



Mobile Frontiers in Higher Education

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Introduction

Higher education is facing changes greater than any seen in at least a century. To enhance economic competitiveness, the US government has specified that a substantially higher proportion of Americans should attain some form of a college degree; this parallels similar goals in many countries. To achieve this goal, many students who historically would not have attended higher education must be prepared to succeed in college and supported to enroll. As these efforts reach fruition, colleges will be faced with massive growth in enrollments of non-traditional students who bring a variety of needs and life situations not satisfied by conventional instructional approaches (*Hess, 2011*).

Further, political leaders and parents are advocating initiatives to reduce the cost and time required to attain college degrees (*Bowen, 2012*). An emerging mechanism to accomplish this is to move away from “seat-time” measures of academic attainment to instead use competency-based credentials. Such a system requires much greater flexibility on the part of faculty and institutions, as some students might attain mastery fairly quickly while others could take a longer time (*Horn & Mackey, 2011*).

In addition, online and blended learning have steadily grown in higher education, because these provide ways to fit learning into the lives of non-traditional students and institutions can expand their reach to enroll students outside their geographic area. Research has repeatedly shown that online learning can provide outcomes equivalent to face-to-face instruction, while blended learning combines the strengths of both (*Clark & Mayer, 2011*). However, these digitally-based forms of learning have required major shifts in colleges’ infrastructures, curricula, schedules, and faculty development (*DeMillo, 2011*). Rapid technological advances are accelerating both the scale and pace of these changes, creating many challenges for institutions (*New Media Consortium, 2014*).

The collapse of geographic monopolies has also intensified competition in higher education, especially given the proven power of online learning to aid student success. In addition to threats from other institutions previously not able to lure away their historic student population, new forms of mass

learning (e.g., MOOCs) are offering alternative forms of credentialing. Many colleges are reevaluating what market niche they can occupy given their missions and internal capacities (*Dede, 2013*).

Mobile learning, and in particular the connections afforded through this type of learning, has the potential to aid with many of the issues confronting higher education. All across the globe, students of every age are increasingly engaging with advanced wireless devices to collaborate with peers, access rich digital content, and personalize their learning experiences. Always-on, always-connected, smartphones and tablets provide today’s students with a ubiquitous gateway to a new ecosystem of information, experts, and experiences, regardless of the physical assets and resources (or lack thereof) in their own communities.

Many leaders in higher education are intrigued with the opportunity to use smartphones and tablets as learning tools on campus and want to understand the power of these devices combined with wireless connectivity to transform teaching and learning. This is also the case in pre-college education. According to the latest Speak Up report on digital learning, school principals believe that the use of mobile devices and mobile-enabled content in the classroom have the potential to significantly impact student achievement (*Project Tomorrow, 2014*). The principals link enhanced student outcomes afforded by the mobile devices to a new classroom paradigm in which the students are more engaged in learning, the learning process is highly personalized and extends beyond the school day, and students develop college and career readiness skills such as critical thinking and teamwork using real world tools and resources.

As this generation of students enters college, they have high expectations for mobile learning opportunities at higher education institutions. As institutions compete for students, a sophisticated mobile technology infrastructure and curricula based on mobile learning are becoming a major advantage. This report discusses how some higher education initiatives are using mobile learning to better achieve their institution’s missions and to position their faculty and students for a prosperous future.







**QUALCOMM'S
COMMITMENT
TO ADVANCING
MOBILE LEARNING**

Qualcomm® is a world leader in next-generation mobile technologies. For nearly 30 years, Qualcomm ideas and inventions have driven the evolution of wireless communications, connecting people more closely to information, entertainment, and one another. Today, Qualcomm technologies are powering the convergence of mobile communications and consumer electronics, making wireless devices and services more personal, affordable, and accessible to people everywhere. At the heart of Qualcomm's culture is the belief that mobile technology presents an opportunity to create value, extend its reach, and make a genuine impact. The company believes that building lasting value to realize this vision requires more than a focus on shareholders – it involves a significant commitment to the global community.

For the past seven years, Qualcomm, through its Wireless Reach™ initiative, has developed an in-depth understanding of mobile learning opportunities and challenges through investments in school and community projects. Via Wireless Reach, Qualcomm has sponsored thought leadership events and published reports that address the opportunities and challenges of mobile learning. Recently, Qualcomm Education, Inc. was formed and launched the Qualcomm® QLearn™ Mobile Education Platform to address a range of opportunities across MOOCs, Higher Education and K-12. Based on Qualcomm's expertise, this paper presents an overview of emerging trends and initiatives in higher education that will help leaders worldwide in their quest to improve learning opportunities for their students through the effective use of mobile and wireless technologies.



Wireless Reach as a strategic initiative

Through Wireless Reach, a strategic initiative that brings wireless technology to underserved communities globally, Qualcomm works with partners to invest 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 funded 103 projects in more than 40 countries, with almost 40 of those projects focusing on education. Education projects are designed specifically to address the barriers to adoption of wireless technology in the classroom, including needs for digital content and assessment, infrastructure, privacy and security, and professional development for teachers.

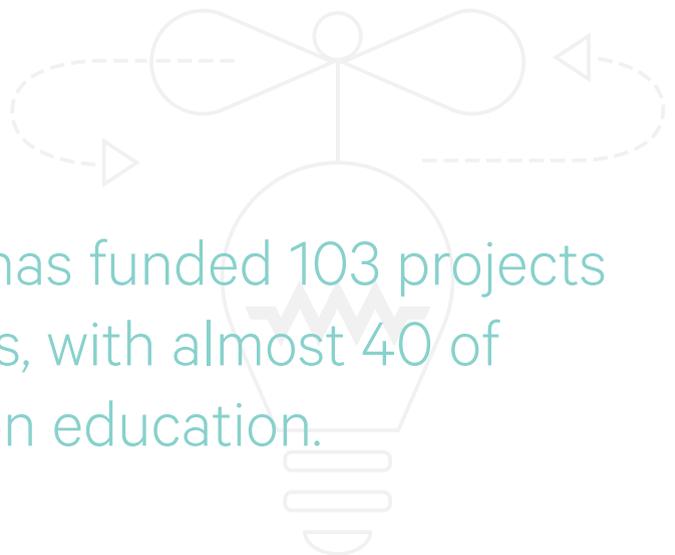
Qualcomm believes that always-on, always-connected advanced wireless devices and ubiquitous tools have the potential to transform teaching and learning in K-20 schooling. When this potential is realized, students will benefit from 24/7 access to digital curriculum that is highly personalized with respect to level, pace, and learning preferences. Teachers will benefit from digital participation in communities of practice with global reach and from dashboards that actively display real-time data about 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. In this vision, researchers too will benefit from a platform that allows the distribution and evaluation of innovations in Internet time.

Education is a key driver for growth, economic prosperity, and the advancement of both developed and developing countries. Mobile devices with wireless access can bring

high-quality education to all communities, regardless of their income status or location. For the millions of children and youth in emerging countries who lack access to formal education, the proliferation of mobile devices could provide a new opportunity, perhaps their only means, for accessing learning resources. Within the United States, only 60% of high school students in low-income communities report having broadband access to the Internet outside of school (*Project Tomorrow, 2014*). In some cities, like Detroit, 70% of students lack Internet access when they leave school grounds (*Kajeet Case Study, 2014*). Wireless Reach is exploring how these devices, so common in our pockets, can be used in education so that all students have the opportunity to learn, prepare for good jobs, and participate in our global economy.

Substantial barriers and challenges remain in effectively utilizing these new technologies in school and in implementing the types of best practices that have been proven to overcome these obstacles. Based upon a comprehensive examination of the effective implementation strategies and resulting successful outcomes derived from the global projects within the Wireless Reach education portfolio, the authors have identified eight essential components of a successful mobile learning initiative in primary and secondary education (see p.26). While no single project or initiative must incorporate all of the essential components, an understanding of these eight essentials for project success and their inter-relationships can help education leaders be more informed and prepared to implement a successful mobile learning project.

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Qualcomm QLearn Mobile Education Platform

Qualcomm's established leadership in modern day mobile technology has been combined with the company's passionate belief that technology can positively impact learning outcomes. The resulting solutions, developed specifically to address many of the challenges uncovered through Wireless Reach investments, provides mobile device manufacturers, content providers, education authorities, network operators, teachers and most importantly students, a practical means to address barriers facing mobile technology deployment in education today.

