationarcade.org

Environmental Detectives
http://education.mit.edu/ar/ed.html

e-tutor
http://www.e-tutor.com

Facet Innovations
http://www.facetinnovations.com

Florida Virtual High School
http://www.flvs.net

Ford-PAS
http://www.fordpas.org

Gapminder
http://www.gapminder.org

Georgia Virtual School
http://www.gavirtualschool.org

Global Challenge
http://www.globalchallengeaward.org/display/public/Outlines+of+the+Challenges

History Game Canada
http://www.historycanadagame.com

iLab Central
http://ilabcentral.org/about.php

Naviance College Planner
http://www.naviance.com/products-services/college-planner.html

Participatory Chinatown
http://participatorychinatown.org

Pearson Progress Assessment Series
http://www.k12pearson.com/teach_learn_cycle/pem/pem.html

Pinnacle Plus Assessment
http://www.globalscholar.com/Products/Pinnacle-Suite.html

Plato Learning Inc.
http://www.plato.com

Project Advance
http://supa.syr.edu

School Tool
http://schooltool.org

Sid Meier's Civilization IV Game
http://www.2kgames.com/civ4/complete

ThinkQuest
http://www.thinkquest.org

Tutor.com
http://www.tutor.com

UDL Bookbuilder
http://bookbuilder.cast.org

Wild Lab Edu
http://www.thewildlab.org

YouthLab
http://www.globalchallengeaward.org/display/public/Outlines+of+the+Challenges

***Programs***

Adobe Youth Voices
http://youthvoices.adobe.com

School of One
http://schoolofone.org

***Schools***

High Tech High
http://www.hightechhigh.org

iSchool
http://www.nycischool.org

New Tech Network
http://www.newtechnetwork.org

OPPortunity High School
http://www.opp.org

Quest to Learn
http://q2l.org

School of the Future
http://www.sofechalk.org

Science Leadership Academy
http://www.scienceleadership.org

# appendix 1

## METHODS FOR THE LITERATURE REVIEW

We conducted a search of the research literature, as well as practice and policy-oriented reports using the following methods:

- Internet searches on Google and educational research databases using the following key words: technology, student-centered learning, personalized learning, and technology integration.
- Review of websites of federally funded national and regional resource centers such as NCTI, REL-NEI and professional organizations and think tanks such as ISTE, the Kaiser Family Foundation, KnowledgeWorks Foundation, and the Stupski Foundation (a list of these websites is included in the reference section above).
- Review of websites of selected private and public foundations that provide funding for projects focused on the use of technology in education, such as the MacArthur Foundation, Bill & Melinda Gates Foundation, Carnegie Corporation of New York, W.T. Grant Foundation, Carnegie Corporation for the Advancement of Teaching, U.S. Department of Education, and the National Science Foundation.
- Review of websites of selected schools that use student-centered learning.

In addition, we convened a meeting of our colleagues at EDC who work on projects related to technology and student-centered learning. We also conducted interviews with educators at selected schools to obtain detailed information about how they are using technology to personalize learning.

Our search yielded a large number of resources that address technology and student-centered learning. In our search we gave priority to resources that included some type of research evidence. We found that few studies have directly examined the effectiveness and impact of specific technology applications or programs. Most of the existing research is descriptive in nature and focuses on the potential of various uses of technology for personalizing teaching and learning and for improving student learning outcomes. Table 1 below lists the sources included in the review and provides information about the research design utilized, key findings, and type of evidence available.

While there are some studies available that have examined the effectiveness of specific technology uses on student learning, very few have addressed questions regarding whether those uses are successful for personalizing learning. Addressing these questions requires complex analyses of outcomes for different student subgroups to examine if specific technology-enhanced instructional practices are successful at reducing existing performance gaps between these groups.

## TABLE 1: STUDIES ON TECHNOLOGY USE IN SUPPORT OF STUDENT-CENTERED LEARNING INCLUDED IN THE REVIEW

| STUDY | RESEARCH DESIGN | KEY FINDING(S) | TYPE OF EVIDENCE |
|---|---|---|---|
| Barbour, M. K., & Reeves, T. C. (2009). The reality of virtual schools: A review of the literature. *Computers and Education,* 52(2), 402–416. | Comparative descriptive study | The research on online learning shows that it typically benefits students who have independent orientations toward learning, are highly motivated by intrinsic sources, and have strong time-management, literacy, and technology skills. Researchers are calling for more research into the factors that account for K–12 student success in distance education and virtual school environments, and more design-research approaches than traditional comparisons of student achievement in traditional and virtual schools. | This paper reviews the literature on online learning between the years 2004 and 2008. |
| Billig, S. H. (2007). Unpacking what works in service learning: Promising research-based practices to improve student outcomes. In: National Youth Leadership Council, *Growing to Greatness 2007.* Saint Paul, MN: National Youth Leadership Council. | Research review | Eight service-learning practices emerged as predictive of student learning outcomes, such as academic achievement, civic engagement, acquisition of leadership skills, and personal/social development. | This paper synthesizes research on service learning and describes practices that are correlated with improvements in student-learning outcomes. |

