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MOBILE LEARNING FOR TEACHERS

IN NORTH AMERICA

> Exploring the Potential
of Mobile Technologies
to Support Teachers and
Improve Practice

TEACHER
FOCUS

UNESCO
Working Paper
Series on Mobile
Learning

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ABOUT THE SERIES

This paper is part of the UNESCO Working Paper Series on Mobile Learning. The Series seeks to better understand how mobile technologies can be used to improve educational access, equity and quality around the world. It comprises fourteen individual papers that will be published throughout 2012.

The Series is divided into two broad subsets: six papers examine mobile learning initiatives and their policy implications, and six papers examine how mobile technologies can support teachers and improve their practice.

Within the two subsets there are five geographical divisions: Africa and the Middle East, Asia, Europe, Latin America, and North America. Each subset also contains a 'Global Themes' paper that synthesizes central findings from the five regional papers.

Two additional 'Issues' papers round out the Series. One paper highlights characteristics shared by successful mobile learning initiatives and identifies supportive policies. A separate paper discusses how mobile technologies are likely to impact education in the future.

As a whole, the Series provides a current snapshot of mobile learning efforts around the world. Collectively and individually, the papers consolidate lessons learned in different regions to provide policy-makers, educators and other stakeholders with a valuable tool for leveraging mobile technology to enhance learning, both now and in the future.

UNESCO has plans to add additional titles to the Series after 2012. The Organization hopes that these resources will help diverse audiences better understand the educational potential of mobile technologies.

To access existing and forthcoming titles in the Series, please see:
<http://www.unesco.org/new/en/unesco/themes/icts/m4ed/>

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Teachers in the United States and Canada participate in professional development (PD) to expand their knowledge and understanding of pedagogy and content. In recent years, the prevalence of technology in schools and the increased availability of digital content and resources have resulted in more PD opportunities focused on the use of technology. While PD often occurs in an online environment, teachers in North America rarely use mobile devices to access online PD, and they are just beginning to participate in PD geared toward using mobile technologies in the classroom. Though mobile learning is still an emergent field, educators are starting to recognize the potential of mobile technologies to deliver PD that is job-embedded, ongoing, sustainable, flexible, personalized and available anywhere at any time.

This paper examines and provides examples of three distinct approaches to mobile learning in PD. First, mobile technologies are used to deliver and enhance PD for teachers. Examples of this type of mobile learning include online courses, mentoring via mobile devices, and participation in online professional communities. Second, mobile technologies can be used to support teachers by streamlining administrative tasks, enhancing classroom instruction, and facilitating communication with parents, colleagues and students. Finally, PD may be focused on teaching educators how to integrate mobile technologies into their classroom instruction. While mobile learning in North America is by no means widespread, a number of schools and districts have implemented innovative PD programmes using mobile technologies, which may serve as a model for future efforts. Based on these examples and a review of the relevant literature, this paper offers several recommendations for developing PD focused on mobile learning or using mobile devices to deliver PD. These include moving from one-size-fits-all to personalized PD; focusing PD on changing pedagogy rather than training teachers to use new technologies; using mobile technologies to make PD accessible during teachers' naturally occurring downtime; and setting aside time for collaboration among teachers in a school or district.

Mobile learning represents an exciting opportunity for educators in North America to expand their professional learning through increased access to instructors, mentors, supervisors and peers, as well as online content and resources. Also, PD specifically focused on using mobile technologies for instruction can help teachers increase student achievement and better meet their students' needs. Through careful planning and implementation, schools and districts in the United States and Canada can develop mobile learning PD programmes that support teachers, improve practice and enhance learning for students and teachers alike.

Research has shown that teacher quality is the single most important school variable influencing student achievement (Hanushek, 2004). In addition to comprehensive pre-service training, rigorous professional development (PD) is essential to prepare highly qualified teachers for the daily demands of the classroom. In the context of education, PD usually refers to in-service training and continuing education, in a formal or informal setting, which teachers use to increase their pedagogical and content knowledge and improve their practice. Typical examples of PD for teachers in North America include workshops, conferences, courses, mentorship and participation in professional communities. Pre-service teacher education – the coursework and practical training required to become a teacher, which varies by state and province – is sometimes considered part of PD; however, for the purposes of this paper, PD will be used to refer to educational opportunities for in-service teachers only.

