Modernizing Education and Preparing Tomorrow’s Workforce through Mobile Technology

Presented by Dr. Irwin Mark Jacobs, Founding Chairman and CEO Emeritus for Qualcomm, Inc.
With more than 6.3 billion mobile connections worldwide, there is an extraordinary opportunity to transform education for the 21st century by taking advantage of what has become the largest information and communication platform in history. Always on, always connected mobile devices in the hands of students can improve educational outcomes by providing ubiquitous access to learning resources and the ability to collaborate with peers and advisors in and out of the classroom. Mobile technology enables the delivery of customized curriculum and real-time assessment, empowers students to become mentors to each other and increases their engagement in learning. Just as wireless technologies have revolutionized the way business professionals work and enhanced their ability to compete, mobile can play a key role in preparing students for jobs in the global economy. In the world’s developing regions, there is an enormous opportunity to improve access to education through the use of mobile technology. Mobile makes it possible to connect students in remote parts of the world where the deployment of wireline infrastructure is not cost effective. While improvements in technology and communications have modernized some aspects of the education system, mobile has the capability of accelerating and compounding technology’s impact by making massive amounts of data and information available to students who otherwise wouldn’t have access to it. To achieve this vision, we must take proactive steps to overcome barriers and challenges. These steps include initiatives such as: extending and expanding the U.S. Federal Communications Commission’s (FCC) “Learning on the Go” initiative, which originated in the FCC’s National Broadband Plan; developing new educational goals and metrics for 21st century learning; helping schools meet the 2014 digital assessment deadline; moving beyond Bring Your Own Device (BYOD) programs to coherent and seamless mobile infrastructures; and overcoming teacher isolation.
Modernizing education and preparing tomorrow's workforce through mobile technology.

**Today's Mobile Landscape**

3G and other advanced wireless technologies provide new avenues to connect people, both via voice and high-speed broadband Internet over the same platform. And for most people in emerging economies, a mobile phone is the first and only computer they will own. 3G wireless growth is accelerating across the globe, with 1.4 billion 3G subscriptions now and a predicted 3.2 billion 3G subscriptions by 2015.

Mobile dominates the growth of broadband, accounting for approximately four in five of the total subscriptions expected in the next three years. Mobile traffic worldwide is expected to increase tenfold between 2010 and 2015. As mobile broadband networks are increasingly able to deliver rich Internet access and data services, mobile data will continue its rapid growth. In 2014, monthly mobile data is predicted to exceed mobile data traffic for all of 2008.

Mobile broadband drives economic growth and provides unprecedented opportunities to empower individuals across all socioeconomic classes. According to the World Bank, a 10 percentage point rise in mobile penetration increases per capita GDP by .8 percent in developing countries. Furthermore, a 10 percentage point rise in internet penetration increases per capita GDP by 1.4 percent in developing countries.

Emerging economies are investing heavily in mobile broadband infrastructure because of the positive returns on this investment for economic development, health care efficiencies and education. Mobile broadband growth in emerging countries is expected to rise from 61 percent of all broadband connections in 2011 to 84 percent in 2016. At this pace, developing regions will surpass the developed world in terms of the number of mobile broadband connections in the first half of 2013.

As a global leader in wireless technologies, Qualcomm believes access to 3G and next-generation mobile technologies can improve people's lives. Qualcomm's Wireless Reach™ initiative is a strategic program that brings wireless technology to underserved communities globally. Working with partners, Wireless Reach invests in projects that foster entrepreneurship, aid in public safety, enhance the delivery of health care, enrich teaching and learning and improve environmental sustainability. To date, Wireless Reach has 84 projects in various stages of development in 33 countries. Examples of Wireless Reach projects that are making a difference globally in the areas of health care, education and entrepreneurship are included in this paper.

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4. ABI Research 2009. (from WEF chapter)
5. Qiang et al 2009. (as cited in WEF chapter)
THE CURRENT STATE OF EDUCATION: AN OBSOLETE MODEL

A nation’s economic welfare and long-term success depends on improving learning for all students. Mobile technology has a critical role to play in preparing students to compete in the global economy. As connected devices have become increasingly affordable and prevalent, wireless technology is bringing learning opportunities and high-quality content to students worldwide, even those without access to a formal classroom.

Simultaneously, the industrial-era model of education — one teacher lecturing to students in a specific location for a set period of time — does not effectively prepare children for the modern business world. As Chris Dede, the Wirth Professor in Learning Technologies at Harvard University, has written (in press):