QLearn addresses this with a suite of integrated solutions for developing mobile first access to education, both within and beyond the classroom. The solutions provide opportunities across the entire education ecosystem, addressing the needs of end users looking for technology that can help improve learning outcomes. The goal of the solution set is to provide students with modern day communication tools that are interactive, engaging, safe, affordable, and offer the opportunity to deliver 24/7 access to learning. The core components of the QLearn solutions include:

- **QLearn Hub** provides a software services solution compatible with the myriad of IT systems that propagate the education sector today. From Learning Management Systems to Student Information Systems and even education based web and mobile app content, all are seamlessly aggregated and managed to provide consistent

real time access – 24/7. Importantly the QLearn Hub is device and platform agnostic – allowing end users (educators, students, parents) the opportunity to select the right devices to suit their needs.

- **QLearn Apps** provides a single interface for students and educators to access across multiple operating systems and devices. Learning content is unshackled from the classroom and is in tune with the “born mobile” generation of students for whom the mobile device is an essential part of their daily lives – a generation who have been eagerly awaiting the time when education will catch up with technology. QLearn Apps are a “one stop shop” for the education needs of students and teachers. For the first time students have mobile access to their course curriculum, notes they make, study projects set by their teacher, and modern day interaction tools with classmates such as IM / video conferencing.
- **QLearn Zone** is a comprehensive tool kit of technology solutions to address the digital divide that exists in the USA and many other places around the world. With an aim to address digital equity, QLearn Zone intuitively manages and provides seamless connectivity across Wi-Fi and cellular broadband networks, ensuring all students benefit from high speed access to learning materials and connecting with peers and teachers in and outside the classroom. Students can now truly go mobile with their studies. As a result, students in the estimated 30% of homes in the USA without access to high-speed broadband are potentially no longer penalized in their ability to learn at the same pace as the rest of their classmates.







THE POTENTIAL AND THE CHALLENGES OF MOBILE LEARNING IN HIGHER EDUCATION

Technology initiatives in higher education tend to fall into two categories: using technology **to do conventional things better** versus using technology to **do better things** (Roschelle, Pea, Hoadley, Gordin, & Means, 2000). While there is value in **doing things better** (i.e., more efficiently and effectively), the deeper value in technology for teaching lies in rethinking the enterprise of education in ways that unlock powerful learning opportunities and make better use of the resources present in the 21st century world. **Doing better things** includes preparing students to be more responsive to the opportunities and challenges of a global, knowledge-based, innovation-centered civilization.

Digital technologies that are well suited to preparing students in higher education for work and citizenship are different than faced by past generations and include (Fishman & Dede, *in press*):

- Collaboration tools, including social media and tools that support knowledge building;
- Online and hybrid educational environments, which are increasingly being used to broaden access to education, but also have the potential to shift the way we conceive of teaching and learning;
- Tools that support learners as makers and creators, and which have their deep roots in helping students learn to become programmers of computers (and not just users of them);
- Immersive experiences that create virtual worlds to situate learning or augment the real-world with an overlay of computational information; and
- Games and simulations that are designed to enhance student motivation and engagement.

Mobile devices offer powerful ways of enhancing each of these methods of teaching and learning.

Another advantage of teaching with these tools is automatically-generated suggestions available from digital learning environments. This feedback is generated by

learning analytics (Bienkowski, Feng, & Means, 2012; U.S. Department of Education, 2012), and represents potentially powerful new information for teaching. Mobile devices also provide a particularly rich vehicle for collecting this data life-wide and life-long.

Online learning or e-learning may be terms that unnecessarily limit what is possible with digital technologies. Both have roots in original conceptions of distance education, where the objective was to port classroom-style learning to off-campus students through an alternative delivery mechanism, whether via the postal service, cable television networks, or the Internet. When the metaphor is changed from “the information age” to connected “learning in a networked world” (NSF Cyberlearning Report, 2008) one should ask “what does ‘e-learning’ look like when it shifts from moving information to being about connections?” Connected learning may be a more useful construct for today’s environment. A working definition of connected learning is (Ito et al., 2013, pg. 4):

...broadened access to learning that is socially embedded, interest-driven, and oriented toward educational, economic, or political opportunity. Connected learning is realized when a young person is able to pursue a personal interest or passion with the support of friends and caring adults, and is in turn able to link this learning and interest to academic achievement, career success or civic engagement. This model is based on evidence that the most resilient, adaptive, and effective learning involves individual interest as well as social support to overcome adversity and provide recognition.

Smartphones, tablets, and mobile broadband provide the ideal infrastructure for connected learning.







The emphasis in higher education is less about acquiring devices and infrastructure, and more on building curricular and human capacity to use connected learning intensively, and well.

Mobile initiatives in higher education have different characteristics than those in pre-college settings. First, mobile learning in colleges and universities increasingly involves bring-your-own-device (BYOD) infrastructures, as almost all students already have at least a smartphone. Mandates that all students on campus must use the same device, whose characteristics are dictated by the college, have disappeared. BYOD means that students already feel a strong sense of ownership in their mobile technology and are familiar with how to use it, reducing the need for centralized support of devices and enforcement of elaborate standards. Instead, the emphasis in campus infrastructures has become coordinating the usage of a broad array of devices and ensuring security, safety, and privacy across this spectrum.

Second, because students in higher education are older than in K-12, they are more accustomed to autonomy in making decisions and typically bring to campus desire for and experience in self-directed learning on a wide range of mobile and handheld devices. Unlike K-12, higher education does not need to convince students and parents about the value of using mobile devices for learning, given the technology-intensive workplaces students will enter when they matriculate. Further, while institutions must be concerned about student safety, privacy, and security online, these issues are less acute than for precollege students and therefore don't pose high barriers.

Third, the emphasis in college campus mobile and connected learning initiatives is on content selection, faculty buy-in and adoption in instruction, and student productivity. Developing advanced content designed for delivery on mobile devices is a major issue. Also, instructors in higher education have much more autonomy than teachers in K-12, so convincing each faculty member to develop instruction

that incorporates mobile learning is more of a challenge. Even in online courses, often faculty assume that students will be using a laptop or workstation, rather than configuring their instruction to delivery on the form-factor of smartphones and tablets. In addition, just because students are accustomed to using mobile devices for informal learning does not mean they understand how to be productive in using the same infrastructure for academic learning.

Thus, in contrast to K-12 mobile learning initiatives, the emphasis in higher education is less on acquiring devices and infrastructure, and more on building curricular and human capacity to use connected learning intensively and well. The mobile learning principles of (a) learner autonomy, (b) always-on access and connectivity, and (c) flexibility and adaptability to different learning goals and approaches support many of the desired outcomes for connected learning in higher education. To fully appreciate the potential of mobile learning to be a catalyst for addressing the challenges facing our nation's colleges and universities, the authors have identified five illustrative mobile learning projects in higher education to review in more detail. Each project discussed brings to the conversation new insights as well as new questions for further research and evaluation.

ILLUSTRATIVE MOBILE INITIATIVES IN HIGHER EDUCATION





Below are brief descriptions of illustrative strategic initiatives in higher education that depict the many ways mobile learning can enhance the activities of students, faculty, and institutions.

Mobile Learning in Teacher Education

The nationally recognized UTeach program, started at the University of Texas at Austin in 1997, has dramatically changed the formula for recruiting math and science majors to pursue teaching careers. Now expanded to include 35 universities nationwide, the UTeach program brings together colleges of education with academic departments in the natural sciences to work together in the preparation of current science, math, technology and engineering majors with the skills needed to teach in these subject areas after graduation. Recognizing that, despite the ubiquity of mobile devices in students' hands, most K-12 teachers do not know how to use these devices to support learning, a recent new collaborative initiative between the UTeach Institute and the Verizon Foundation aims to address this situation (*UTeach Institute, 2014*). Working directly with science and math college students who are pursuing secondary teaching certification, this new program helps these future teachers explore how to integrate tablets into their lesson plans.