PD aims to help teachers enhance their instruction and improve student outcomes, and it is often required for recertification. While the amount of time devoted to PD can vary widely, teachers in the United States typically spend between thirty-three and fifty-six hours per year on PD (Wei et al., 2010). PD can be formal or informal; ongoing or finite in nature; and delivered in person, online or through blended learning, a hybrid approach that mixes face-to-face and online instruction. Recently, due to the pervasiveness of smartphones and other mobile devices in North America, some educators in the USA and Canada have begun using mobile technologies to access online and blended PD.

Mobile learning is still an emergent field, and the use of mobile devices for PD and teacher support in North America is not well-documented (Ally and Palalas, in press). According to representatives of the schools, districts and organizations surveyed for this paper, teachers in the USA and Canada are just beginning to learn how to use mobile technologies in classrooms, and the number of teachers accessing PD through mobile devices is small. A recent Canadian study reported that mobile devices are not used as frequently in the education and training sectors as they are in other industries (Ally, 2009). Although most Canadians own a mobile device, the majority do not use technology for learning; in a recent survey, 47% of employers said that less than half of their employees use mobile devices for either formal or informal learning (Ally and Palalas, in press). Nevertheless, because so many teachers own mobile devices, educators are hopeful about the potential of mobile technologies to widen the range of PD opportunities available.

Mobile learning has the potential to both increase teachers' access to PD and improve the quality of in-service training and support. The leaders of organizations that focus on teacher training have described mobile technology and digital learning as important components of PD. Melinda George, vice president and chief operating officer of the National Commission on Teaching and America's Future (NCTAF), said:

We know that PD can no longer only consist of a teacher being pulled out of the classroom and attending a one-size-fits-all PD session. To be effective, PD needs to be ongoing and sustained and supported by collaboration and teamwork among educators. Mobile technologies allow for team members and their resources to be piped in to the teacher as needed, wherever and whenever the

teacher is teaching. These are the devices that are going to take collaboration and effective teaching to a whole new level. (personal communication, 12 October 2011)

Mobile devices can enable teachers to participate in PD more frequently and with more flexibility than traditional training sessions that are constrained to a particular time and place. They can also strengthen collaborative PD by facilitating communication among peers and mentors. Many education leaders anticipate that teachers will soon be using mobile technologies to access widespread professional communities and engage in collaborative learning online (Bjerede et al., 2010).

According to Learning Forward, an international non-profit association focused on professional learning for teachers, PD is a process of continuous improvement for teachers and principals that both transforms practice and increases student achievement. The association stresses that effective professional learning builds collective responsibility among educators within a school (Killion, 2011). For example, a principal might find that aligning PD with the focus areas identified in the school's three-year improvement plan increases teachers' investment in the plan and helps them understand how their teaching practice fits into the larger school goals. This shared sense of responsibility, in which teachers feel they are part of a team, is best cultivated through collaborative approaches to PD, including mentoring and participation in professional learning communities (PLCs) and communities of practice (CoPs) – formal and informal groups dedicated to improving knowledge within a shared profession. Mobile technologies can support and facilitate each of these approaches. For example, in the mentoring model, a new teacher paired with an experienced teacher-mentor can benefit from more regular contact with his or her mentor via text messaging. The pair can also increase the number of lessons the mentor observes by recording, uploading and sharing video through mobile devices, which allows the mentor to provide frequent and immediate feedback. Teachers who participate in PLCs and CoPs can use mobile technologies to communicate and collaborate with peers; pose questions and discuss ideas; and share videos, lesson plans, presentations and other resources quickly and easily.