The industrial-era model of schooling we still use, with only minor changes since its inception, was designed based on business practices from the early 20th century: students segregated by age and grouped in classes of approximately equal size, disciplinary specialization of teachers beyond the elementary level, and fixed amounts of time spent in turn on each subject by a single teacher per subject. In general terms, its educational model is similar to the production of goods: learners are processed through an assembly-line system that involves identical amounts of one-size-fits-all instructional treatment from a single source, with occasional summative tests utilized to determine each student’s fitness to move on to the next stage of the process. The amount students are “processed” is held constant; student learning is allowed to vary. The deficiencies that emerged in this educational system were not considered serious because, in the industrial era, only the top tier of students needed to attain deep mastery of knowledge. The remainder of students were prepared with sufficient knowledge to follow orders and to perform routine work efficiently; students who learned little in school still could have good lifestyles in reasonably well paying blue collar jobs.
The United States now faces a very different situation; we must compete in a global, knowledge-based, innovation-centered economy. The United States now faces a very different situation; we must compete in a global, knowledge-based, innovation-centered economy. To have a reasonably prosperous lifestyle and to participate effectively in modern democratic decision making for a complex society, every student must master knowledge beyond a high school education, either through college or via career-based learning (Wagner, 2008). In contrast to the industrial era, all students must attain high levels of learning, so instructional “processing” must vary. For our nation to compete successfully, all students’ educational outcomes should include motivation (both intrinsic interest and self-efficacy), academic achievement (content and skill acquisition), 21st century skills, entrepreneurial thinking, and character attributes such as persistence and flexibility. Students who do not succeed in school are very likely to live in poverty, creating burdens for society in terms of downstream costs such as welfare and crime.

As Dede describes, the trend is toward jobs that require workers to think critically and creatively, solve problems and make decisions as a team. All children should be provided with the knowledge and skills needed to compete in the global economy. They need to be learning these 21st century skills in school, using the same technology that business professionals use every day.

Further evidence of education lagging behind business is offered by the Brookings Institution: “...innovation and increases in productivity have occurred faster and been more effective in the broader economy than in the field of education. In other words, education has faced a relative innovation deficit. Overall, the United States spends about three percent of its total expenditures on research and development (R&D), with that figure reaching as high as 23 percent in pharmaceuticals. In education, however, only 0.2 percent of expenditures are spent on R&D.”

Educational attainment is highly correlated with income, and the gap between the two is growing. The Brookings Institution reports that over the past 40 years, incomes for college graduates have increased by more than 33 percent while incomes for those with only a high school degree have stagnated. Additionally, high school dropouts earn less now than they did in 1970.

Neither the percentage of Americans who leave high school without a diploma nor the percentage of Americans that attain a college degree has changed since 1970.

Education is a significant determinant of whether individuals marry, how long they live and whether their children grow up in two-parent households. The children of less-educated and less-wealthy parents begin their own education at a disadvantage and are less likely to do well in school.

As a result of increasing globalization and automation, traditional middle-class jobs will not be available to Americans with limited education in the very near future. Michael Greenstone and Adam Looney of The Brookings Institution’s Hamilton Project argue: “...today, for what may be the first time in American history, we are failing to invest enough in our skills and productivity to stay ahead of these trends, and the impacts of this failure are reflected in the declining wages of many American workers.”

Measures of educational attainment have stagnated in recent decades. Neither the percentage of Americans who leave high school without a diploma nor the percentage of Americans that attain a college degree has changed since 1970. Per-pupil spending has more than doubled since 1970, with virtually no change in math test scores. America once boasted the world’s best-educated workforce, but now lags behind more than a dozen other nations. The U.S. ranks 15th in the world in college completion rate, 11th in high school completion rate and 25th in international assessments of math.

Globally, education and skills development are critical in reducing unemployment, inequality and poverty, and promoting economic growth. Every $1 spent on education can generate $10 to $15 in economic growth. If 75 percent more 15-year-olds in the world’s poorest countries were to reach Organization for Economic Co-operation and Development (OECD) benchmarks for mathematics, 104 million people could escape extreme poverty, and economic growth could improve 2.1 percent.¹³

In 30 of the 59 countries assessed by UNESCO’s Education for All Global Monitoring Report, at least half of 15 to 19-year-olds lack foundation skills.

UNESCO’s Education for All Global Monitoring Report finds “progress toward universal primary education is stalling,” with 61 million children out of school — 47 percent of whom are expected to never enter school. Employers want job applicants who have strong foundation skills, can solve problems, take initiative and collaborate with colleagues rather than merely follow set routines. These are all transferable skills that can be acquired through quality education, but are often lacking in new entrants to the labor market. In 30 of the 59 countries assessed by UNESCO’s Education for All Global Monitoring Report, at least half of 15 to 19-year-olds lack foundation skills.

Much of the world faces significant teacher shortages. An estimated 2 million new teachers are needed by 2015 just to sustain current education models.¹⁴ The problem is particularly severe in developing nations that produce an increasing share of the world’s workers. India alone is expected to supply roughly a quarter of the global talent pool by 2030: “Global demographic trends mean that soon a disproportionate share of the world’s human capital will be born in developing countries. Yet these countries, particularly those with high levels of inequality like India, do not have good education systems that can prepare their young people to be the talent that companies want to hire. India alone lacks 400,000 teachers.”¹⁵ While 21st century models of learning promise new ways of providing instruction outside of school settings, a sufficient number of skilled educators who can help students build their knowledge and skills is required in order for education to evolve.

U.S. educators increasingly recognize the value of incorporating digital content into their schools and classrooms, with 74 percent of administrators reporting that digital content increases student engagement and 50 percent reporting that it helps to personalize instruction.