This new mobile technology initiative is currently underway at UTeach programs at 8 universities: Cleveland State University, Temple University, University of California at Berkeley, University of Colorado at Boulder, University of Kansas at Lawrence, University of Massachusetts at Lowell, University of Tennessee, Knoxville and University of Texas at Austin. Central to the program is that the pre-service students (the science and math majoring college students)

and the secondary school students they teach are both provided with Samsung Galaxy Note tablets with LTE service. In the first year of the program, the college students integrate the tablets into their course work on inquiry-based lesson plan development, as well as their field experiences in middle schools. Master teachers developed a series of model lessons to help guide the pre-service teachers in how to use the tablets to support inquiry methods as well as differentiating instruction for diverse learners. Leveraging the access to the devices and the master teacher lessons, the first cohort of college students developed 80 distinct lesson plans using over 40 different apps and online resources for the tablets in their lessons. In addition, many of the students tapped into the PhET Interactive simulations from the University of Colorado at Boulder to support their math and science lessons, creating new and engaging learning environments for their middle school students.

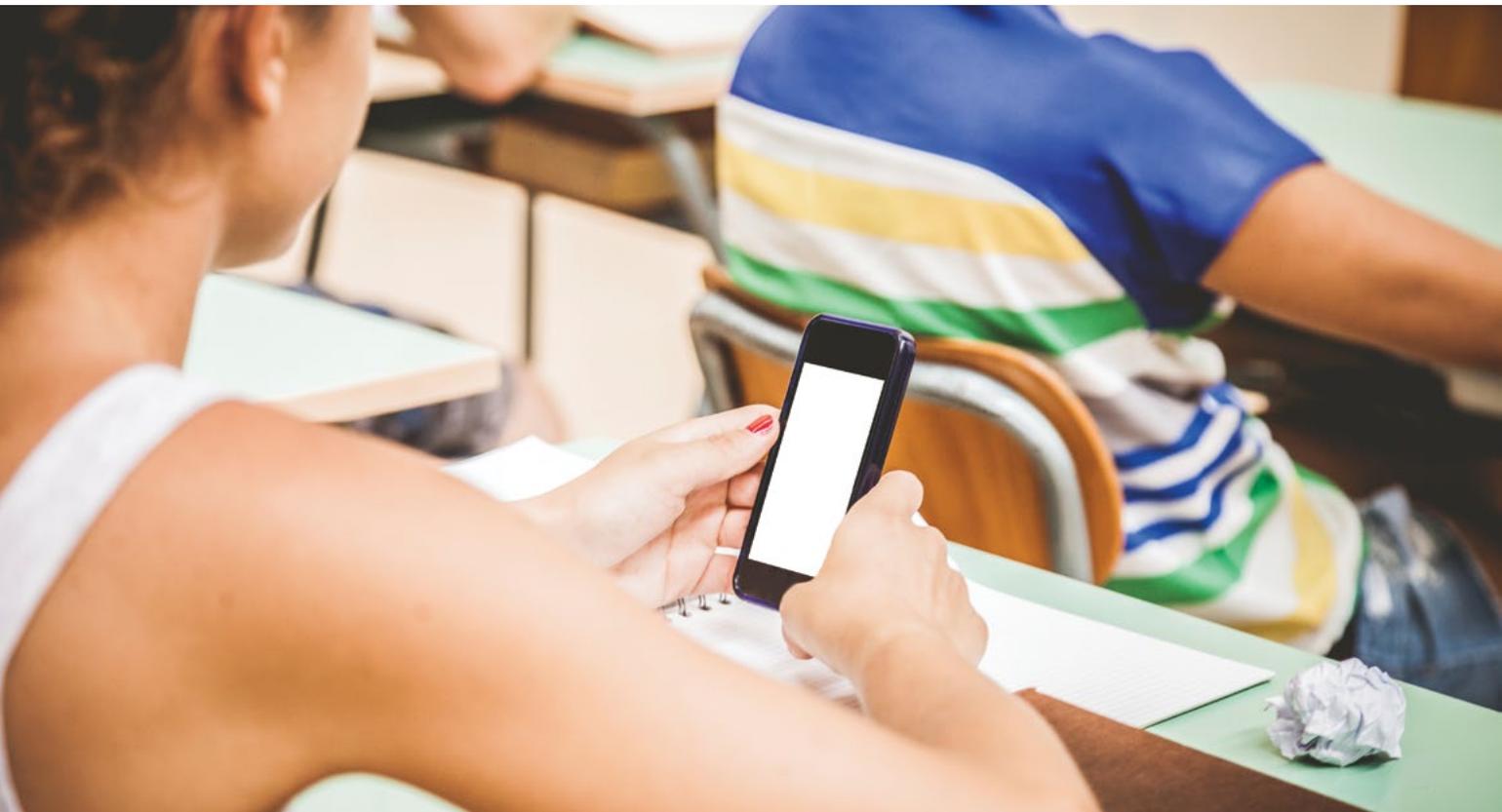
While the intent is to ensure that the next generation of math and science teachers nationwide is skilled and comfortable with using mobile devices within instruction, the UTeach Institute also recognizes that the model lessons developed by the master teachers and the college students could be valuable for other teaching programs. To that end, the Institute hopes to incorporate the technology based lesson plans throughout their curriculum and to share these resources with master teachers.

The model lessons developed by the master teachers and the college students could be valuable for other teaching programs.

Using QLearn Apps as Core Component of Blended Learning Experience

Blended learning environments are increasingly gaining the interest of instructors and students alike as a hybrid approach to learning that integrates the best qualities of face-to-face instruction with the potential power of digital tools, resources and content. According to the Clayton Christensen Institute for Disruptive Innovation, blended learning is a formal education program in which part of the students' learning is self-directed with some level of personal control over the pace, path and place of the learning process, in addition to more structured class time in a brick and mortar environment with classmates and an instructor. Various technology tools are utilized within the blended learning environment to facilitate peer collaborations and student-centric learning as well as access to rich digital resources. The management of the blended learning process, and in particular, well-facilitated communications between instructors and students is a critical component in successful implementations.

In fall 2014, the Qualcomm QLearn team piloted a blended learning experience for students taking an Introduction to Psychology course at a state university in Northern California. The pilot included 73 students and five Teaching Assistants meeting for weekly live class meetings, engaging in activities and assignments via the QLearn app, and also participating in asynchronous learning opportunities designed by the instructor. This pilot resulted in very positive student data including a 95% pass rate by the course participants. Additionally, 87% of the students noted that they would recommend the QLearn app to peers as advantageous and eight in ten students wanted to use the QLearn app in other courses. From a course management and communications standpoint, 90% indicated a preference for using the QLearn app over other learning management systems within their courses.



Mobile Learning via Edutainment at Georgia Regents University

Motivation is an important factor in learning, yet at times an academic field's knowledge and skills can be difficult to master because some of its substance and process are not engaging for students. Mobile devices offer a potentially powerful capability for aiding with this problem, because smartphones and tablets are proven vehicles for life-wide entertainment, including various forms of gaming. Georgia Regents University (GRU) is exploring the idea that academically oriented games could provide 'edutainment' that keeps students interested even through the less intriguing parts of a subject (Fuhrman, 2014).

Blackboard's application suite and the Unity 3D gaming development platform are the infrastructure GRU uses to create edutainment-oriented mobile applications, multimedia, animations, simulations, gaming, 3D and other forms of technology-enhanced communications. One illustration is **Build-A-Brain Explorer**, an app that enables studying virtual slices through a brain. Another example is **Hanyu**, an app designed by GRU's Confucius Institute to interest students in the Chinese Language through interactive media and sound experiences that include the opportunity to practice Chinese calligraphy. The edutainment experiences GRU is developing and studying go beyond college-age students; an app called **Allergen Alert** helps patients at its Children's Hospital to learn about allergens through a game that destroys them.

Michael Casdorff, associate vice president of academic and research technology, cites faculty involvement as crucial in the success of GRU's initiative. Instructors provide suggestions for edutainment experiences in their fields, and their subject matter knowledge is essential for making the knowledge and skills taught by these apps authentic and valid. Faculty are also important partners in integrating mobile entertainment into their instruction and in evaluating their effectiveness, as well as suggesting improvements in design. In addition, students are valuable collaborators in design and evaluation, since faculty are not always in tune with what students consider engaging.

Based on the success of its mobile edutainment initiative, GRU is now seeking collaborations with other institutions. This could create co-branded apps that greatly expand the range and depth of mobile edutainment experiences available. Also, the GRU model for internal development is a valuable asset other colleges could adapt.

Motivation is an important factor in learning, yet at times some of an academic field's substance and process are not engaging for students.