Another important component of PD is focused on the instructional use of mobile technologies in the classroom. Mobile learning efforts in schools often represent a paradigm shift for teachers and students; as instructional activities become more student-driven, the teacher's role becomes less about imparting knowledge than facilitating learning – teaching students to teach themselves. While most teachers would agree with the goal of creating life-long learners, many may be sceptical about using mobile technology to achieve this goal. PD that incorporates mobile technologies can increase teacher buy-in by allowing teachers to experience mobile learning from a student's perspective. Ideally, PD focused on mobile technologies should facilitate a shift toward active, student-centred learning and provide concrete examples of how mobile devices can be used to support this approach.

This paper explores three aspects of mobile learning for teachers in North America: (1) the use of mobile technologies for professional development; (2) the use of mobile technologies for teacher support; and (3) professional development on the instructional use of mobile technologies in schools. For the purposes of this paper, professional development for teachers refers to learning opportunities for in-service teachers and includes formal or informal instruction, mentoring and participation in professional communities, while teacher support is loosely defined as any programme, feature or activity that makes a teacher's job easier or more satisfying. Individual sections describe the various approaches to mobile learning in PD

and teacher support, and analyse their strengths and weaknesses. The paper also identifies factors that can promote or hinder mobile learning for teachers, and concludes with recommendations for implementing successful mobile learning programmes to support teachers and improve practice.

METHODOLOGY

Data for this paper were collected in late 2011 through an in-depth literature review; interviews with educational leaders at the national, state and provincial, and local levels; and an email survey. The national organizations selected to participate were chosen because they were among the most authoritative agencies in the field they represent. See Table 1 for a list of organizations that participated in this review. The school districts and universities were chosen because they have implemented programmes or initiatives that include mobile technologies. Representatives from the districts and universities listed in Table 2 were interviewed for this review. See Appendix A for a list of individuals interviewed.

Table 1. National organizations that participated in this review

American Association of Colleges for Teacher Education
Apple
Consortium for School Networking
International Society for Technology in Education
Learning Forward
National Association of State Boards of Education
National Commission on Teaching and America's Future
Project Tomorrow
Qualcomm
US Department of Education

Table 2. School districts and universities represented in this review

Abilene Christian University, Texas
Canby School District, Oregon
Fairfax County Public Schools, Virginia
Forsyth County School District, Georgia
Homewood City Schools, Alabama
Katy Independent School District, Texas
The Country School, Maryland
Radford University, Virginia
Rockdale Independent School District, Texas
Saddleback Unified School District, California
Shelby County Schools, Alabama
St. Mary's School, Ohio

An online survey was sent via email to the departments of education in all US states and the District of Columbia, and to the ministries of education in all Canadian provinces between September and December 2011. For a copy of the survey, see Appendix B. Of the sixty-four

surveys sent, twenty were returned. Representatives from sixteen US states, the District of Columbia and three Canadian provinces completed the survey. See Table 3 for a list of the states and provinces that provided survey responses.

Table 3. States and provinces that participated in the survey

United States	United States (cont.)
Arkansas	New Jersey
California	New York
Delaware	Ohio
Illinois	South Dakota
Iowa	Vermont
Kansas	Washington
Maine	
Michigan	Canada
Nebraska	Alberta
Nevada	Manitoba
New Hampshire	Ontario

Although tablet devices are being used in education and PD, this study is limited to mobile phones and similar hand-held devices because of their lower cost and greater mobility. This review is not intended to include every example of PD using mobile technologies but rather to provide a representative picture of current mobile learning efforts for teachers in North America.

APPROACHES TO MOBILE LEARNING FOR TEACHERS

Research on professional development provides an important backdrop for the findings and examples presented in this paper. While little documentation exists on the use of mobile technologies in PD, there is a large body of research on what constitutes effective PD for teachers. According to Learning Forward, PD should be ongoing, intensive, connected to practice and school initiatives, focused on specific academic content, and designed to build strong working relationships among teachers (Darling-Hammond et al., 2009). Rigorous scientific studies have shown that when high-quality PD approaches are sustained by fifty or more hours of support per year, student test scores rise by an average of 21% (Darling-Hammond et al., 2009). PD specific to technology is also important; Canadian research on information and communications technology (ICT) found that effective classroom ICT integration occurs through needs-based, collaborative PD, while another research review affirmed that PD is needed to improve student learning while integrating technology (Ringstaff and Kelley, 2002). A recent US study indicated that teachers consider learning more about technology use in the classroom a top priority for PD (Darling-Hammond et al., 2009).