TABLE 1 CONTINUED: STUDIES ON TECHNOLOGY USE IN SUPPORT OF STUDENT-CENTERED LEARNING INCLUDED IN THE REVIEW

| STUDY | RESEARCH DESIGN | KEY FINDING(S) | TYPE OF EVIDENCE |
|---|---|---|---|
| Bouffard, S. (2008). *Tapping into technology: The role of the Internet in family–school communications.* Cambridge, MA: Harvard Family Research Project. | Comparative descriptive research | Overall, findings from this national study suggest that the Internet represents a promising but largely untapped opportunity for promoting family–school communication. Despite the fact that such communication is relatively infrequent at the current time, it is associated with academic benefits. | This paper summarizes the results of the analysis of a large national data set. Data were taken from the Education Longitudinal Study of 2002 (ELS), a nationally representative dataset from the National Center for Education Statistics, which follows students from 10th grade into the postsecondary years. Data for this study was collected from 14,387 10th graders. Data were also collected from 88% of participants' parents and 99% of school administrators. |
| Black, P. & William, D. (1998). Assessment and classroom learning. *Assessment and Evaluation,* 5(1), 7–74. | Research review | Formative testing raises standards in the classrooms, but there is room for improvement in this area. | This paper synthesizes research in the field of formative assessment, and builds on the authors' previous work. |
| Caldwell, J. E. (2007). Clickers in the large classroom: Current research and best-practice tips. *CBE—Life Sciences Education,* 6. | Review of research and best practices | ARS's are especially valuable for teachers of classes with large numbers of students, providing them with instant feedback on students' thinking about problems. | This paper summarizes descriptive research and best practices on the use of clickers in large classrooms. |
| Clark, T. (2008). Online learning: Pure potential. *Educational Leadership, Reshaping High Schools,* 65(8). | Review of descriptive research and policy documents | This article discusses the potential benefits of online learning, and how educators and policy makers might work toward realizing that potential. | This describes examples of the potentials and misconceptions of online learning. |

## TABLE 1 CONTINUED: STUDIES ON TECHNOLOGY USE IN SUPPORT OF STUDENT-CENTERED LEARNING INCLUDED IN THE REVIEW

| STUDY | RESEARCH DESIGN | KEY FINDING(S) | TYPE OF EVIDENCE |
|---|---|---|---|
| CNA Corporation. (2005). *Ford PAS Implementation Study* (2003–2005). Unpublished report. | Qualitative research | Even where implementation was limited or relatively new, students who participated in *Ford PAS* classrooms were enthusiastically engaged and were developing important 21st century skills and knowledge. | This study describes the potential impact of the *Ford PAS* curriculum on students. |
| Cramer, M. (2009). Digital portfolios: Documenting student growth. *Horace*, 25, (1). Available online at: http://www.essentialschools.org/resources/526 | Qualitative case study | Teachers at Camino Nuevo cite many benefits of their digital portfolio program, including having a positive impact on student achievement, giving parent and community access to student work, and preparing students to present themselves professionally in the real world. | This article describes the implementation and benefits of the digital portfolio assessment program at Camino Nuevo High School. |
| Davis, M. R. (2010). E-Learning seeks a custom fit. Education *Week Digital Directions,* 3(2), 18-19. | Qualitative research | Online courses are especially suited to provide students with personalized learning experiences. Virtual schools and classes use everything from online data collection to one-to-one virtual interactions with teachers, and can offer more options for accessing course material than classes in brick-and-mortar schools provide. | This article draws on the research literature and interviews with researchers in the field and online education providers to describe the potential of online learning for supporting personalized learning. |
| Dawley, H. (2006). Time-wise, Internet is now TV's equal. *Media Life.* Available online at: http://www.medialifemagazine.com/cgi-bin/artman/exec/view.cgi?archive=170&num=2581 | Research review | This article discusses the rise of the Internet as a standard medium in the home. | The article summarizes existing research in the field in order to portray the current landscape of Internet media. |

TABLE 1 CONTINUED: STUDIES ON TECHNOLOGY USE IN SUPPORT OF STUDENT-CENTERED LEARNING INCLUDED IN THE REVIEW

| STUDY | RESEARCH DESIGN | KEY FINDING(S) | TYPE OF EVIDENCE |
|---|---|---|---|
| DiPietro, M., Ferdig, R. E., Black, E.W., & Preston, M. (2008). Best practices in teaching K–12 online: Lessons learned from Michigan Virtual School teachers. *Journal of Interactive Online Learning,* 7(1), 10–35. | Qualitative research | Teaching in online learning environments is different than teaching in face-to-face environments. The paper concludes with implications for policy, research, and practice. | This article reports on best-practices based on interviews conducted with 16 virtual-school teachers from the Michigan Virtual School (MVS). |
| Dziuban, C., Hartman, J., & Moskal, P. (2004). Blended learning . *EDUCAUSE Center for Applied Research Research Bulletin, 2004*(7), 1-12. Available online at: http://net.educause.edu/ir/library/pdf/ERB0407.pdf | Quasi-experimental | Blended learning experiences are most beneficial in higher-education classrooms, and least beneficial for younger students. | The article reports the results of a survey conducted by the University of Central Florida. |
| Education Development Center (2009 b). *Lessons Learned: Innovative Exhibits.* Newton, MA: Education Development Center.<br><br>Education Development Center (2009 c). *Lessons Learned: AYV Afterschool.* Newton, MA: Education Development Center.<br><br>Education Development Center (2009 d). *Lessons Learned: Integrating AYV into the Classroom.* Newton, MA: Education Development Center. | Qualitative research | This set of publications describes Adobe Youth Voices (AYV) as having provided the following benefits in classrooms:<br><br>Generate interest and investment: Hands-on, youth-driven projects can engage students in learning, and extrinsic goals can lead to additional investment and motivation.<br><br>Plan and support projects: Scaffolding student learning is important, whether it be through a series of incremental projects or by providing models and examples.<br><br>Connect with fellow teachers: Collaboration among educators can bring in complementary skills, enhance educators' own learning, and provide a positive experience for youth. | This series of reports presents findings from case studies of the integration of AYV in formal and informal education settings. These cases demonstrate various approaches that educators have taken to make AYV a successful part of their existing classes. |