Course Design for Mobile Learning at the University of Illinois—Springfield

The Center for Online Learning, Research, and Service at the University of Illinois—Springfield is its hub for the study and application of online learning pedagogy, technology, and best practices. One initiative of the Center is to develop design strategies for mobile learning that take into account the form-factors, capabilities, and limits of smartphones and tablets (*Gribbins, Cook, & Schroeder, 2014*). Another important factor in their development is the characteristics of mobile learners: where, when and how these types of students like to have their educational experiences.

Five challenges the Center has identified in repurposing content for mobile learning are:

- A lack of interoperability between PC/laptop applications and mobile applications;
- A wide variety of form-factors, some of which are quite limiting in terms of how content can be presented, both in terms of screen space and processing power;
- The need to tailor multimedia content, layout, and interface to different types of end-user devices, including smart-sensing of what configuration to use;
- A lessened degree of interactivity (e.g., written input speed) on mobile devices compared to laptops and PCs; and
- Limited learning management system (LMS) support (although, as the QLearn Apps case above describes, this situation is improving over time).

Additionally, limits on power storage (e.g., battery life, charging rapidity) are a developing issue of importance as well.

Some insights on overcoming these challenges are emerging. One of the two large assessment consortia, the Partnership for Assessment of Readiness for Colleges and Careers (PARCC), has developed device-neutral design and implementation strategies (PARCC, 2013). Also, the Advanced Distributed Learning (ADL) Initiative is currently exploring new instructional design models and accompanying instructional systems design (ISD) principles for mobile learning (ADL, 2014). These include Koole's Framework for the Rational Analysis of Mobile Education (FRAME) model that includes social, device, and learner dimensions. Also incorporated into ADL's approach is Park's Pedagogical Framework for Mobile Learning, which delineates types of mobile learning based on "transactional distance" (extent of psychological and communication space between learners and instructors), as well as social vs individual learning.

Design strategies for mobile learning are continuing to evolve. A mature, stable set of approaches will likely not emerge, as device capabilities rapidly shift, creating expanded opportunities for various kinds of pedagogies. Moreover, the needs and desires of learners are also altering as new types of media shift their strengths and preferences.

Design strategies for mobile learning are continuing to evolve.

Augmented Reality in Higher Education

Augmented reality (AR) involves superimposing a combination of multimedia information (including spatial 3D models, images, textual information, video, animations and sound) into a learning environment (Klopfer, 2008). As discussed later, mobile broadband devices are an ideal infrastructure for infusing AR in classrooms and throughout life. Several universities are experimenting with AR as an emerging medium for enhancing student motivation and learning.

For example, Coventry University in the United Kingdom has designed and studied AR-based learning experiences in the field of Informatics at the University of Sussex and in information science at City University (Liarokapis & Anderson, 2010). The teaching materials were developed to incorporate 1) a set of distinctive marker cards to trigger the AR overlays, 2) the digital overlays themselves, and 3) tutorials that incorporate these elements into a unit focused on a suite of knowledge and skills in the academic subject. Examples of tutorials incorporating AR included 3D representations of various parts of computer architecture (e.g., the central processing unit), and an educational game involving interactive, collaborative problem-solving of a 3D puzzle involving various topological configurations. Preliminary results on student motivation and learning were promising.

The New Media Corporation's Horizon Report for Higher Education (2014) describes the potential of AR as a visualization and engagement medium and cites "Mentira," a mobile AR for learning Spanish language skills developed at the University of New Mexico. Students build their vocabulary

and understanding in the course of playing a game to solve a murder mystery (Holden & Sikes, 2012). This is an example of an AR that takes students beyond a classroom setting into an authentic real-world context, increasing the likelihood of transferring academic skills into life settings.

Bower (2014) provides an overview of the potential of AR in higher education, including numerous examples of AR images and videos showing applications to various fields. As discussed later, AR supports pedagogies such as constructivism (in which users develop knowledge from hand-on experiences), games and simulations, inquiry-based learning, and situated learning (educational experiences involving a rich context that contributes to mastering knowledge and skills). Further, because AR is not technically difficult to author, students can learn by designing ARs that express their current understanding, then having those evaluated by experts.

Overall, AR is an emerging technology whose strengths and limits for post-secondary learners are not yet fully understood. Research and development in this area is a promising frontier for higher education, and investments are needed to develop pilot projects. Qualcomm has developed a variety of learning-related capabilities in its Vuforia app, and incorporating these capabilities into instructional authoring shells for mobile learning in higher education is an important next step to realizing the vision of AR in higher education.



**APPLYING THE EIGHT
ESSENTIALS FOR A
SUCCESSFUL MOBILE
LEARNING INITIATIVE
TO HIGHER EDUCATION**

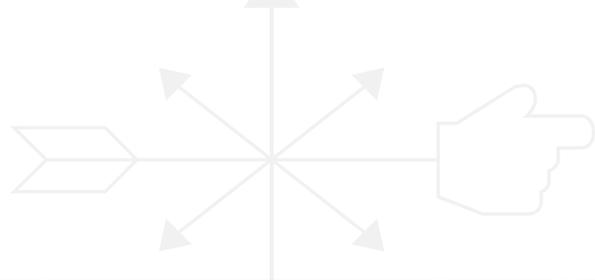


The almost 40 Wireless Reach funded education projects across the globe have produced many insights about how to design, deliver, and evaluate highly successful mobile learning projects. Mobile learning projects include learning environments, both inside or outside of classrooms, in which each student has access to a personalized mobile device, such as a smartphone or tablet, from which they can access Internet resources and tools. A hallmark of the Wireless Reach initiative is the recognition that, to have emerging mobile solutions impact more students and instructors, the K-20 educational sector needs best practices, proven solutions, and evidence-based exemplars that address commonly held challenges and concerns about mobile learning. As discussed in *The Eight Essentials for Mobile Learning Success in Education* (Baker, Dede, & Evans, 2014), this research-informed set of eight essential components addresses that vital need and provides valuable input to inform local plans and initiatives:

- Planning purposefully for mobile device usage
- Leveraging content and curriculum that are mobile-empowered
- Understanding the power of Internet access

- Preparing educators effectively
- Securing leadership buy-in
- Building personal learner efficacy and capacity for self-directed learning
- Measuring project results with meaningful metrics
- Creating an ecosystem that is sustainable and scalable

Evaluation results from the Wireless Reach projects indicate that the thoughtful application of these strategies in combinations that meet the needs of the local context substantially increases the probability of a successful implementation of a mobile learning initiative. Below, we provide an explanation of the value for each of the eight essential components, and we indicate how the higher education mobile learning initiatives described above illustrate that characteristic.

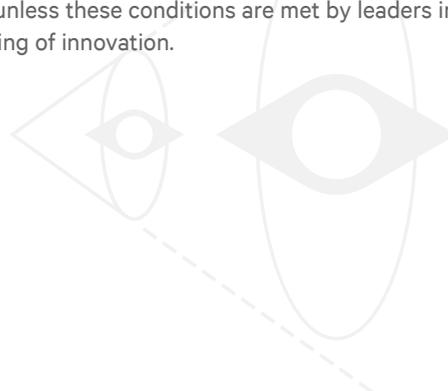


Purposeful planning for mobile device usage

The first step in designing a mobile learning experience is understanding that its power for improving student outcomes does not magically come simply from using a mobile device. Smartphones and tablets are not like fire, a technology from which one gets a benefit simply by standing near it. Instead, learning technologies serve as catalysts: their power for effective education stems from enabling deeper content, more active forms of pedagogy, more authentic and diagnostic assessments, and more links between classroom experiences and life. Usage of mobile devices without empowering at least one of these dimensions—or some other evidence-based mechanism for deeper learning—is a waste of time, effort, and resources, because phones and tablets don't intrinsically create learning any more than does a pencil.