MOBILE TECHNOLOGY OFFERS NEW WAYS TO PREPARE STUDENTS FOR 21ST CENTURY JOBS

The use of always on, always connected mobile devices in the hands of students has the potential to dramatically improve student success by providing unprecedented access to learning resources and the ability to collaborate with peers and advisors in and out of the classroom. Personal learning and connected devices for every student and educator, with training and support for optimal usage, can empower new learning opportunities.

Mobile devices have the potential to transform teaching and learning. Access to educational content and communities 24/7 can effectively extend learning beyond the school day and the four walls of the classroom, as well as streamline in-class logistics to decrease time teachers spend on rote work, while increasing time they spend on guiding students in active learning.

When the potential of mobile broadband in learning is realized, students will benefit from 24/7 access to digital curriculum that is highly personalized with respect to level, pace and learning style. Teachers will benefit from digital participation in communities of practice with global reach and from dashboards that actively display real-time data regarding their students’ progress. As wireless education technologies allow learning to expand beyond the four walls of the classroom and the hours of the school day, teachers will gain flexibility in how they can use precious classroom minutes.

U.S. educators increasingly recognize the value of incorporating digital content into their schools and classrooms, with 74 percent of administrators reporting that digital content increases student engagement and 50 percent reporting that it helps to personalize instruction. Much like their students, American educators are meeting their professional development needs via online professional learning communities and not while they are in school earning their teaching credentials.
Findings from Qualcomm’s Wireless EdTech conference held in Washington, D.C. in October 2012 indicate that there are four areas that will drive the 21st century learning environment: 1) professional development for teachers when every student has a mobile device, 2) infrastructure needed to support a one-device-per-student mobile environment, 3) privacy and security concerns when students have access to the Internet, and 4) digital content and assessment that takes advantage of mobile.

A major contributor to student success is having an e-classroom support structure made possible with 3G connectivity, allowing students to connect with their peers, tutors and teachers after school hours and outside the classroom walls. With mobile broadband connectivity, students who otherwise lack access to the Internet at home can visit helpful websites and communicate with each other via blogs and instant messaging to assist with assignments. In one Wireless Reach project aimed to improve student math scores, smartphones and tablets were provided to students to facilitate learning algebra. Student scores improved significantly; however, much of the progress can be attributed to the increased time students reported working together on algebra outside of class via instant messaging and other online collaboration tools.

While today’s 3G technologies are rich with possibility for education, the new 4G LTE technology, which is just beginning to roll out globally, enables faster, more capable networks. This, in turn, presents greater opportunity for innovation in mobile learning. Contextual awareness, peer-to-peer networks, advanced audio technologies, smart TV and augmented reality (AR) are some of the new technologies that can be used to make mobile learning richer, more engaging and fun. Mobile devices are increasingly being created with ‘sixth-sense’ capabilities: knowing where you are, interacting with networks, sensing local content and services, discovering relevant things, enhancing your surroundings with information and simulation, and learning your interests as well as how and with whom you like to learn. Advances in software development are making these features a reality for educational environments. The challenge is how to realize this potential and make this vision a reality.
OPPORTUNITIES TO REALIZE MOBILE LEARNING

Worldwide, tens of millions of children who should be in school aren’t, and progress towards universal participation has stagnated.

Below are a few examples of the ways National policies can provide the incentives needed to spur innovation, new technologies and new products. Through efforts like these, the benefits of public and private collaborations that utilize mobile broadband solutions in order to modernize learning are starting to come to fruition.

Use Mobile Learning to Transform Education

Always-on, always-connected mobile devices can play a central role in addressing the most pressing challenges in preparing students for the interconnected global economy: Universalizing access to education and modernizing existing educational systems.

Worldwide, tens of millions of children who should be in school aren’t, and progress towards universal participation has stagnated. In developing nations, many children do not attend school. Even among those students who are able to attend school, a large gap exists between those who attend well-funded schools and those who attend lower-quality schools where resources are stretched thin. In addition, legacy approaches to education can create additional barriers to learning — girls are often discouraged from pursuing interests in mathematics and sciences; classroom environments can disadvantage less assertive or less confident students.

The ever-changing global economy requires an innovative approach to education that reaches more children and does so more effectively than ever before. Areas of focus should include modernizing systems and infrastructure with mobile being top of mind, funding programs and curricula that have proven results of engaging students with different learning styles, and training teachers so they are comfortable with new instructional models that emphasize active learning rather than passive assimilation. The 2010 U.S. National Educational Technology Plan provides a compelling vision of 21st century education that is lifewide, lifelong, and lifedeep (U.S. Department of Education, 2010).
Modernizing education also requires an investment in professional development for educators. Teachers need ongoing training in the use of connected devices for collaborative, distributed learning, and in re-focusing instruction on the skills most relevant in evolving global economy. As studies of next-generation professional development indicate, the medium by which teachers learn new models of instruction must reinforce the message of change. As discussed later in this paper, innovative strategies for mobile-based professional development are emerging.

Leverage Mobile to Drive Student Engagement

Student engagement in learning is widely seen as a key to successful education. Studies have found a relationship between student engagement — commonly defined as including positive behavior, effort, participation, interest, a belief in oneself, tenacity, identification with school, a sense of belonging, and a positive attitude about learning — and academic outcomes.