TABLE 1 CONTINUED: STUDIES ON TECHNOLOGY USE IN SUPPORT OF STUDENT-CENTERED LEARNING INCLUDED IN THE REVIEW

| STUDY | RESEARCH DESIGN | KEY FINDING(S) | TYPE OF EVIDENCE |
|---|---|---|---|
| Englert, C. S., Zhao, Y., Dunsmore, K., Collings, N. Y., & Wolbers, K. (2007). Scaffolding the writing of students with disabilities through procedural facilitation: Using an Internet-based technology to improve performance. *Learning Disability Quarterly* 30(1), 9–29. | Quasi-experimental | Students in the blended online condition outperformed students in the face-to-face condition. | This study examined the effectiveness of a web-based writing program with 35 elementary grade students from six special-education classrooms across five special-education schools. The study compared student achievement in blended online courses with that in matched face-to-face classrooms. |
| Gee, J.P. (2005a). Good video games and good learning. *Phi Kappa Phi Forum.* 85(2), 33–7. | Qualitative | Learning is an inherent part of playing and mastering a digital game. The author suggests looking at digital games as academic learning tools. | This article summarizes findings from the author's qualitative research on digital games and learning. |
| Gee, J.P. (2005b) Learning by design: Good video games as learning machines. *E-Learning and Digital Media,* 2(1), 5–16. | Qualitative | Video games can be a powerful learning tool that can help teach and hone a number of 21st century skills. | This article summarizes findings from the author's qualitative research on digital games and learning. |
| Groff, J., Haas, J., Klopfer, E., & Osterweil, S. (2009). *Using the Technology of Today in the Classroom Today.* Cambridge, MA: The Education Arcade, MIT. | Case studies and research review | Teacher strategies for the successful use of games in the classroom include: explore the games, partner with a colleague, find additional supports. | This paper offers suggested practices and approaches for teachers using game-based learning and social media in their classrooms. |
| Keefe, J. W. & Jenkins, J. M. (2008). *Personalized Instruction: The Key to Student Achievement.* Pennsylvania: Rowman & Littlefield Education. | Case studies and research review | This book presents a conceptual rationale for personalizing instruction, provides twenty working strategies to assist schools in redesigning themselves for personalization, and cites specific examples of personalization in the subject disciplines and in selected schools. | The authors describe best practices based on a number of ethnographic case studies as well as a review of research in the field of personalized learning. |

TABLE 1 CONTINUED: STUDIES ON TECHNOLOGY USE IN SUPPORT OF STUDENT-CENTERED LEARNING INCLUDED IN THE REVIEW

| STUDY | RESEARCH DESIGN | KEY FINDING(S) | TYPE OF EVIDENCE |
| --- | --- | --- | --- |
| Light, D., Cerrone, M., & Reitzes, T. (2009). *Evaluation of the School of One Summer Pilot: An Experiment in Individualized Instruction.* New York, NY: Education Development Center. | Qualitative Research | This paper discusses the pilot program for the School of One program in NYC. The program drastically changes the role of the teacher, while giving students more access to digital technology and online learning environments. | The paper draws on the authors' ethnographic research and analysis. |
| Long, M. & Jennings, H. (2005). *Does it Work? The Impact of Technology and Professional Development on Student Achievement.* Calverton, MD: Marco International. | Randomized control trial | Students in the blended online condition outperformed students in the face-to-face condition on a researcher-developed multiple-choice test. | This study examined the impact of the Pathways to Freedom electronic fieldtrip as part of a unit on slavery and the Underground Railroad. The study compared student achievement in a blended online condition with that in a face-to-face condition. |
| Maloney, J., Peppler, K., Kafai, Y., Resnick, M., & Rusk, N. (2008). *Programming by Choice: Urban Youth Learning Programming with Scratch.* Cambridge, MA: MIT Media Lab. | Qualitative research | Youth enjoy using Scratch in informal clubhouse settings. In those settings, the multimedia building-block interface of Scratch allows young people with no prior experience to acquire and use programming skills and concepts. | This paper reports findings from a review of 536 Scratch projects by children and youth between the ages of 8–18 collected at a Computer Clubhouse (an after-school center) over an 18-month period. |

## TABLE 1 CONTINUED: STUDIES ON TECHNOLOGY USE IN SUPPORT OF STUDENT-CENTERED LEARNING INCLUDED IN THE REVIEW

| STUDY | RESEARCH DESIGN | KEY FINDING(S) | TYPE OF EVIDENCE |
|---|---|---|---|
| Means, B. (2006). Prospects for transforming schools with technology-supported assessment. In R. K. Sawyer (Ed.), *The Cambridge Handbook of the Learning Sciences* (pp. 505-519). New York, NY: Cambridge University Press. | Research review | This paper reviews research relating to two types of technology-based assessments: accountability-oriented, large-scale assessment, which provides districts with copious amounts of student data and teacher accountability measures, and formative assessment, which is recommended by the learning sciences community as a way to unearth student misconceptions and lead to more in-depth understanding of content. | This paper synthesizes research on technology-supported assessment. |
| Means, B., Toyama, Y., Murphy, R., Bakia, M., & Jones, K. (2009). *Evaluation of Evidence-Based Practices in Online Learning: A Meta-Analysis and Review of Online Learning Studies.* Washington, D.C.: U.S. Department of Education, Office of Planning, Evaluation and Policy Development. | Meta-analysis and review of online learning studies | On average, post-secondary students in online learning conditions performed better than those receiving face-to-face instruction. | This study reports the results of a meta-analysis of 46 experimental studies comparing online and face-to-face learning. |
| MPR Associates. (2009). *2008–09 Evaluation of Ford PAS Implementation.* Unpublished report. | Survey | Teachers and site coordinators indicated the program is having a strong impact on the 21st century skills the program is designed to advance; in particular, teachers reported a very strong positive effect on communication and problem solving. | This report describes how sample of users of the *Ford PAS* curriculum perceive its impact on student learning. |
| O'Dwyer, L. M., Carey, R., and Kleiman, G. (2007). A study of the effectiveness of the Louisiana Algebra I online course. *Journal of Research on Technology in Education 39*(3), 289–306. | Quasi-experimental | This study found that students in an online Algebra course outperformed students in face-to-face Algebra courses. | This study examined the impact of an online Algebra 1 course. The study compared student achievement in blended online courses with that in matched face-to-face classrooms. |