Given the characteristics of mobile learning in higher education discussed earlier, what types of planning are needed? First, just as with any other form of educational innovation (technology-based or not), it's important to consider some fundamental questions:

- **What are the learning goals to be accomplished?** These can include not only cognitive dimensions, but also intrapersonal and interpersonal skills, including motivation.
- **Who are the learners, and what prior knowledge and skills do they bring to the experience?** Students are not empty vessels to be filled with information, but instead bring many skills, ideas, and misconceptions—as well as developmental levels and individual motivations—that must be considered in designing effective learning experiences.
- **Who are the faculty, coaches, guides, and mentors serving to enhance learning, and what prior knowledge and skills do they bring—and need?** Part of the power of mobile devices is their ability to involve human resources “life-wide” for students, not just in classroom settings.
- **What instructional and curricular materials are available—or need to be developed—and how will these materials be delivered via mobile devices?** The Internet can supply vast resources, but these are of variable quality and frequently require integration and alignment to be effective for learning. In addition, there are a variety of learning platforms available to deliver course materials. When making decisions about content delivery solutions, built-for-mobile platforms have advantages using native features of the device, such as the camera. Other features might include online collaboration tools using video, the ability to cache large content on the device so a student can review it anywhere and anytime, video grading capabilities for faculty, push notifications from faculty to student, student to student interactions, access to instructional materials when offline, adjustment of content displayed to the form-factor of the device, integration with cloud services, and analytics.
- **What will be measured to determine and enhance educational effectiveness, and how?** Embedded, diagnostic measures of student learning formative for instruction are crucial for success; and summative assessments of student learning, along with other evaluative measures, are very important in determining the effectiveness of the initiative.
- **What are the contextual “conditions for success” that must be met for the initiative, and what leaders in each setting will ensure these conditions are developed and sustained?** Just as taking a medication must be done in certain ways to ensure its effectiveness (e.g., right dosage, proper timing, sufficient duration), so educational innovations require contextual conditions (e.g., prepared faculty, quality curriculum) in order to succeed—and will fail unless these conditions are met by leaders in the setting of innovation.





- **How will the initiative be sustained and scaled when special start-up resources are gone?** Too often, educational innovations are developed in a way that requires a continuous infusion of outside resources to keep them going. This limits both how many sites can use the innovation and how long the improvements will last, because the initiative disappears as soon as external funding is discontinued.
- **Are the views of students and faculty included in the planning process for the mobile initiative?** By virtue of already using these devices to support self-directed learning outside of classrooms, students are a treasure trove of ideas for effective campus implementations. And faculty members who are part of the planning process can help to articulate the benefits to a larger audience, as well as provide insights into how to build sustainable funding to support proven programs.

In summary, thoughtful planning with a focus on determining the foundational objectives of the mobile learning initiative combined with the active involvement of the education stakeholders, including students, are primary requisites for a successful mobile learning initiative.

The Center for Mobile Learning at the University of Illinois—Springfield illustrates the importance of planning as an essential. In particular, their development of design strategies for mobile learning that take into account the form-factors, capabilities, and limits of smartphones and tablets (Gribbins, Cook, & Schroeder, 2014) shows the power of this approach. Without prior planning, colleges and universities often transfer instructional materials from face-to-face settings or from laptop/desktop-based distance learning, only to find that the delivery of these materials on mobile devices is hampered by their constraints. At the same time, developers who ignore planning miss the opportunities mobile devices provide from anywhere, anytime learning due to lack of involvement by various stakeholders in instruction. The Center for Mobile Learning at UIS is an exemplar of this essential because the dimensions of planning listed above are integral to its designs.

Leveraging content and curriculum that are mobile-empowered

Curriculum that supports the learning goals for a mobile initiative is essential for its success. These materials provide resources for both students and faculty to guide their activities. It is crucial that the curriculum provides a balance of activities between passive forms of assimilation (e.g., reading, watching videos) and active forms of learning (e.g., writing, designing, gathering data, collaborating). Also, the curriculum must be tailored to fit particular student characteristics. For example, to help students with special needs or learning preferences, providing alternate modalities (e.g., reading text, listening to audio, viewing a video) is good.

This range of options is important because learning is a human activity quite diverse in its manifestations from person to person (Dede, 2008). Consider three activities in which all humans engage: sleeping, eating, and bonding. One can arrange these on a continuum from simple to complex, with sleeping towards the simple end of the continuum, eating in the middle, and bonding on the complex side of this scale. People sleep in roughly similar ways; if one is designing hotel rooms as settings for sleep, while styles of décor and artifacts vary somewhat, everyone needs more or less the same conditions to foster slumber. Eating is more diverse in nature. Individuals like to eat different foods and often seek out a range of quite disparate cuisines. People also vary considerably in the conditions under which they prefer to dine, as the broad spectrum of restaurant types attests. Bonding as a human activity is more complex still. People bond to pets, to sports teams, to individuals of the same gender and of the other gender. They bond to others similar or opposite in nature, for short or long periods of time, to a single partner or to large groups. Educational research strongly suggests that individual learning is as diverse and as complex as bonding, or certainly as eating. Yet theories of learning and philosophies about how to use technology for instruction tend to treat learning like sleeping, as a simple activity relatively invariant across people, subject areas,

and educational objectives. Current, widely used instructional technology applications have less variety in approach than a low-end fast-food restaurant.

Mobile learning can do much better than that, because today's phones and tablets are powerful enough to support a wide range of options, and their capabilities keep expanding over time. That said, the form-factor of mobile devices (small screen, varied network speeds on wireless connections, difficulty typing text) means that some types of educational materials and activities are best done on larger computers or via non-digital media. In instructional design for mobile initiatives, understanding which materials to deliver via various means is important.

In summary, for all types of technology-based learning, it is important to build on existing digital resources, but recognize that adaptation and integration are necessary. Curricula developed for large-screen devices may need alteration for small-screens. Isolated “learning objects” may need modification and synthesis to form a coherent, aligned, cumulative set of learning experiences. Budgeting resources for the kinds of development discussed above is important for mobile learning initiatives. The good news is, as the initiatives described earlier illustrate, developers are starting to build “mobile first” content that goes beyond a flat PDF.

Georgia Regents University is an illustration of leveraging content and curriculum that are mobile-empowered. In people's personal lives, gaming is now a major form of entertainment, and the rise of mobile games (e.g., **Angry Birds**, **Candy Crush**) has shown how well suited the mobile platform is to this medium. GRU is taking advantage of this by substituting edutainment for entertainment, designing academically oriented games that are developed for mobile devices to take advantage of their capabilities. The success of this initiative in fostering anytime, anywhere learning highlights the importance of mobile-empowered instructional materials as an essential.

Understanding the power of Internet access

Equity of access to educational resources is increasingly becoming the next high profile civil rights issue of our global society. At the heart of this issue worldwide is access to the Internet as one gateway to a plethora of rich educational content and tools that could be accessed by students for learning purposes. The Internet access discussion, however, includes a wide spectrum of types of equity. For many students in Kenya, for example, equity starts with whether Internet connectivity is even available in their community, and then, what types of devices can be provided to those students to facilitate that access, in classrooms and throughout life. Limited or non-existent access equates to diminished educational opportunities.

Internet access anyplace, anytime, is a powerful tool for learning that is uniquely provided by mobile devices. In addition to all the web-based resources this enables, the combination of the Internet and Global Positioning Satellite (GPS) capabilities opens up new forms of learning, such as augmented reality (AR). As discussed earlier, AR enables students carrying mobile wireless devices through real-world contexts to interact with virtual information, visualizations, and simulations superimposed on physical landscapes. For example, via AR a tree might describe its botanical characteristics, a historic photograph might offer a contrast with the present scene, or a cloaked alien spaceship might appear, visible only through the mobile device. This type of immersion infuses digital resources throughout the real world, augmenting students' experiences and interactions (*Klopfer, 2008*).