PD and mobile learning intersect in three main areas: using mobile technologies for PD; using mobile technologies for teacher support; and PD on the instructional use of mobile technology. The following sections describe the different approaches to mobile learning in each of these areas.

USING MOBILE TECHNOLOGIES FOR PROFESSIONAL DEVELOPMENT

PD opportunities in North America fall roughly into three main categories: instruction, mentoring and participation in professional communities. Mobile technologies can be used to support each type of PD by enhancing face-to-face instruction and increasing access to online courses or blended learning experiences; improving communication between teachers and mentors; and facilitating participation in online communities.

INSTRUCTION

FACE-TO-FACE INSTRUCTION

Face-to-face instruction is the most common delivery method for PD in the United States and Canada. While mobile technologies are not generally used in face-to-face PD, this review found one exception: using mobile devices as response systems. Taking advantage of the mobile devices that most teachers already own, a PD instructor can elicit responses and feedback from participants in real time and modify instruction accordingly. This use of mobile

devices in teacher training creates opportunities for formative assessment that were previously unavailable. Specific examples of mobile devices being used in this way include Poll Everywhere, an audience response system that uses mobile phones, Twitter and the internet. Education leaders in the US state of California and the Canadian provinces of Alberta and Manitoba reported using Poll Everywhere in combination with Google applications to enable teachers participating in PD to provide instant feedback and responses to their instructors.

ONLINE COURSES

Research indicates that online learning can be as effective as – or in some cases more effective than – traditional place-bound learning (Killion, 2011). Once considered a poor substitute for face-to-face learning, online learning is shedding its reputation for dubious quality and lack of oversight and is growing increasingly popular in North America. In Canada, K–12 (kindergarten through Grade 12) distance education enrolment in 2010 was estimated to be between 150,000 and 175,000 students (Barbour, 2010); in the United States in 2009, it was estimated at more than three million (Horn and Staker, 2011). While not as pervasive as the online learning offered to K–12 students, online PD for teachers seems likely to expand given how rapidly students are engaging in online learning. Indeed, the number of online learning platforms for PD is increasing steadily, and school districts are making substantial investments in expanding opportunities for online PD (Killion, 2011).

Online PD courses offer educators ongoing learning opportunities and provide access to experts and resources that might otherwise be cost-prohibitive or limited by geographical restraints (Dede et al., 2009). Although online PD may involve some expenses, such as instructor fees or licensing for the course management system used to deliver instruction, the overall cost is substantially less for online options, as they do not require the school or district to rent meeting rooms, purchase projection equipment, or hire substitute teachers for the time teachers spend in traditional PD sessions, which are typically conducted during school hours. Because it is less expensive than face-to-face instruction, online PD can be sustained over longer periods of time, offering continuous support to teachers. Also, since online PD is accessible at any time of the day or week, it is not contingent on the alignment of participants' schedules, which can often be difficult to coordinate. The flexibility and low cost of online PD can make participation feasible in situations where face-to-face instruction is not an option.

Current online PD courses are typically accessible via computers rather than smartphones. However, some companies have developed mobile applications to complement their online professional learning platforms; examples include Blackboard Mobile, Adobe Connect Mobile and PD 360. In addition to providing access to course documents and discussions, these mobile applications enable teachers to participate in multipoint video conferences using the mobile device's camera. They also allow instructors to control attendee access rights and privileges. While these types of mobile PD options are still developing and are certainly not the norm, they have the potential to greatly improve the quality of online learning and expand teachers' access to online PD opportunities. For example, a rural vocational education teacher who is getting recertified to teach car mechanics could participate in an online course taught by an instructor in another part of the country. Rather than being tethered to a desktop computer or laptop when he is showing participants how to work on a part of the car's engine that is not easily accessible, the instructor could connect to Adobe Connect Mobile through his smartphone and use video capture to demonstrate a specific skill. Meanwhile, the rural

vocational teacher would be able to participate in the course using her mobile device at times when she does not have access to a computer. While these mobile applications are robust in their functionality, they do require high bandwidth, which may limit their usefulness in some instances.