TABLE 1 CONTINUED: STUDIES ON TECHNOLOGY USE IN SUPPORT OF STUDENT-CENTERED LEARNING INCLUDED IN THE REVIEW

| STUDY | RESEARCH DESIGN | KEY FINDING(S) | TYPE OF EVIDENCE |
|---|---|---|---|
| Penuel, W. R., Boscardin, C. K., Masyn, K., & Crawford, V. M. (2006). *Teaching with Student Response Systems in Elementary and Secondary Education Settings: A Survey Study. Association for Educational Communications and Technology.* | Survey study | Teachers use clickers as a tool for checking for student understanding in real time, diagnosing misconceptions, displaying responses to trigger discussion, providing formative data to guide instruction, and efficiently administering and scoring quizzes. | This study reports descriptive data about how teachers are using Automated Response Systems in elementary and secondary classrooms. |
| Peppler, K. & Kafai, Y. B. (2007). From SuperGoo to Scratch: Exploring media creative production in an informal learning environment. *Journal on Learning, Media, and Technology,* 32(2), 149–166. | Ethnographic study | Creative design in digital media proves beneficial to young people, giving them greater fluency and flexibility across platforms, providing an opportunity to explore their own interests while learning new skills, and developing a critical eye toward digital media in the world. | This paper draws on ethnographic research done by the authors in computer clubhouses. |
| Quillen, I. (2010). E-Learning delivery debated. *Education Week,* 29(30), 55. | Expert interviews | Synchronous and asynchronous means of instruction are no longer at theoretical odds, but each approach has its unique benefits. | This paper describes benefits of synchronous and asynchronous online learning as identified by experts on virtual education. |
| Ravitz, J. (2009). Introduction: Summarizing findings and looking ahead to a new generation of PBL research. *Interdisciplinary Journal of Problem-Based Learning,* 3(1), Article 2. | Literature review | Looking largely at medical education, this review outlines the benefits of project-based curricula over traditional teaching methods. | This article reviews three meta-analyses on Project Based Learning. |
| Rockman et al. (2007). *ED PACE final report.* Submitted to the West Virginia Department of Education. San Francisco: Author. | Quasi-experimental | This study found no significant differences in students' oral and written Spanish for the blended online and face-to-to face conditions, and a significant advantage of the face-to-face condition over the online condition for improvements in students' writing ability. | This study examined the impact of blended online middle school Spanish courses offered by the West Virginia Virtual School. The study compared student achievement in blended online courses with that in matched face-to-face classrooms. |

TABLE 1 CONTINUED: STUDIES ON TECHNOLOGY USE IN SUPPORT OF STUDENT-CENTERED LEARNING INCLUDED IN THE REVIEW

| STUDY | RESEARCH DESIGN | KEY FINDING(S) | TYPE OF EVIDENCE |
|---|---|---|---|
| Salen, K., & Zimmerman, E. (2004). *Rules of Play: Game Design Fundamentals.* Cambridge, MA: MIT Press. | Case studies | This book discusses the authors' theories on game-based learning | The authors draw on their own experiences in the field as well as look at a number of case studies throughout. |
| Smith, R., Clark, T., & Blomeyer, R. L. (2005). *A Synthesis of New Research on K–12 Online Learning.* Naperville, IL: Learning Point Associates. | Experimental research | No significant improvement in student learning was found as a result of online learning. However, there are many important implications for further research of online learning. | This paper is a synthesis of the results of eight studies sponsored by the North Central Regional Education Laboratory (NCREL) in 2004. |
| SPEC Associates (2006). *Ford Partnership for Advanced Studies at the Advanced Technology Academy.* Dearborn, MI: Advanced Technology Academy. | Case study | *Ford PAS* can help prepare students for postsecondary education and refine career aspirations, as well as improve cognitive skills such as research, problem-solving, and interpersonal skills. | This study reports qualitative data about the potential impact of the *Ford PAS* curriculum on students. |
| SRI International (2009). *The Power of Project Learning with ThinkQuest.* Menlo Park: CA: SRI International. | Qualitative research | Anecdotal evidence from case studies of classrooms using ThinkQuest suggests that the use of this online learning environment can results in improved outcomes for students. These include critical thinking, creativity, teamwork, cross-cultural understanding, communication, technology skills, and self-direction. | This paper draws on a broad international research base and case studies of actual classroom projects supported by ThinkQuest to illustrate both the theory and practice of 21st century teaching and learning. |
| Strobel, J. & van Barneveld, A. (2009). When is PBL More Effective? A Meta-synthesis of Meta-analyses Comparing PBL to Conventional Classrooms. *Interdisciplinary Journal of Problem-based Learning 3*(1). Retrieved March 3, 2011 from http://docs.lib.purdue.edu/ijpbl/vol3/iss1/4 | Research synthesis | Project-based learning was superior when it comes to long-term retention, skill development and satisfaction of students and teachers, while traditional approaches were more effective for short-term retention as measured by standardized board exams. | This paper synthesizes meta analyses comparing project-based learning to more traditional instruction. |