There is evidence from students and educators alike that mobile learning coupled with strong curriculum and teaching can help increase student engagement. Fifty-five percent of students say they are engaged by projects and lessons involving technology. Educators have found that digital content increases student engagement. In one study, 74 percent of school administrators said digital content helps increase student engagement in school and learning, 64 percent said it helps extend learning beyond the school day, and more than half said it increases the relevancy of instructional materials.  

Collaborative learning incorporating technology is an effective way to increase student interest in science, technology, engineering and mathematics. Students in classrooms where learning is a team-based activity guided by teachers are 35 percent more likely to express a strong interest in a Science, Technology, Engineering, and Math (STEM) field than those in classrooms where the instruction is teacher-directed and technology use is minimal or nonexistent.  

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New technologies such as Augmented Reality allow educators to embed information into the physical environment, which contributes to learning and transfer from academic settings to real world contexts.

Game-based Learning

New Media Institute claims that the same factors that make well-designed games highly motivating also make them ideal learning environments:

“Good game-based learning applications can draw us into virtual environments that look and feel familiar and relevant. According to Dr. Susan Ambrose, director of Carnegie Mellon’s Eberly Center for Teaching Excellence, this is motivational because we can quickly see and understand the connection between the learning experience and our real-life work.”

Cathy N. Davidson, a professor at Duke University explains that “being able to harness the energy of games” — something for which mobile devices are well-suited — “is one of our best learning tools […] You can advance physical, mental, linguistic, and intellectual progress through games where the testing isn’t after the fact but is intrinsic to and embedded in the very structure of play.”

According to New Media Institute:

Research supports the effectiveness of game-based learning in virtual environments — for example, according to a meta-analysis of flight simulator training effectiveness, simulators combined with aircraft training consistently produced training improvements compared to aircraft-only training.

The implications of delivering game experiences for education and training are enormous. In the US, nearly 170 million people played computer and videogames in 2008, spending a record $11.7 billion. Harness the power of well-designed games to achieve specific learning goals, and the result is a workforce of highly motivated learners who avidly engage with and practice applying problem-solving skills.

As described later in this paper, new technologies such as Augmented Reality (AR) allow educators to embed information into the physical environment, which contributes to learning and transfer from academic settings to real world contexts. Two forms of AR are emerging: location-based and visual-based. Location-based AR leverages GPS and compass technologies, so that as people walk around a physical environment, they encounter hotspots with embedded media designed to educate. With visual-based AR, individuals point the camera in their mobile device at a two-dimensional image, triggering a 3-D model. AR is an ideal technology for game-based learning. In fact, evidence suggests that AR applications can make students more active and engaged in learning.
Continuing and Expanding the Work of Digital Promise

The U.S. Education Opportunity Act of 2008 authorized a nonprofit corporation — the National Center for Research in Advanced Information and Digital Technologies — commonly known as Digital Promise. This organization “supports a comprehensive research and development program to harness the increasing capacity of advanced information and digital technologies to improve all levels of learning and education, formal and informal, in order to provide Americans with the knowledge and skills needed to compete in the global economy.” Dr. Irwin Jacobs, founding chairman and CEO Emeritus for Qualcomm, sits on the board of directors for Digital Promise.

Founded after more than a decade of effort, including a 2004 report to Congress, Digital Promise has been endorsed by virtually every major national association of educators and educational institutions, libraries and museums. The project that gave rise to Digital Promise was launched by the Carnegie, Century, Knight, MacArthur and Open Society foundations, sustained by the Federation of American Scientists, and championed by a coalition of Republicans and Democrats, civic and business leaders, who came together on its behalf. Continuing to support and expand this work is essential to fully realize the impact of mobile and education.
Students are requesting learning experiences that have immediate relevance to their lives and future careers.

WIRELESS REACH CASE STUDIES ILLUSTRATING THESE OPPORTUNITIES

EcoMOBILE Enables Students to Explore New Worlds

Qualcomm’s Wireless Reach initiative has teamed up with MoGo Mobile Inc. (MoGo) and researchers at Harvard University’s Graduate School of Education to develop unique educational Augmented Reality Experiences (AREs) using 3G-connected mobile devices and MoGo’s FreshAir™ development platform. AREs overlay digital educational material onto physical environments and can be accessed anywhere from a mobile device with wireless connectivity, a camera, and GPS capabilities. The EcoMOBILE research team at Harvard designed custom AREs using Vuforia™, Qualcomm’s AR platform, providing students with interactive media including text, images, audio, video, 3-D models, and multiple-choice or open-ended questions during a science fieldtrip to an outdoor environment. This has enabled new types of powerful and engaging mobile learning experiences.