BLENDING LEARNING

Blended learning combines online delivery with certain features of face-to-face learning to allow for personalization and differentiation of instruction. The use of blended instruction in education has been growing for some time, especially at the postsecondary level. In a 2003–04 survey, 93% of college instructors and administrators reporting having used blended learning strategies in some way, and 70% expected nearly half of their schools' courses to be taught using blended instruction by 2013 (Bonk and Graham, 2006). Although blended learning is a viable PD delivery format in practice today, its integration with mobile technologies has been slow. The individuals surveyed and interviewed for this paper could not point to specific instances of blended PD using mobile technologies. However, one innovative programme being implemented for pre-service teacher training deserves mention here, as it may provide a model for in-service PD.

Building on the success of its initial Teachers Learning in Networked Communities (TLINC) project, the National Commission on Teaching and America's Future launched the TLINC 2.0 project during the 2011–12 school year to enable a group of pre-service student teachers to work with peers, mentors and colleagues in a 'blended collaborative learning community' (NCTAF, 2011). Teachers in the initial cohort have been provided with mobile devices for their student teaching internships to allow for 'anytime/anywhere access to resources, including college faculty, peers, and collaborating teachers.' They have 24/7 access to a network of collaborative tools and are able use their mobile devices to locate content-specific resources designed to accommodate a wide variety of learning styles and student needs. TLINC 2.0 also facilitates classroom observations conducted via video, which expands the possibilities for mentoring and feedback. This project has the potential to promote the use of mobile technologies in education as new teachers become mobile learning 'experts' in their schools, mentoring other teachers and facilitating the cultural shift toward meaningful integration of mobile technologies into teaching and PD (NCTAF, 2011).

MENTORING

Mentoring is a formal model for professional learning that pairs a new or developing teacher with a peer mentor, usually in the same content area or grade level, who provides support, feedback and assistance. The benefits of mentoring are well-documented: it is an effective way of providing one-on-one, job-embedded and personalized PD (Joyce and Showers, 1983; 1995; 2002). However, mentoring is very expensive and time-consuming. Mentors are often district teachers who are released from their teaching duties on a part-time or full-time basis to observe and meet with new teachers, requiring the district to hire substitute or replacement teachers to cover the time devoted to mentorship. Mentors hired from outside the school require an additional salary, while teachers within the school who take on mentorship duties are usually paid a supplementary stipend. Because of these personnel costs, many schools and districts do not have the financial capacity to provide this kind of PD. Mobile technologies may be able to alleviate some of the costs of mentoring by increasing the

number of new teachers a mentor can support and reducing the time required for observations and meetings. For example, by conducting video observations and sending feedback via mobile devices, a mentor could potentially provide more frequent feedback while reducing travel time between classrooms and schools. Not only is this arrangement more convenient from a logistical perspective, but it may also improve the quality of feedback by allowing the mentor to pause and replay the video, something that is not possible in live observations. Mentoring using mobile technologies can also strengthen the level of support teachers receive by facilitating more regular communication between teachers and mentors.

Mobile technologies can also facilitate video observations in pre-service teacher training. Teacher education programmes commonly require teachers to record their lessons for evaluation by professors, supervisors and classmates as well as for self-assessment. Because many smartphones are now equipped with powerful cameras and microphones, pre-service teachers can use mobile devices in lieu of more expensive video cameras to film themselves teaching a lesson or lesson segment. The lesson can be viewed in real time, using mobile web-conferencing, or the student can upload the video to a server for professors and peers to access at their convenience. Regularly uploading observation videos creates an archive of student performance that professors can use to conduct authentic assessments and provide feedback based on actual classroom experiences. This approach to observation is also practical, as it requires only high bandwidth, Wi-Fi access and a mid-range smartphone.