TABLE 1 CONTINUED: STUDIES ON TECHNOLOGY USE IN SUPPORT OF STUDENT-CENTERED LEARNING INCLUDED IN THE REVIEW

| STUDY | RESEARCH DESIGN | KEY FINDING(S) | TYPE OF EVIDENCE |
|---|---|---|---|
| Sun, K., Lin, Y., & Yu, C. (2008). A study on learning effect among different learning styles in a web-based lab of science for elementary school students. *Computers & Education* 50(4), 1411–22. | Quasi-experimental | Students in the blended online condition outperformed students in the face-to-face condition. | This study examined the impact of a virtual web-based science lab. The study compared student achievement in blended online courses with that in matched face-to-face classrooms. |
| Thissen-Roe, A., Hunt, E., & Minstrell, J. (2004). The DIAGNOSER project: Combining assessment and learning. *Behavioral Research Methods, Instruments, and Computers* 36(2) 234-240. | Qualitative research | This paper discusses the development of an online assessment system based on a facet-based instruction model. In one study, students who used Diagnoser outperformed their peers on state level tests by 14%. | This paper describes the development of the Diagnoser tool while exploring its theoretical and pedagogical foundations. |
| Tierney, W. G., Bailey, T., Constantine, J., Finkelstein, N., & Hurd, N. F. (2009). *Helping Students Navigate the Path to College: What High Schools Can Do: A Practice Guide.* (NCEE #2009-4066). Washington, DC: National Center for Education Evaluation and Regional Assistance, Institute of Education Sciences, U.S. Department of Education. | Quasi-experimental research | Technology can play a role in helping students navigate the search for the right college and manage the application process. | The recommendations for practice outlined in this paper are based on a review of college access programs, school reforms, and policy interventions that have shown promise in increasing access to college, particularly for low-income and first-generation students. |
| Trotter, A. (2010). Online Options for Credit Recovery Widen. *Education Week,* 38, 12-13. | Qualitative research | Using online providers for credit-recovery courses allows students to receive remedial instruction tailored to their needs, and eases the burden on schools that may not have the resources to provide their students sufficient opportunity for credit recovery. | The article describes current options for and uses of online credit-recovery courses. |

TABLE 1 CONTINUED: STUDIES ON TECHNOLOGY USE IN SUPPORT OF STUDENT-CENTERED LEARNING INCLUDED IN THE REVIEW

| STUDY | RESEARCH DESIGN | KEY FINDING(S) | TYPE OF EVIDENCE |
|---|---|---|---|
| Wagner, T (2008). *The Global Achievement Gap: Why Even Our Best Schools Don't Teach the New Survival Skills Our Children Need—And What We Can Do About It.* Basic Books, New York. | Case studies and research review | The author describes many problems with the national education landscape in the United States and points to a number of innovative schools that are successfully reimagining public education, including High Tech High. | The author draws on a wide range of research on US education policy as well as a number of case studies. |
| Watson, J. (2009). *Keeping Pace with K–12 Online Learning: A Review of State-Level Policy and Practice.* Evergreen, CO: Evergreen Education Group. | Qualitative research | In addition to the spread of online learning programs to most states across the country, the majority of existing online programs show considerable growth in the number of students they are serving. Forty percent of the online programs responding to a recent survey reported annual growth of over 25 percent in the 2006–2007 school year, and half of these programs reported growth of 50 percent or higher. | This paper reports results of a survey on the state of online education throughout the United States. |
| Wood, C. (2005). The Virtual Classroom Redefines Education. *Edutopia.* Available online at: http://www.edutopia.org/online-education-virtual-classrooms | Review of research and practices | Virtual schools make available a world of new courses, from obscure electives to advanced-placement classes, which challenge students intellectually and open up new doors educationally. Students with a range of special circumstances (from health issues to job or family constraints) don't have to fall behind or drop out. | This article describes a number of examples of virtual schools around the United States, and draws on existing research. |
| Ysseldyke, J., & Bolt, D. M. (2007). Effect of technology-enhanced continuous progress monitoring on math achievement. *School Psychology Review,* 36(3), 453–467. | Experimental study | Students showed increased achievement on standardized math tests in classrooms where teachers used continuous technology-supported progress monitoring to track student work and differentiate instruction. | This study shows the potential effect of Accelerated Mathematics, a progress monitoring system, on student achievement. |

# appendix 2

## HIGH TECH HIGH

High Tech High (HTH) was founded as a charter school in 2000, serving 200 students from the San Diego area. Since then, HTH has grown into a school development organization comprised of a growing network of K-12 charter schools that serves some 3,500 students and employs 350 faculty and staff *(Edutopia, 2008; Wagner, 2008).* At its inception, HTH partnered with the wireless technology company Qualcomm, who donated $100,000 a year for the first five years of the program. Other than that, HTH operates its schools with the standard $6,200-per-student operating budget that the state provides for charter schools (Wagner, 2008).

At HTH all learning is designed to be authentic and applicable to the real world. For students at HTH, that means they are encouraged to utilize their schools' wealth of technology, from new media publishing programs to robotics labs, in order to pursue projects about subjects they are passionate about. Students also use their junior year full-semester 8 hour/week internship to become engaged in work that they are interested in. The leadership at HTH believes that giving their students the freedom to pursue their passions, and providing them with the tools to do so in a professional, authentic manner, results in students who are more engaged than students forced to work on projects of little or no interest to them. And engagement through personalization "creates ownership...and then the skills you need to succeed in school and life kind of trail along" says the principal.