Challenge
• Teachers are looking for creative new ways to increase student engagement and learning that align with state education standards.
• Teachers are concerned about student engagement and participation. Lack of student interaction in the classroom is problematic to learning, and teachers are looking for new and creative ways to involve students in the curriculum.
• Many students and teachers do not have resources to apply classroom lessons to real-world experiences.
• Teachers are interested in teaching real-world issues, such as global environmental problems, that help students learn how to analyze complex systems and to work collaboratively to solve difficult problems.
• According to data collected from focus groups facilitated by Project Tomorrow, a national education nonprofit organization, students are requesting learning experiences that have immediate relevance to their lives and future careers. For example, they prefer science activities that are connected to a larger and meaningful context and in an environment that resembles scientific practice.
• There is room for improvement in the teaching of STEM subjects. STEM education is important to our nation’s economic prosperity in the global economy. Strong STEM skills are a central element of a well-rounded education.

Solution
• Researchers at Harvard University’s Graduate School of Education created three middle school AREs aligned with science education standards for students in multiple school districts.
• The project, called EcoMOBILE, teaches students about ecosystems by adding visual overlays, supplemental information, and just-in-time feedback to a field trip experience where students work individually or in teams.
Modernizing education and preparing tomorrow’s workforce through mobile technology

For example, one EcoMOBILE ARE allows students to follow a virtual carbon atom around an ecosystem. They work individually to track an atom and in the process they learn about ecological transformations like photosynthesis and respiration. Using 3G wireless mobile devices students can “observe” ecological processes as they occur at the molecular level. Students track different atoms and come together at the end to learn from each other about the path that another atom has followed.

Students learn about the approaches and techniques used by scientists to collect and analyze data in outdoor settings and collaborate with each other to solve problems.

Lesson plans for teachers and assessment material were also developed to gather information on student engagement and gains in content knowledge after participating in the AREs.

Results

Teachers reported that the activities were more student driven and less teacher directed, providing the students with a different sense of ownership over the experience.

Teachers noticed that AREs helped students to better understand complex ecosystems. One student said, “It helped me learn what pH, turbidity, and dissolved oxygen were, and if it was good or bad for the environment.”

Afterwards, teachers discussed how the technology facilitated interactions among students and with the pond environment that resemble scientific practice. They also spoke about the benefits of managing a productive fieldtrip. “It felt like 90 percent of the time they were at the pond environment, they were working on interacting with the pond and their partner, whereas previous times it felt like it was maybe 60 or 50 percent of their time they were independently interacting,” said a science teacher using EcoMOBILE.

Teachers commented that the smartphones helped to structure students’ movement through space and guided their interaction with the pond and with classmates. The students were able to work independently, at their own pace, with the teacher acting as a facilitator.

Overall, student survey responses showed a positive shift in their attitudes about their ability to understand focal topics, gain science related skills, and draw connections between what they are learning in class and in the real world.

Significant learning gains were witnessed on the content survey results with students’ scores increasing by an average of 19 percent from the pre to post survey.

Technology-rich activities tended to receive the highest student ratings in comparison to less technology focused activities.

The results of the student opinion and content surveys support the idea that the smartphones sustained high levels of student engagement. The student learning gains were most apparent on items related to the combination of AR and probeware, which allowed students to measure environmental variables in real time during the field trip activities. The AREs and probeware were complementary in supporting student development of skills and knowledge related to the methods and procedures of scientific practice.

For more information, please see http:ecomobile.gse.harvard.edu.

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Project K-Nect: 24/7 Wireless Collaboration and Teaching Enhances Student Engagement and Math Development

Project K-Nect is a pilot program that began during the 2007-2008 school year to discover if 24/7 connected smartphones could play a role in enhancing student engagement and learning. The project addressed the need to improve math skills among at-risk students in North Carolina who scored poorly in math and did not have access to the Internet at home. Algebra I digital content that aligned with current lesson plans was created and students were encouraged to learn from each other in and out of the classroom. Students did so by using social networking applications on the smartphone, as well as other Internet resources such as algebra.com.

Challenge
- With increased focus from the U.S. government and schools across the country to improve math skills, based on analysis released by the National Center for Education Statistics where math and science scores of 15-year-old U.S. students were compared with students from other countries, U.S. students were found to score below average in math and science. The study also found that in math, U.S. students scored in the bottom quarter of the 29 countries that participated.
- According to the Congressional Research Service report on STEM education, “there is growing concern that the United States is not preparing a sufficient number of students, teachers and practitioners in the areas of STEM. A large majority of secondary school students fail to reach proficiency in math and science, and many are taught by teachers lacking adequate subject matter knowledge.”
- Students report that the policies that prevent them from using their own mobile devices for learning are the biggest barriers they face to using technology in school, according to Learning in the 21st Century: Taking it Mobile!, a research report released by Project Tomorrow and Blackboard Inc. in October 2010.

Solution
- In 8th-12th grade, 150 qualified students have been given 3G-enabled smartphones to wirelessly connect to educational resources on the Internet and to each other both on and off school campus.
- The phones provide access to supplemental math content aligned to their teachers’ current lesson plans and also allow students to collaborate and contact after-school tutors who can assist them with mastering a targeted skill set.
- The program only allows authorized users to communicate electronically within the secure system and is monitored by teachers to ensure acceptable use policies are not violated.
- Teachers use software applications on their laptops to send messages to students on their phones, giving them homework assignments and viewing their collaborative work. Teachers can manage assignments and provide real-time support and training through remote control technology.
- Students use Qualcomm’s 3G EV-DO Rev. A mobile technology, which allows them to access broadband wireless services with a peak data rate of 3.1 Mbps, which is comparable to a digital service line.
The 2010 Evaluation Report prepared by Project Tomorrow found that 85 percent of students feel more successful in math and more than 50 percent are now thinking of a career in the math field as a result of participating in Project K-Nect.