Wireless Reach supported EcoMOBILE, a very successful pre-college AR learning experience in ecosystems science and scientific inquiry (*Kamarainen et al, 2013*). This project explores the potential of augmented reality (as well as the use of data collection “probeware,” such as a digital tool that measures the amount of dissolved oxygen in water), to support learning in environmental science education (<http://ecolearn.gse.harvard.edu>). As an example of an

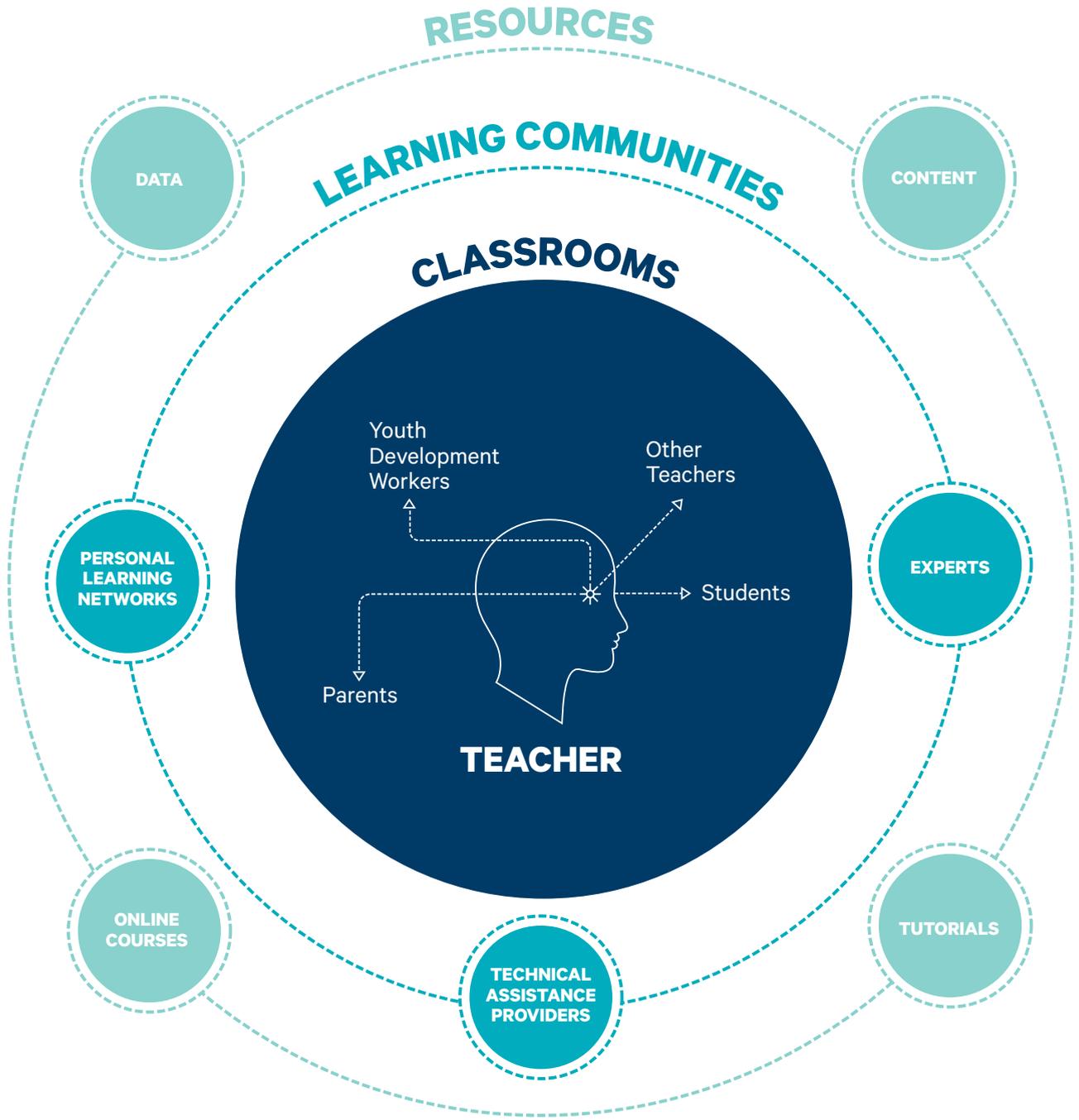
EcoMOBILE learning activity, students go on a field trip to a nearby pond, in order to study the relationship between biological and non-biological factors in the ecosystem, practice data collection and interpretation, and learn about the functional roles (producer, consumer, decomposer) of organisms in the life of the pond. At a number of spots around the pond, students' handheld devices show them visual representations—overlaid onto the real environment—of the natural processes at work in the real environment, as well as interactive media including relevant text, images, audio, video, 3D models, and multiple-choice and open-ended questions. Students also collect water measurements using Vernier probes. On the next school day after the field trip, back in the classroom, students compile all of the measurements of temperature, dissolved oxygen, pH, and turbidity that had been taken during the field trip. They look at the range, mean, and variations in the measurements and discuss the implications for whether the pond is healthy for fish and other organisms.

EcoMOBILE and other outdoor augmented reality projects illustrate the power of Internet access for learning anyplace and anytime, rather than just in classrooms and homes. As discussed earlier, augmented reality as a medium is still emerging in postsecondary education, but holds promise to bring academically oriented instruction to the life-wide settings in which college students do much of their informal learning. This success of AR in pre-college education underscores the importance for higher education of this essential.

Preparing educators effectively

The U.S. National Education Technology Plan (*US Department of Education, 2010*) discusses how enabling the life-wide learning described above requires that mobile initiatives prepare K-20 educators for connected teaching (*Figure 1*).

Figure 1. “Connected” teaching across multiple locations and people (NETP, 40)



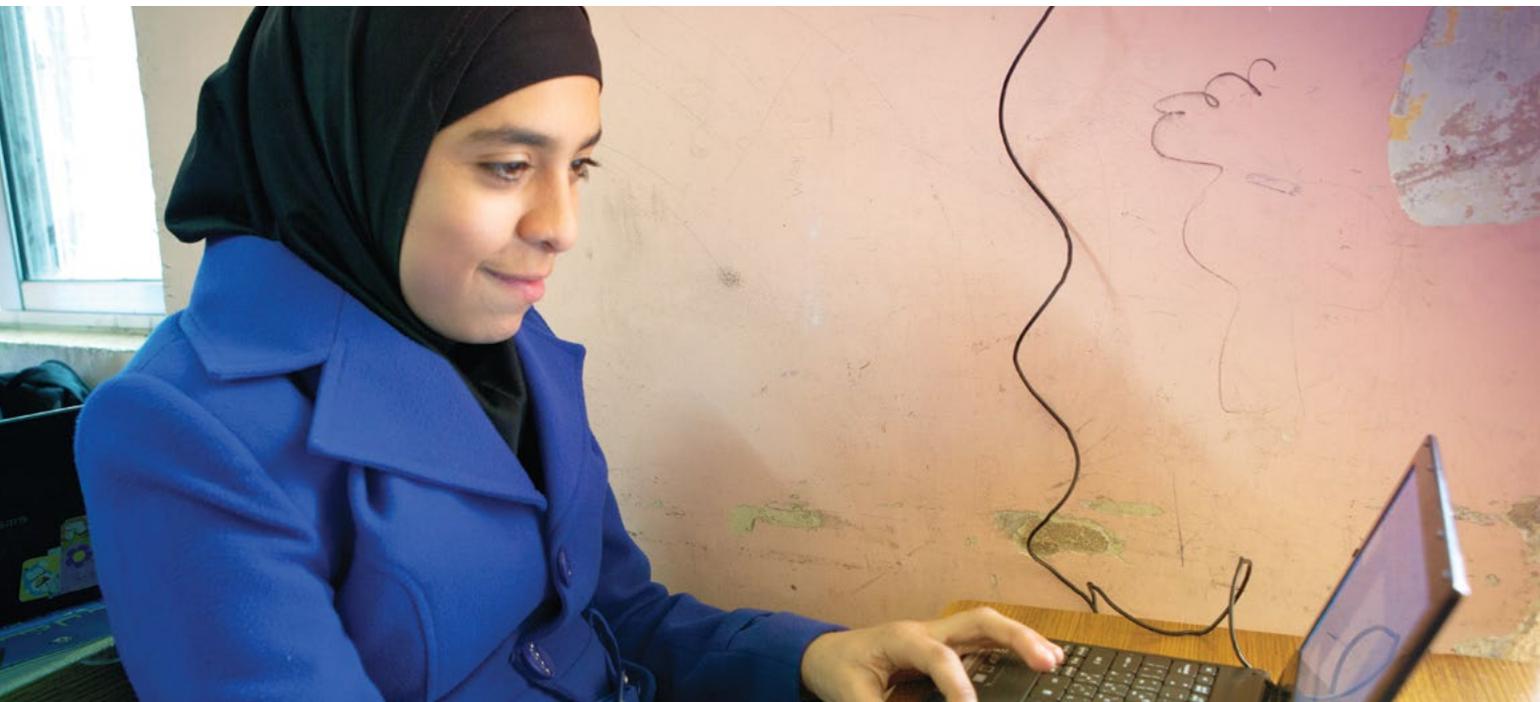
Potentially, parents trained and licensed as tutors, informal educators (e.g., museum staff, librarians) certified as coaches, and community members prepared and licensed as mentors can supplement what faculty do in campus settings.