### *Design Principles*

HTH has taken a student-centered approach to just about every aspect of their schools' practices. The organization's academic approach is a break from the traditional industrial model of teachers lecturing in front of rows of students. At HTH, students engage in extended project-based learning, and most of the time those projects are grounded in community related issues. Often, students are working on real-world problems, and are able to see the impact of their work.

The HTH program and curriculum are based around three core "design principles," which pervade every aspect of the program from pedagogy to facilities. The design principles are:

- ***Personalization:*** Students have faculty advisors, pursue their interests through project work, and compile and present their work in digital portfolios. The HTH facilities are designed to foster small-group collaboration, with networked wireless laptops, project rooms, and exhibition space for student work throughout the schools.

- ***Adult World Connection:*** Starting in the 9th grade, HTH students might shadow an adult through a workday, participate in community service projects, or attend "power lunches" on areas of interest with adults from outside the schools. In 11th grade, students are required to complete a semester-long academic internship, and in the 12th grade students develop and carry out projects that foster learning while focusing on real-world problems or interests.

- ***Common Intellectual Mission:*** All students at HTH receive a "technical" education, acquiring real-world career skills, as well as a "college prep" education. All students are held to the same, performance-based standards, learning through projects with no focus on test-prep.

HTH school facilities are designed to reflect and embody the HTH design principles. Accounts of school visits often include an impression that the school feels more like a high-tech workspace than a traditional school building *(Wagner, 2008; Edutopia, 2008).* The school buildings all have high ceilings, bright colors, comfortable furniture in informal meeting areas, and lots of windows, both internal and external. The walls in the schools' hallways and public areas are transparent, allowing someone walking through the school to actually see students and teachers at work in the seminar rooms and labs.

The schools are equipped with Specialty Labs for students to work in a range of sciences from biotechnology to robotics. To support team teaching and an integrated curriculum, teams of teachers share an office next to the seminar rooms in which they teach. The walls of the seminar rooms themselves are dynamic, and able to be easily reconfigured to support a variety of different projects and exhibition needs. Student work is exhibited in Gallery Spaces throughout the school. These spaces take up much of the wall and ceiling space in school hallways and common areas.

***Use of Technology***

The HTH program is both technology-focused, with students and teachers learning and using different technologies in and out of the classroom, and grounded in technology. From the ground up, technology enables many of the innovative practices at HTH.

At HTH, teachers work in teams and across disciplines to construct integrated projects and curricula in order to ensure that their students are frequently taking part in projects that confront real-world issues and problems. These projects often result in student-made products that are presented to an audience of student peers and adults, and are exhibited in the school, the surrounding community, or online. While not all student work is technology-based, many projects result in technology-enabled student products from blogs to multimedia art to documentary films. Sample projects that integrate technology include:

- In a collaboration of art and science, an art teacher, a math teacher, and an engineering teacher designed a project for students to create interactive, museum-quality exhibits that fit in a window frame and illustrate a principle of math or physics. The project was called "Analog Flash for Windows" (analog: projects were mechanical, Flash: projects were similar to digital Flash designs, Windows: projects were displayed in actual windows around the school building. The project lasted a whole semester, and students and teachers used an online calendar and digital weekly check-in to keep track of their work.

- A more traditional integrated project was created by an English teacher and a multimedia teacher, where students used multimedia to expose hidden cultural paradigms. Projects ranged from documentaries to photo essays and video installations, and covered topics including graffiti, the media, and self-mutilation. The students' finished work was displayed at the San Diego Museum of Contemporary Art.

Technology also plays a role in how teachers learn and reflect on their own practices at HTH. One option for teachers preparing for a structured reflection session (in which they sit down with an administrator and have a one-on-one conversation about their practice) is to make a video of one of their lessons, pick out a 10-minute segment, and come up with a question to frame the discussion. One administrator writes that "with video, the teacher can literally play back the lesson and observe the classroom dynamics through fresh eyes, often catching student interactions and conversation they may have missed. This allows for deeper reflection than when I simply conduct my observations."

### *Assessment*

Assessment at HTH is seen not as an endpoint in the learning cycle, but as an "episode of learning," and as such, takes place almost daily in the form of everything from quizzes to peer reviews and oral presentations. Most assessment is performance-based. Students are graded on long-term projects that culminate in a performance or product, with intermediate checkpoints or products assessed along the way. Rubrics are used to make expectations for student work explicit. At the end of a project, students participate in a Presentation of Learning (POL), where they display, discuss, and reflect on their work in their school or at a space in the local community. Audiences at POLs are comprised of students, faculty, community members, and experts in the field when possible. POLs are intended to be community learning events rather than presentations. According to Rob Riordan, HTH's "Emperor of Rigor," the goal of assessment at HTH is to assess students' abilities "to access content, play with it, transform it, synthesize it, and use it, and how to work with others to do all of that." HTH students also develop digital portfolios that serve as a record of their work, learning, and projects throughout their academic careers at HTH. Students update their digital portfolios each semester, documenting their learning over time. Consistently good test scores on compulsory state examinations and SATs, as well as the constant exhibition of student work to parents and other stakeholders has allowed HTH to maintain an alternative approach to assessment.

### *Professional Development*

High Tech High takes a unique approach to teacher professional development. In 2004, in partnership with the University of San Diego, HTH started its own teacher-credentialing program, the Teacher Intern Program. The Teacher Intern program is a 2-year program. It is unique because its candidates teach full time, receiving salary and benefits, while completing the program. In other words, similar to medical residency programs, students learn through on-the-job training. Candidates who successfully complete the course receive California state teaching credentials. HTH believes that keeping teacher training and certification in-house would help them recruit strong teachers and teach them the organization's design and pedagogical principles. Further, by training all their own teachers, HTH eliminates the need to orient new teachers, trained elsewhere, to those principles.