**Impact**

**Phase I (2008)**
- There was a positive correlation between students who actively participated in Project K-Nect and their final Algebra I proficiency level on a standardized exam given by the State of North Carolina.
- Students at one of the participating Project K-Nect schools increased their proficiency rates by 30 percent on the State of North Carolina's End of Course exam, compared to classes not in Project K-Nect, but taught by the same teacher.
- Students discovered creative ways to use the phones and the 24/7 Internet connectivity to increase their understanding of Algebra I, especially with social networking tools such as blogging and instant messaging.
- According to the students, one of the most helpful applications was the use of the video capability on the smartphones. Students would record each other working out problems on a white board then post the videos on blogs, so all students within the network could access them.

**Phase II (2009)**
- According to an evaluation by Project Tomorrow, teachers revealed that the mobile devices and the problem-based learning approach encouraged by Project K-Nect transformed the way they taught math.
- Teachers relied more on facilitating and less on direct instruction, encouraged students to talk with and teach each other, and created relevance by providing assignments that helped them see math in the world.
- Based on positive results from Project K-Nect, the Department of Defense Education Activity granted a participating school district $2.5 million to expand the reach of mobile learning to all Algebra I students in Onslow County, North Carolina.

**Phase III (2010)**
- The 2010 Evaluation Report prepared by Project Tomorrow found that 85 percent of students felt more successful in math and more than 50 percent were thinking of a career in the math field as a result of participating in Project K-Nect.
- Project K-Nect expanded beyond North Carolina to Virginia and Ohio, with approximately 4,500 students.
- The FCC awarded Project K-Nect E-rate funding to provide 24/7 Internet access to more than 1,400 high school students in Onslow County as part of the FCC’s 2011 Learning On-The-Go wireless pilot project.

Students at one of the participating Project K-Nect schools, increased their proficiency rates by 30 percent on the State of North Carolina’s End of Course exam, compared to classes not in Project K-Nect, but taught by the same teacher.
Personalized Learning via 3G in Jordanian Schools: Anytime, Anywhere Access to Educational Resources

To reach the entrance to the Balqees School, located in the district of Jabal Al-kalaa, Jordan, one must walk on uneven concrete up narrow corridors in between buildings perched on the side of a hill. Students at this school and others in Jordan lack access to much needed technology tools for learning. Qualcomm through its Wireless Reach initiative, in collaboration with the Jordan Education Initiative (JEI), is supporting a pilot project that gives students 3G connected mobile devices to learn in and out of the classroom. The project intends to demonstrate student success and engagement when given access to advanced mobile technology to gain valuable 21st century skills that will better prepare them for the future. Project results are being monitored and evaluated in order to shape a large-scale technology-integrated education model for public and private schools in Jordan and other countries.

Challenge
- Many students in remote areas of Jordan do not have mobile devices with 3G connectivity, limiting their access to educational resources 24/7.
- A number of schools require an introduction to a technology-integrated learning approach. There is a need to work with schools and the local community to educate them on the use of technology as a learning tool, as well as with teachers to encourage change from traditional teaching methods to a personalized learning approach.

Proposed Solution
- Since fall of 2011, more than 200 students in grades 7-10 and 35 teachers at Balqees and Um Abhara schools have been provided with 3G-enabled netbooks to conduct online research, complete multi-media presentations, and collaborate with their teachers and each other anytime, anywhere.
- JEI is providing professional development to teachers, students and parents on interactive personalized learning, netbook maintenance, computer software training, online educational resources, Internet safety, 21st century skills, and how to access the Ministry of Education’s EDUWAVE portal with e-learning content.
- The new environment enables students to extend their learning beyond the classroom walls and is part of an international movement towards individualizing learning and increasing independence.
- A classroom management software program is installed on the netbooks allowing teachers to send and receive student assignments. Some of the teachers are creating their first email account and learning how to communicate with other teachers and students using the Internet for the first time.
- With the new tools, parents have become more actively involved in their child’s academic progress.
- Schools are also receiving intensive technical support and maintenance from JEI.
- Results will be monitored and shared with the goal of advancing policy change.
WE Learn: Building the 21st Century Classroom with 3G Smartphones in Singapore

Qualcomm’s Wireless Reach initiative, in collaboration with partners, is putting the power of computers in the pockets of third-grade students at Nan Chiau Primary School in Singapore. The “WE Learn” mobile education project uses 3G-enabled smartphones to transform learning from a traditional, teacher-centric model to a student-centric, inquiry-oriented, collaborative model. By enabling 24/7 access to resources in and out of the classroom, the project allows students to acquire and practice 21st century competencies and knowledge.