Two mobile applications – Observation 360 and GoObserve – have been designed specifically for classroom observations using smartphone and tablet devices. With Observation 360, a mentor or administrator can use a mobile device to enter comments electronically during an observation, link the comments to the observation video, and immediately send the teacher a copy that is also backed up and secured in an online environment. These videos can follow the teacher throughout his or her career and can be accessed by other district officials as necessary. The GoObserve mobile application allows mentors and administrators to sync the program with a calendar to schedule observations and send reminders about scheduled sessions. School principals and mentors can also save time during the observation by selecting from a variety of preset phrases and notes. GoObserve automatically generates reports that can be exported to computers or other mobile devices.

PROFESSIONAL COMMUNITIES

By far the most common use of mobile technologies in PD is for participation in online professional communities. Teachers engaged in this type of PD may choose to join online PLCs and CoPs, or they may access less formal professional communities through social networking sites. Online content repositories can also give teachers access to a wide variety of tools for professional growth and may substitute for more formal professional learning when funding for PD is scarce.

ONLINE PLCS AND COPS

PLCs and CoPs are similar, but there are important distinctions between the two. According to Learning Forward's Standards for Professional Learning, a PLC is a formal learning community composed of members who take collective responsibility for the learning of all the students served by its members (Learning Forward, 2011). Learning teams, which usually consist of

four to eight teacher members, meet regularly to examine curriculum standards, plan more effective lessons, critique student work and develop solutions to problems that arise with individual students or groups of students. For example, a team of fourth-grade teachers might form a PLC focused on infusing twenty-first century skills into the curriculum. After assessing their students' current level of performance, the teachers would convene to create or modify existing lessons to address the areas in which students needed improvement. They would implement the lessons and then collaboratively analyse the students' work for evidence of learning. In cases where expectations were not met, they would strategize ways to improve student outcomes. The cycle of planning, implementing and assessing could continue indefinitely.

CoPs, by contrast, are groups of people who share a concern or passion for something they do and want to learn how to do it better through regular interaction. Three components characterize a CoP: (1) the domain, (2) the community, and (3) the practice (Wenger, 2009). The domain represents members' shared area of interest, commitment and competence. The community is the social dimension in which members engage with each other. This social engagement is the hallmark of a genuine CoP. The third component, the practice, is reflected in the members' development of resources and strategies to define and improve the aspect of their profession in which they share a common interest. In education, a CoP refers to a community of teachers convening to talk about a shared professional interest. While PLCs are intentional, focused and results-based, CoPs tend to be much less structured.

In the United States, approximately one-quarter of all K–12 educators belong to at least one online professional community through which they seek information, share, collaborate and connect (PBS and Grunwald Associates, 2011). Online PLCs and CoPs are especially beneficial for teachers who feel isolated because they work in rural areas or teach a low-incidence subject, such as physical education or music, with no colleagues in their content area at their school or district (Killion, 2011). For example, a special education teacher who has a student with Tourette syndrome might be struggling to find a colleague at her school who can relate to her experience and offer useful advice. She can join an online CoP designed for teachers of students with Tourette syndrome that will connect her with other educators who have experience teaching students with this disability. Through an online forum, she can ask questions, share ideas and strategies, and gain access to a digital library of helpful resources compiled by the group's members.

The US Department of Education (USDOE) recognizes the value of building systems for peer-to-peer professional learning. The USDOE's 2010 National Education Technology Plan (NETP), *Transforming American Education: Learning Powered by Technology*, outlines a vision for a highly connected teacher who is empowered by continuous access not only to digital content, tools and resources but also to experts and peers who can offer immediate assistance, unrestricted by geographic boundaries (USDOE, 2010). In addition to emphasizing peer connectedness in the NETP, the USDOE also recently launched a project specifically dedicated to CoPs. The Connected Online Communities of Practice (COCP) project aims to increase the quality, accessibility and effectiveness of online CoPs. Project activities include launching new online CoPs, conducting research into CoP use and content, and developing new designs and infrastructure for CoPs to better facilitate connections among educators. The Canadian government also supports several online CoPs, such as 2Learn.ca, backed by the Ministry of Education of Alberta, and Learning Connections, sponsored by Ontario's Ministry of Education. In addition, several non-profit CoPs have been started by non-governmental

organizations (NGOs); these include SIGML, created by a special internet group within the International Society for Technology in Education centred on mobile learning, and Classroom 2.0, a practitioner-created CoP.