### *Student Outcomes*

HTH schools report sending 100 percent of their students to college with 80 percent attending four-year schools, and 27 percent earning technical degrees in math, science, or engineering (the national average is 15 percent). As of 2008, more than half of HTH graduates are first-generation college students *(Wagner, 2008).*

## QUEST TO LEARN

Quest To Learn (Q2L) grew out of a collaboration between Parson's Institute for Play and New Visions for Public Schools. The collaborators were awarded a 2-year planning grant from the MacArthur Foundation, and opened Quest To Learn, a public school in New York, with a 6th grade in the fall of 2009. One grade will be added each year until the school has grades 6-12. On average, there are 25 students per class. The school focuses on using new designs for learning environments to create a place where students engage in rigorous integrated curricula as they prepare for the demands of the 21st century workplace and world. Because Quest To Learn is a very new school, there has been little research and documentation of school practices so far. However, the school's website and a number of news articles have provided a wealth of information about the school's pedagogical foundations, as well as some details about their curriculum and technology use.

### *Design Principles*

A number of things separate the Quest To Learn model from other middle and secondary school models, but the most significant difference is Quest's focus on games as a pedagogical model. Quest eagerly points out that focusing on games does not equate to having students playing commercial games. Drawing on research in the learning sciences and digital media, Quest has constructed a pedagogical philosophy that centers around games, which they define as rule-based learning systems where players actively participate. Transposed to a theory of learning, the game-based pedagogical model at Quest is founded on the principles of game design to create immersive learning experiences where students use strategic thinking to make decisions, problem solve, seek content knowledge, receive constant feedback, and consider multiple points of view. The game-based foundation resonates through most aspects of the school from a game-based curriculum to assessment, as well as to the school's advisory program.

The curriculum at Quest is founded on the following core principles:

- Learning for design and innovation,
- Learning for complexity (systemic reasoning),
- Learning for critical thinking, judgment, and credibility,
- Learning using a design methodology,
- Learning with technology and smart tools,
- Prep for college and world of work.

Based on these principles, Quest works to design an integrated game-based curriculum that meets state and national standards while focusing on game-design and systems thinking. To achieve this, subject areas such as math, science, language arts, and social studies are blended together into domains.

At Quest, a curricular domain is a big idea that calls on content from two or more traditional subjects. For example, the sixth-grade curriculum is broken down into 6 domains: The Way Things Work, Codeworlds, Being Me, Being Space and Place, Sports for the Mind, and Wellness. The Quest website has thorough descriptions of each domain, as well as their respective core values. Figure 1 contains the school's description of the Codeworlds domain, which integrates math, English language arts, and computer programming.

***Figure 1:***
Wellness is both designed into the curriculum as a domain and is a constant area of focus for school-wide practice. As a domain, Wellness is intended to help Quest students grow individually and as part of their communities, and develop and make informed decisions concerning their bodies, minds, and emotions. The domain draws from such fields as human sexuality and personal health, nutrition, mindfulness, interpersonal and group dynamics, conflict mediation, and movement.

In practice, the domain teachers work with kids on 10 week long "missions," which are narrative-driven, challenge-based units that are then divided into a series of smaller "quests." Each quest revolves around complex problems students have to learn how to solve. Solving those problems may require students to analyze text, build digital games, or do scientific experiments, among other things.

The school's game based-pedagogy is seen in their homeroom/advisory program as well. At Quest, advisories are called Home Bases, and are made up of groups of 10 students who meet with their adult advisor at the beginning and end of each day. Home Base groups not only prepare for and reflect on their school days, they also take part in curriculum-driven, collaborative school-wide group activities, called Boss Levels, many of which integrate technology. For example, one Boss Level may have all the Home Bases in the school competing to build a Rube

# codeworlds

(INTEGRATED MATH/ELA/COMPUTER PROGRAMMING)

Students practice decoding, authoring, manipulating, and unlocking meaning in coded worlds, to meet shared needs or for their own purposes. Work in this learning context requires students to practice with the concept of language and literacy across disciplines, from math to ELA to computer programming. Codeworlds draws on games as learning environments that produce meaning through the interpretation of symbolic codes ordering our world. As students reflect on how the underlying rules of a system shape expression and communication, they gain experience in comprehending the world as a meta-system made up of multiple systems, each containing a set of values, assumptions, and perspectives.

***Core Values of the domain:***

- ↗ All codes convey meaning;
- ↗ Need for literacy across systems: code is key to that literacy;
- ↗ Math is a language that describes the world;
- ↗ Students will gain literacy in multiple languages;
- ↗ Code is a symbolic system that is predictable, repeatable, and interpretable;
- ↗ Code is a material for the representation of ideas;
- ↗ Code is a common way of making meaning between people (shared);
- ↗ Code is a foundation for innovation;
- ↗ Code is organized by rule sets;
- ↗ Code is a dynamic system;
- ↗ All language is constructed & can evolve and change;
- ↗ Ordering, sequencing, patterning (novel);
- ↗ By manipulating language you can create worlds;

Goldberg machine over a number of weeks. Having gained the content knowledge to accomplish this task in previous missions, and having been presented with an assessment rubric, students will work with each other and their advisor to build the best machine. At the conclusion of the Boss Level, a panel of judges will award points to each Home Base for their design and construction.

Students also have the opportunity to attend the Mobo Studio afterschool program at the Institute of Play. The Mobo Studio is a space for students to work with adults and peers on digital media projects and learn skills they can bring back into the classroom.