Challenge
- The Singapore Ministry of Education (MOE), in its third Masterplan for Information and Communications Technology (ICT) in Education, promotes a framework to enhance the development of 21st century competencies and further transform the learning environment for students.
- The plan focuses on two key skills — self-directed learning and collaborative learning. MOE’s Masterplan 3 aims to better prepare the nation’s students to thrive in a fast-changing and highly connected world.
- As an MOE-designated “Future School in Singapore,” Nan Chiau Primary School is leading the way with a 21st century classroom that implements the MOE’s framework and serves as a model for primary schools throughout Singapore and Asia.

Proposed Solution
- Provide 3G-enabled smartphones powered by Snapdragon™, mobile broadband connectivity and educational applications to 350 third-grade students and their teachers, giving students 24/7 access to educational content, web-based resources and a broad range of learning tools that support self-directed and collaborative learning.
- Use those 3G mobile technologies to enable teachers to become mentors who provide personalized guidance and to give students the means to take responsibility for their own learning.
- Create customized curriculum in English, Science and Chinese that leverages the benefits of mobile, Internet-connected learning devices.
- Construct MyDesk, a next-generation mobile learning platform (MLP) that leverages the capabilities of Microsoft’s Windows Phone operating system.
- Use MyDesk and a broad range of educational applications to enable students to access their assignments, visit relevant websites, view podcasts and video and create multiple media artifacts.
- Back-up and synchronize files created by students on their MyDesk-enabled smartphones to a cloud-based Teaching Management System, thus providing an electronic portfolio for each student that teachers can access for grading and feedback purposes and that parents can examine to better understand how their child is performing in school.
- Provide professional development experiences for Nan Chiau teachers in the WE Learn pedagogy.
- Monitor and assess the impact of the WE Learn effort on Nan Chiau.

The Technology
- 3G-enabled, Windows Phone smartphones powered by Qualcomm Snapdragon processors.
- 3G mobile broadband connectivity via SingTel’s 3G wireless network.
- MyDesk, an MLP running on top of a Windows Phone and populated with a range of educational apps that are essential tools for 24/7 learning. The MLP also contains an always-visible, digital Classroom Message Board and a cloud-based Teaching Management System.
Turkey aims to equip 16 million of the country’s students with tablet computers over the next few years.

CHALLENGES THAT MUST BE OVERCOME

Extending and Expanding the “Learning on the Go” Initiative in the National Broadband Plan

Julius Genachowski, Chairman of the US Federal Communications Commission (FCC), supports a national policy to use broadband connectivity to improve education. He has acknowledged the FCC’s role and responsibility in fostering universal accessibility to mobile learning and stressed the importance of partnership from the private sector. In fact, the FCC’s National Broadband Plan states, “the country’s economic welfare and long-term success depend on improving learning for all students, and broadband-enabled solutions hold tremendous promise to help reverse patterns of low achievement.”

The National Broadband Plan is an ambitious strategy to harness the opportunities of high-speed internet and promote U.S. global competitiveness. It is crucial that the FCC, in conjunction with the U.S. Department of Education, and other relevant federal, state and local education agencies, focus on implementing this strategy. Yet, the FCC’s investment in mobile may not be enough.

Many countries are investing heavily in wireless mobile broadband infrastructure, which will lay the foundation for a new ecosystem to develop around mobile learning. The technology platform to enable all of this exists today and can deliver mLearning at scale. What must follow is the development of the ecosystem and acceptance of technology into the learning environment – both formal and informal. Turkey, for example, is moving forward with its FAITH Project (Movement of Enhancing Opportunities and Improving Technology), which aims to equip 16 million of the country’s students with tablet computers over the next few years.24

Just as rural electrification was a national priority in the last century, universal mobile broadband coverage should be a national priority today to ensure every student has access to 21st century learning materials. To take advantage of the opportunity mobile learning provides, students need more than broadband coverage. They need access to mobile devices and interactive learning content designed for mobile.

The FCC’s “Learning On the Go” (aka E-rate Deployed Ubiquitously) pilot program, which provided a total of $9 million for pilot projects around the country to fund off-campus wireless connectivity for students, was a good start, but it was only a start. The E-rate program provides discounts on certain services and products that are essential for schools and libraries to receive voice, video and data communications. The amount of the discount depends on the level of poverty and location of the school or library receiving service. The discount ranges from 20 to 90 percent of the cost of eligible services. The program was originally used to wire school buildings. Over time, it has evolved to support wireless connectivity but only on school grounds. Twenty participants in 14 states, including districts, individual schools and town libraries, were chosen to receive a portion of a $9 million grant from the FCC to fund off-campus wireless connectivity in the short pilot. However, at present, the FCC has not extended or expanded the “Learning on the Go” program, despite positive outcomes from the pilots.
Developing New Education Goals and Metrics for 21st Century Learning

Policymakers must develop new education goals and metrics that prioritize the skills demanded by the modern global economy. The Common Core State Standards Initiative is a state-led effort coordinated by the National Governors Association Center for Best Practices (NGA Center) and the Council of Chief State School Officers (CCSSO). The standards were developed in collaboration with teachers, school administrators and experts to provide a clear and consistent framework to prepare our children for college and the workforce. These standards define the knowledge and skills students should have within their K-12 education so that they will graduate high school able to succeed in entry-level, credit-bearing academic college courses and in workforce training programs.