The government support for online professional communities and the number of educators participating in them are a strong indication of the potential benefits of online PLCs and CoPs. However, this type of online PD also poses some challenges. The quality of each group depends on the competence and commitment of its members. Although the online community might be created or managed by an expert or authority in the field, it relies primarily on the contributions of the participants. Joellen Killion, deputy executive director of Learning Forward, expressed concerns that collaboration in these groups might not always be based on best practices, and said that participants need to think critically about the source of any information (personal communication, 26 October 2011). In addition, registration procedures, which typically require participants to create an account with a user ID and password, can create barriers to participation. Participants registered on multiple sites are also burdened with updating their information in several different places as their interests and experiences change. Finally, the informal nature of online communities can imply a lack of rigor, which affects their perceived legitimacy as PD options. While some schools and districts may encourage teachers to participate in professional communities, educators in the USA typically earn ‘no formal credit or even informal validation’ for participating in PLCs and CoPs (USDOE, 2011). Failure to legitimize professional learning that occurs in an informal manner could represent a missed opportunity to encourage professional inquiry and improve teaching practices. In Canada, for example, adults spend more time on informal learning than on formal learning; withholding credit for the former means discounting a large portion of the time people spend engaged in professional learning (Livingston, 2000).

Mobile technologies provide an additional access point to online PLCs and CoPs. The portability of mobile devices and their 24/7 connectivity enable teachers to participate in online communities at any time and from virtually any location, without the need for a computer or laptop. This flexibility allows teachers to engage in professional learning in small, five- to ten-minute intervals, taking advantage of short breaks in their schedule. The technology offered by mobile devices can also help facilitate interactions between members of professional communities. For example, a new teacher who belongs to a PLC might be struggling to transition students from the time they enter the classroom to the time when instruction should begin. She would like the members of her PLC to be able to see exactly what is happening in the classroom, but it is not feasible for them to visit her class, nor is there any guarantee that the students would behave in the same way with a crowd of observers present. As a solution, she could use a free video-conferencing application on her mobile device to allow the members of her PLC to observe the techniques she uses with students. On the basis of those observations, her peers might be able to offer recommendations for other techniques that may be more effective.

Some online PLCs and CoPs have also developed mobile applications to allow users to download lesson plans, assessments, audio files and videos; rate digital content; comment on resources; and share resources with others, all from their mobile device. In Shelby County Schools, a large school district in Alabama, educators are using a mobile application to access Edmodo, an online social network for K–12 education that hosts the district’s PLCs. PLC members use their mobile devices for communicating and collaborating, which cuts down on face-to-face meetings that can be difficult to schedule. When teachers do meet in person, they

are able to accomplish more because they have been engaging in an ongoing dialogue online. Additionally, an administrator can join the PLC via mobile device, observe the group's activities and make comments without having to attend all of the meetings. The administrator can gauge the tenor of the conversations and use specific comments to address any frustrations or issues that arise. Teachers can pose questions to the administrator who can in turn provide feedback, all via mobile devices. This typically gives teachers more access to their administrator, who is rarely available to attend meetings in person (L. Woolley, personal communication, 5 December 2011).

SOCIAL NETWORKING SITES

According to a 2011 study, 65% of all adult internet users in the United States participate in online social networking (Pew Research Center, 2011). A 2008 Canadian study revealed that 14% of adult wireless users access social networking sites through their mobile devices (Harris/Decima, 2008). These statistics imply that many teachers are already familiar with some of the most commonly frequented social networking sites, such as Facebook, Twitter and LinkedIn, and that they know how to access them using mobile technologies. Although these sites were not designed with teacher collaboration and professional growth in mind, teachers often use them to engage in informal professional learning. For example, teachers 'follow' prominent education leaders on Twitter, 'like' or 'friend' educators and educational organizations on Facebook, and connect with colleagues and join education-related groups on LinkedIn. These informal connections represent significant opportunities for professional growth.