***Technology***

As a school founded on the principles of game-based learning and design, Quest To Learn has a unique relationship with technology. While technology is prevalent throughout the school's curriculum, its role is no different from that of other tools that help drive student learning. Quest's approach to technology can be gleaned from the following four technology principles:

1 Technology is linked directly to curriculum and learning objectives.

This principle dictates that the use of technology for teaching and learning is teacher driven and implemented only as it serves to further student understanding.

2 Technology adds breadth and depth to educational experiences.

Similarly, this principle stresses that technology is implemented only as it serves the purposes of teaching and learning.

3 Technology is integrated with purpose and an eye on pedagogy.

This principle speaks to teachers who are thinking about using technology in their classrooms. Teachers should always think about technology as it serves to help their students' understanding.

4 Technology is a tool like any other in the school.

This principle posits that while students should be comfortable with using different technologies, they should also be able to discern when using a piece of technology is beneficial and when it is not. In other words, "part of being savvy with technology is learning when it is not needed, as well."

Though Quest employs a critical and discerning theoretical approach to technology, the school has built a number of technology tools and programs in an effort to ensure that technology is used well. One such program is the Mission Lab. The Mission Lab is a game and curriculum design, program evaluation, and assessment space situated in school. The goal of Mission Lab is to give teachers and students access to experts qua game designers and digital media specialists who help them plan and work on projects. As per the Q2L website, the four responsibilities of the Mission Lab are:

1 Support current and future curriculum development through collaboration with Quest teachers and content experts;
2 Offer professional development for current and incoming teachers;
3 Design learning tools and toolkits for use in the school and within the Digital Media and Learning Network;
4 Undertake research and development around assessment and student development.

A review of the literature on Q2L has found few examples of explicit Mission Lab work, though Mission Lab staff members are perpetually working with teachers to help them develop innovative curriculum that utilizes technology to enhance student understanding.

One unique use of technology at Quest is their Being Me Social Network. Designed by the Institute of Play, Being Me is intended to support student academic and socio-emotional growth through online collaboration, sharing of work and ideas, and community building. Through exploring and taking on a variety of ideas and social spaces, designers hope Being Me will help students discover and develop their own intellectual and career interests.

Being Me has similar functions as other social networking sites students might be familiar with: there is a portfolio space for them to put up and share work with the community, an Expertise Exchange where they can seek out advice and knowledge from peers, Mission Channels where students can share their work through blogs or audio/video broadcasts, and a data repository that tracks the issues and ideas students are talking about in the online community.

Another innovative use of technology is the school's SmallLab, a space that uses digital projection and motion-capture cameras to provide a learning space where students can physically interact with teacher-designed curricular content. The SmallLab is intended to give students kinesthetic learning experience by having them use wireless controllers to interact with the content. We were unable to find a more detailed description of the SmallLab or examples of its uses. It is currently being integrated into the Codeworlds domain described above.

***Assessment***

Assessment at Q2L is performance-based, and may be supplemented by tests. Assessments are based on New York standards, but push students to display enduring content knowledge, higher order thinking skills, and appropriate technology proficiency. Q2L has developed a list of assessment principles, including but not exclusive to:

- ↗ Assessment is situated in learning—located in the discourse, actions, and transactions of individuals, peers, and groups.
- ↗ An assessment program should be designed to allow learners to eventually assess themselves.
- ↗ Assessments should measure the extent to which students can innovate within a domain.
- ↗ Knowledge to be assessed emerges from engaged participation, reasoning, and resolution of Missions and their Quests.
- ↗ Assessment tools support valid inferences about learning. Assessment tools must facilitate answers to the question: "What does a particular performance reveal about how students know, reason with, and use their knowledge?"
- ↗ Assessment is dynamic: equitable and inclusive, meeting student needs before, during, after, and in-between learning experiences.
- ↗ Participatory assessment requires that expectations, co-constructed and delivered criteria, and documentation is 'open source' for all participants.

For example, in a unit called Spartan Private Investigators from the 6th grade ELA/Social Studies domain, Being, Space and Place, students are assessed through daily online journaling, oral presentations, the creation of video podcasts, and a culminating assignment asking students to create a policy brief they will then present to the class. At the end of the course, students are asked to work in groups to put together and revise their policy briefs, create a more in-depth analysis that must be supplemented with Google Maps to show the effect of geography on their work, and then presented.

***Professional Development***

Q2L has instituted a professional development program, called Studio Q. Teachers at Q2L are required to participate in this three-year professional development program, including summer sessions. In Studio Q, teachers work through their teaching methods and curriculum while constantly reflecting on their practice. Every day teachers either have a planning period or a meeting with their grade-level team or Mission Lab. Q2L has developed six dimensions for teacher development and evaluation:

1. ***Systems-thinker:*** Teachers understand the architecture of dynamic systems and are able to think systemically.
2. ***Practitioner:*** Teachers exhibit exemplary pedagogical practices in areas such as: differentiation, integrating content expertise, classroom management, communicating with parents, lesson planning, engaging students in learning, and maintaining an effective learning environment.
3. ***Designer:*** Teachers co-design, implement, and revise game-like curriculum with game designers and curriculum directors.
4. ***Assessor:*** Teachers design and implement embedded assessment, use data from assessments to evaluate student learning, make adjustments to curriculum based on assessments, and help students set learning goals.
5. ***Wellness Integrator:*** Teachers understand dynamics among their students and with other members in the school community. They are able to act on understandings of interpersonal

and group dynamics to address students' emotional, academic, physical, and nutritional needs.

6 ***Technology Integrator:*** Teachers are able to seek out, identify, and use technology to enhance student learning.

***Research***

The Parson's Center for Transformative Media is serving as a research institution for the Quest To Learn School. CTM is working to better understand the connections between digital media, games, and learning, while continuously informing educators and administrators at Quest about their findings and implications for teaching and learning practices.

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