Ultimately, the effectiveness of a mobile learning initiative depends on the quality of the educators involved. As discussed earlier, the innovation is not technology, but instead the empowerment of human performance through changing the ways education is structured and delivered. This type of professional development is very challenging because participants must not only learn new skills, but also “unlearn” almost unconscious beliefs, assumptions, and values about the nature of teaching, learning, and schooling. Professional development that requires unlearning necessitates high levels of emotional/social support in addition to mastering the intellectual/technical dimensions involved. The ideal form for this type of professional development is distributed learning communities, so that the learning process is consistent with the knowledge and culture to be acquired. In other words, faculty must experience technology-based learning as the medium of their professional development as well as its message.

The need for professional development that is tailored to faculty members’ busy schedules, that draws on valuable

resources not available locally, and that provides work-embedded support has stimulated the creation of online and blended professional development programs. Generally, these programs are available to faculty at their convenience and provide assistance. In addition, they often give universities access to experts and archival resources that fiscal and logistical constraints would otherwise limit. A range of objectives for educational improvement underlie these online professional development ventures, such as introducing new curricula, altering beliefs and instructional and assessment practices, changing campus organization and culture, and enhancing relationships between college and community.

In summary, to succeed, mobile learning initiatives must include professional development that meets these criteria and fosters educators’ capacity for connected teaching. The UTeach initiative discussed earlier illustrates this essential. Science and math college students who are pursuing secondary teacher certification are learning strategies for integrating mobile devices into their lesson plans. The combination of using tablets in their teacher preparation course work and in their field experiences in schools builds skills and confidence in connected teaching. The UTeach model is representative of both an innovation in teacher education and the criticality of ensuring that tomorrow’s teachers are well prepared to use mobile devices within instruction.



Securing buy-in from faculty and administration

Every innovation has conditions for success without which it cannot succeed. The effective use of antibiotics illustrates this concept: Antibiotics are a powerful innovation, but worshiping the vial that holds them, rubbing the ground-up pills all over one's body, or taking all the pills at once are ineffective strategies for usage – only administering pills at specified intervals works as an implementation strategy. A huge challenge faculty and college administrators face, and one of the reasons this field makes slower progress, is the complexity of conditions for success—and the sophistication of the processes necessary to achieve these conditions—required in effective interventions.

A crucial challenge for leadership in mobile learning initiatives is ensuring that their conditions for success are met at each implementation site. The concept of leadership is fraught with misconceptions. People often see leadership as a combination of meticulous management, adept political maneuvering, and responsive facilitation of others' activities. While each of these is important in advancing the field of educational technology, the true nature of leadership for mobile learning by faculty and administrators is exemplified by four attributes (Dede, 1993).

- **Leadership Requires Envisioning Opportunities.**

One of the most important attributes that distinguishes leaders from managers is “vision”: the ability to communicate desirable, achievable futures is quite different from where the present is drifting. Leaders create and convey compelling images of how our reach is much less than our potential grasp; they redefine people's paradigms about what is possible.

- **Leadership Requires Displacing Cherished**

Misconceptions. An important attribute of leaders is their ability to displace deeply held, cherished misconceptions with alternative visions that more accurately depict reality. Mistaken beliefs most people hold about teaching and learning form a barrier that blocks improving education, particularly for new models like mobile learning. Leadership requires packaging alternative assumptions and paradigms as part of a larger vision that inspires new roles for educational stakeholders.

- **Leadership Requires Inspiring Others to Act on**

Faith. Inspiring a group to work toward a shared vision necessitates building trust: faith that this team of people can overcome all the obstacles that block the creation of a future quite different from the present. We often speak of visions as “dreams” because we do not believe they are possible; we doubt that they can be made real. Actualizing a plan for the future involves harnessing people's emotions as well as their minds, developing both understanding and belief. Leaders build on the enthusiasm that mobile devices induce to encourage an affective climate that rewards risk-taking and accepts occasional failures as an inevitable byproduct of developing new approaches.

- **Leadership Requires Discouraging Followers.**

A destructive myth about leadership is that a visionary person gives directions to followers who execute this plan. Real leaders discourage followers, instead encouraging use of their visions as a foundation for other, better insights. True solutions to problems are always based on ideas from multiple perspectives; no individual, however capable, can incorporate the full range of knowledge and experience needed to invent an educational system that fulfills the needs of a diverse community. A leader in educational technology should inculcate others' visions, knowledge, and commitment to the point that all are jointly leading. This requires moving beyond the role of team facilitator or coordinator, acting as an exemplar by deliberately following others instead of always leading.

In summary, faculty and college administrators using these characteristics of leadership to meet the conditions for success required at each implementation site of a mobile learning initiative is crucial for its effectiveness. To achieve that goal, college administrators and faculty need to learn how to provide leadership support and guidance for their institutions.

The Georgia Regents University initiative on mobile gaming illustrates the importance of securing buy-in from faculty and administrators. Instructors are active in game design, piloting, and evaluation, drawing on their detailed knowledge of their subject matter and of how students best master that type of material. Without following this essential to develop buy-in, the edutainment games produced would likely not be academically effective, nor would a wide range of faculty incorporate these into their teaching.

Building personal learner efficacy and capacity for self-directed learning

As discussed earlier, two important characteristics of 21st century education are (1) personalized learning for each student in classroom settings and (2) life-wide learning outside the classroom and course meetings. The Software Information and Industry Association (SIIA) describes personalized learning as (Wolf, 2010, pg 6):

...ensuring that a student's educational path, curriculum, instruction, and schedule be personalized to meet her unique needs, inside and outside of school... through a wide range of resources and strategies appropriate for her learning style, abilities, and interests, as well as social, emotional, and physical situation.

The knowledge and skills students acquire from a mobile learning initiative should have intrapersonal and interpersonal dimensions, not just cognitive attributes. For example, mobile learning can foster academic engagement: sustained voluntary participation in pursuits related to learning academic knowledge (content, skills, culture), both in and out of classrooms (Lepper & Henderlong, 2000). This would not only encompass excitement about learning in science classes and in the extra-curricular robotics club, but also hobbies such as computer programming for fun (computational thinking), making clothing that is a mixture of textiles and electronics (engineering), or adeptly selecting players in fantasy sports leagues (statistical reasoning). Engagement is a mixture of states (e.g., using social media on a mobile device to collaborate with friends) and traits (e.g., approaching all new situations with intense curiosity about their causes). An individual's traits related to engagement are difficult to change, but can alter slowly based on experiencing a series of states that push in a particular direction (e.g., many children enter schooling curious about academic issues, but become disengaged after years of boredom).

Mobile learning can also help to build academic tenacity, another important capability for student success (US Department of Education, 2013). Pushing onward with learning even when not engaged in the moment is important because through persistent practice learners can reach

proficiency levels sufficient to “unlock” experiences that further increase engagement. For example, at a certain stage of sustained learning, foreign language students gain the proficiency of spontaneous conversation in the new language, which promotes a virtuous cycle of increased motivation (based on autonomy, flow, relevance...). Many types of academic engagement are characterized by this type of threshold, where attaining a level of fluency enables new forms of motivating experiences.

Sports are a good analogy: Practice is not fun, but succeeding in a competition is. Casual golfers may have fun in an intriguing hobby, but are unlikely to improve over time. In contrast, professional golfers put up with the rigors of training because they are motivated by competition, pursuit of excellence, fame, and fortune. Self-regulation includes strategies such as setting specific proximal goals, adopting powerful strategies for attaining the goals, monitoring one's performance selectively for signs of progress, restructuring one's physical and social context to make it compatible with one's goals, managing one's time use efficiently, and self-evaluating one's methods. Teenage gymnasts succeed through self-regulation to progress by endless grueling practice that is certainly not fun; sometimes coaches overdo the drills and the gymnast drops out because the rewards do not seem worth the struggle.

In summary, the relationship between momentary engagement, learning, and continued involvement through tenacity is complex, not simply reciprocal reinforcement. Mobile learning initiatives should be designed with an understanding of these motivational dimensions and issues. The EcoMOBILE augmented realities illustrate this essential. Teachers report that, in contrast to conventional field trips where students clump around the teacher and require detailed instructions about what to do next, in augmented realities learners seem themselves as autonomous scientists, exploring the ecosystem with on-demand guidance from the devices as necessary. The self-efficacy in science these students are developing indicates the importance of this essential in attaining deep educational outcomes both cognitively and affectively.