Additionally, publishers are beginning to develop rich content for the Common Core that takes advantage of new and emerging technologies and software. There is an opportunity for leading technology companies to work with publishers to ensure they are developing content that can be implemented successfully on mobile platforms.

Helping Schools Meet the Digital Assessment Deadline

All school districts must be capable of implementing high stakes assessments digitally by 2014. This is a mandate funded by the U.S. Department of Education for $350 million. Two consortia are leading the effort. One is called Partnership for the Assessment of Readiness for College and Careers (PARCC or Partnership http://www.achieve.org/PARCC). The other is called SMARTER BALANCED (http://www.k12.wa.us/smarter/). There is no clear path (or instructions) as to how school districts will meet the new mandate. And, while most districts are not thinking about mobile, they are about to make heavy investments in technology to be ready for the looming deadline. While districts are investing in technology, there is an opportunity to help them think about their long-term mobile learning plan.

Moving Beyond Bring Your Own Device Programs to Coherent Infrastructures

Many schools are moving to a BYOD model due to funding limitations. Because this model can result in a myriad of mobile devices, operating systems and network challenges, it may be more burdensome for a small IT staff to manage. The BYOD model holds costs down for schools but may limit the potential of mobile devices to close gaps in access to education and risks widening the gap between students who have devices and those who don’t. Because different school districts have different needs, implementation will likely vary, with some schools rolling out a BYOD model and others rolling out school-owned devices. Rajeev Singh-Molares, chair of the World Economic Forum’s Global Agenda Council on ICT,
offers suggestions on how to advance mLearning from promising pilot projects, like BYOD, to mass-scale adoption:

One part of the solution is to cultivate an mLearning ecosystem that includes strategic investment in broadband, mobile technology, software and training. Many countries have realized the importance of affordable broadband for their citizens, with more than 90 embarking on national broadband programs. [...] China is coupling that investment in infrastructure with a ten-year digital education plan. This includes developing an education “cloud” comprising more than 20,000 high-quality lectures and resources accessible by PC, tablet computer and other mobile devices. This push has boosted China's mLearning market by 60 percent, making it the fastest growing in Asia.

Developed countries as well as developing countries such as China, Turkey, India, Thailand, Vietnam, Indonesia and Malaysia, are also developing “e-backpack” tablet programs for students – pushing mLearning one step closer to wide-spread adoption. But more must be done to realize the full potential of a connected education system.

Coordinated cross-sector involvement is required to put affordable devices into the hands of those in need of them. This is not a short-term ambition as it requires long-term programs and goals like China’s Five-Year Plan for proper implementation. These goals need to combine social and commercial incentives to motivate people to achieve more in the sphere of education. This is essential if we want to close the digital divide.²⁵

Overcoming Teacher Isolation

To overcome the feelings of isolation that new teachers have when they enter classrooms for the first time, a Qualcomm Wireless Reach project provides underserved, pre-service teachers at five universities with wireless mobile devices and access to a networked community for practice and support. Through the National Commission on Teaching and America's Future (NCTAF), these teachers have real-time communication with professors and peers and are working to integrate wireless technologies into teaching. This effort enables communication, collaboration and the availability of limitless resources. It also helps to build closer connections between teacher preparation programs and the districts they serve. Still in its pilot phase, this program uses mobile devices and content to focus on the teacher training needed to support a 21st century learning environment where all students have mobile devices. This is one good example; however, more should be done to ensure teachers have the tools they need to succeed in a mobile environment.

The McKinsey report showed that 65 percent of children who are in grade-school today will hold jobs that have not yet been created.

CONCLUSION

Improving the quality of education across the world is good for children and for economic growth. According to a recent McKinsey & Co. analysis, a small improvement in educational quality for children born in 2010 across 40 different countries could have a positive economic impact of about $115 trillion. What’s more, innovation in classrooms is important to prepare children for tomorrow’s jobs. The McKinsey report showed that 65 percent of children who are in grade school today will hold jobs that have not yet been created. The analysis also pointed to the considerable business opportunities that exist in global mobile education. Right now, the market totals about $3.4 billion. By 2020, it will be 20 times greater, at an estimated $70 billion.

The U.S. educational system, created during the industrial revolution, still operates like an assembly line. Wireless technologies present an opportunity to change that paradigm and change how education takes place in the classroom. Benefits of integrating wireless technology into the classroom include the ability to:

- **Personalize**: the right content can be delivered at the right time for each individual student.
- **Coach**: student learning will be facilitated by helping students analyze and synthesize data, as well as by enabling students to collaborate through peer-to-peer networks.
- **Assess**: providing nearly instantaneous feedback for teachers to help them adjust teaching methods in real time.

Now is the time to leverage this technology to transform education. Technology enables peer-to-peer learning, AR and context awareness that provides students with new views and insights. In addition, there is an exciting opportunity to develop applications that engage students in interactive new ways. But the challenges listed earlier must be overcome to realize this vision.

It is critical that all stakeholders continue to participate in the conversation about building the global education ecosystem and spread the early successes from mobile technologies across the globe. Doing so will create better experiences for students and will ensure a better future for everyone.
ADDITIONAL SOURCES