Measuring project results with meaningful metrics

In mobile initiatives, embedded, diagnostic measures of student learning formative for instruction are crucial for success; and summative assessments of student learning, along with other evaluative measures, are very important in determining the effectiveness of the initiative. Dede and Richards delineate the central role of technology in empowering these types of assessment in their 2012 book, *Digital teaching platforms: Customizing classroom learning for each student*.

Digital Teaching Platforms (DTPs) are a new kind of learning platform enabled by advances in theory, research and 1:1 computing infrastructures in classroom settings. This type of learning platform is designed to operate in an instructor-led classroom as the major carrier of the curriculum content and the primary instructional environment. A full-fledged DTP enables personalization through three major aspects of classrooms that have 1-1 student/computer ratios:

- First, a DTP is a networked digital portal that includes interactive interfaces for both faculty and students. To use a DTP, each student and the instructor have a mobile device connected to the network. Faculty use the administrative tools of the DTP to create lessons and assignments for students, and to manage and evaluate the work the students return. These capabilities include specific tools for assessment: for creating tests and other types of measures, assigning them to students, and reviewing the results. The instructor tools also provide timely reports on student progress and on their remedial needs. The administrative tools for students allow them to complete assignments and assessments. More important, these tools allow for both individual and group work: some students can work independently on individualized assignments, while others work collaboratively on shared assignments.
- Second, a DTP provides the content of the curriculum and assessments for teaching and learning in digital form. This content includes the material in the curriculum, the instructional strategies, the exercises, and the assessments. The content includes interactive elements, manipulative activities, special-purpose applications,

and multimedia materials. If developed in a format suitable for the DTP, faculty can add additional content and assessments.

- Third, a DTP supports real-time, instructor-directed interaction in the classroom. The system includes special tools for managing classroom activity; monitoring progress on assignments; displaying student work to the entire class, displaying demonstrations and challenges on an interactive whiteboard or similar device; managing group discussions; and coordinating large-group and small-group activities. The DTP is an assistant for all the types of instructional activities an instructor might wish to implement. All of these features of a DTP are designed to function effectively in the give-and-take atmosphere of a classroom. The instructor can shift quickly from large-group demonstrations, to small-group activities, to individualized practice and assessment. Students move seamlessly from using their devices for these activities to ignoring their laptops and participating in discussions. The instructor is fully in control of student activities by giving assignments, mentoring individuals, and leading discussions.

Through this suite of capabilities, the system provides support for a shift in teaching and learning away from one-size-fits-all presentational/assimilative instruction and high stakes assessment to instead personalized active learning with embedded assessments that provide continuous diagnostic feedback tailored to each student. Although mobile devices do not at present support all of these functions, they can be an important aspect of a DTP and provide a stepping-stone towards this vision of integrated instruction and assessment. In planning mobile learning initiatives, it is important to see today's mobile devices, which will rapidly become more powerful, as a transitional step towards strategic goals.

Beyond the use of mobile devices to enable more sophisticated forms of assessment, the evaluation of mobile learning projects is critical for understanding first, if the project met the learning goals that were established as the foundation for the implementation, and second, what



can be done to improve outcomes in the next iteration of the project. Too often, an evaluation of the mobile learning project is an afterthought or something that is valued only for its role in funding compliance. Due to the twin issues of complexity and potential associated with mobile learning projects, it is imperative that a mobile project evaluation plan meet the following specific criteria to collect and report on meaningful metrics:

1. The evaluation plan should be an **inherent part of the overall project planning** from the first discussions about the project goals to implementation strategies.
2. The identification of the project goals should be a **shared exercise with key stakeholders** so that the buy-in is evident not only for the implementation efforts but also for the data collection processes as well.
3. The types of evaluation data or metrics that are used to evaluate project impact should be **contextualized to the local environment** of the school or community. One size definitely does not fit all with mobile learning projects. Since the transformative potential of mobile is within the personalization of the learning environment, the evaluation processes should reflect that ethos as well.
4. Evaluation results should not be based solely upon an examination of student achievement data. A successful mobile implementation should be seamlessly integrated within the classroom environment. Therefore, the evaluation process should take into account the **overall lived experiences of the students and the teachers** in that classroom. As evident by many recent mobile learning evaluations, a meaningful measure of the impact of a mobile learning project focuses on how the features and functionality of the mobile devices create an environment for increased teacher effectiveness, a proven foundation for increased student achievement.
5. The evaluation plan should report on a **variety of outcomes and the lessons learned**. While there is public benefit in reporting on quantitative results of a project it is within the lessons learned from the experience that the school or district can build capacity and sustainability for the benefits realized through the mobile project implementation.

In summary, in contrast to other technologies being used in the classroom, the discussion of meaningful metrics involves both the use of mobile devices as data collection tools, as well as the focus of evaluating project goals around student learning outcomes and instructor effectiveness.

As noted in other mobile learning examples, project purpose and explicit learning goals drive the determination of the appropriate metrics for evaluating impact. The QLearn case study is representative of this approach as well. Student performance was of paramount importance in the blended learning environment at the state university in Northern California. The goal of incorporating the QLearn apps was to provide operational support to the students to enhance their learning experience and ultimately, their learning outcomes. The identification of specific metrics such as course grades, percentage of students that passed the course, and student attitudes about the mobile-enabled experience were aligned with the overall objectives of the state university.

Creating an ecosystem that is sustainable and scalable

As an overarching goal, Wireless Reach selects which projects to fund in part on their potential for scalability and sustainability. Research has documented that in education, unlike other sectors of society, the scaling of successful instructional programs from a few settings to widespread

use across a range of contexts is very difficult, even for innovations that are economically and logistically practical (Dede, Honan, & Peters, 2005). In fact, research findings typically show substantial influence of contextual variables (e.g., the instructor’s content preparation, students’ self-efficacy, and prior academic achievement) in shaping the desirability, practicality, and effectiveness of educational interventions. Therefore, achieving scale in education requires designs that can flexibly adapt to effective use in a wide variety of contexts across a spectrum of learners and faculty. Clarke and Dede (2009) document the application of a five-dimensional framework for scaling up to the implementation of the River City multi-user virtual environment for middle school science:

- **Depth:** evaluation and design-based research to understand and enhance causes of effectiveness
- **Sustainability:** “robust design” to enable adapting to inhospitable contexts
- **Spread:** modifying to retain effectiveness while reducing resources and expertise required
- **Shift:** moving beyond “brand” to support users as co-evaluators and co-designers
- **Evolution:** learning from users’ adaptations to rethink the innovation’s design model



The UTeach initiative illustrates the important of sustainability and scalability as an essential. The UTeach model of preparing pre-service teachers for mobile learning has grown to eight universities and continues to expand. To succeed in adding partners and in continuing its impact on participating institutions, UTech must adapt to the various institutional contexts in which it is implemented (sustainability), make entry into the program easy (spread), and help faculty take ownership of the redesigned courses (shift). That the UTeach initiative is expanding illustrates the importance of this essential for long-term impact on education.

Summary Thoughts - Lessons Learned for Higher Education Administrators and Faculty

As the case studies in this paper document, always-on, always-connected, smartphones and tablets have the power to transform teaching and learning in many ways, across the world. Students, faculty, and university leaders may want to implement mobile learning; but providing the devices is only a first step in enabling learning anyplace, anytime for every student. Reaching the full potential of mobile learning requires going beyond the classroom and course meeting time to provide 24/7 access to digital curriculum that is

highly personalized with respect to level, pace, and students' strengths and preferences. This is essential as a driver for growth, economic prosperity, and the advancement of both developed and developing countries, giving all students the opportunity to learn, prepare for good jobs, and participate in our global economy.

Through its Wireless Reach and QLearn initiatives, Qualcomm has developed eight essential strategies that can help innovators achieve success in their mobile learning initiatives. Not every project need implement all eight strategies to succeed; rather, each initiative should use combinations of strategies that meet the needs of its local context. The descriptions and case studies in this paper are designed to help innovators understand each strategy and its role in an overall model for innovation in mobile learning. That such a wide range of educators worldwide have succeeded in their Wireless Reach projects using these strategies shows that any group can benefit from this approach.

We hope that you will be empowered by this paper to move forward with your mobile learning initiative, realizing the full potential of smartphones, tablets, and mobile broadband. We look forward to hearing about your successes and adding to the casebook of illustrations that show how mobile learning can benefit all students, helping transform education for the 21st century.

Always on, always-connected smartphones and tablets have the power to transform teaching and learning in many ways across the world.

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