One advantage of social networking sites is that they allow for personalized learning: in most cases, the teacher self-selects the people or groups with whom to connect, depending on his or her own needs and interests. Members can serve as a sounding board for classroom issues, and teachers can ask specific questions. The 24/7 availability of social networking sites is appealing because it gives teachers the freedom to participate on their own schedules. The sites can be accessed for any increment of time, from a large block to a few minutes. They also typically make it very easy to add groups or people of interest, usually requiring no further login or commitment, and teachers can remove themselves from groups at any time. As a final benefit, most social networking services are free.

Nevertheless, the use of social networks for professional learning presents some drawbacks. As mentioned earlier with regard to PLCs and CoPs, the quality of the content can vary widely depending on the contributors. Also, administrators and colleagues may be sceptical of professional learning that occurs through social networking sites. For example, as a member of a LinkedIn group focusing on emerging trends in education, a teacher might learn a great deal about new practices, but these informal interactions lack the perceived legitimacy of other forms of PD. In addition, teachers who are not familiar with social networking sites may be reluctant to create an account and unsure how to navigate the various platforms and respond to invitations or requests from other members. Finally, the amount of content on these platforms can be overwhelming, even for the frequent user.

Although the educators surveyed for this paper did not report widespread use of mobile devices to access social networking sites for professional learning, they did point to a few innovative examples of PD involving social networking and mobile technologies. In Alberta, Canada, education leaders reported that many PD programmes use Twitter to obtain

information and feedback from participants, and to encourage active engagement in the programme. For instance, twice a year Alberta hosts Jurisdiction Technology Contacts (JTC) events, which gather representatives from the Ministry of Education, school jurisdictions (or districts) and professional development organizations for informational sessions and panel discussions on topics relevant to technology in education. Event participants use Twitter to send updates and information about what they are learning to colleagues in their schools, districts or organizations. In another example, consultants in Winnipeg, Manitoba, often use mobile devices and Twitter during teacher PD sessions and have formed a Twitter group called the Manitoba Educational Tweeters, who ‘tweet’ on their mobile devices during conferences. The consultants also collect information from participants using their mobile devices during meetings, PD sessions and conferences.

In the US state of Massachusetts, the Education Development Center and Harvard University’s School of Education worked together to develop a three-week course on using data to inform and support instruction, which was delivered using mobile devices and Twitter (Hough, 2011). The course was designed to be accessed during short periods of free time – while waiting in line for coffee, for instance. The use of Twitter, which limits entries to 140 characters, forced participants to keep their contributions succinct. The project was launched as a small-scale pilot and relied heavily on participant feedback to gauge effectiveness. One participant indicated a desire to spend longer amounts of time on PD and said that the character limit dissuaded her from posting as many comments as she would have liked. She also found the necessity to check in often to keep up with the posts unappealing. One of the lessons learned after the pilot was that more time should be spent before the course helping participants become comfortable with the platform. It was also found that instead of relying solely on Twitter, the course would need to combine technologies so that participants could use mobile devices for short written interactions, and computers to read longer pieces.

ONLINE CONTENT REPOSITORIES

Online content repositories are becoming increasingly prevalent. These portals provide educators with access to large amounts of digital content, such as lesson plans, videos, podcasts and interactive media. Some education portals also connect with online learning communities. Portals can be created by private-sector organizations, such as Apple’s iTunes University (iTunes U), or by non-profit organizations, state education agencies or individual practitioners (e.g. Curriki, OER Commons and Arizona Department of Education’s IDEAL). The websites range in their levels of access from 100% free to paid-subscriber access for all content. The content might be created by the host organization, derived from expert sources, or user-generated. As is the case for all online information, teachers accessing online content repositories should be cautious and consider the source of the content before accepting it as credible.

As budget cuts in the education sector diminish funding for intensive PD opportunities and decrease or eliminate the availability of travel funds for attending PD events, online content repositories can provide a substitute for formal PD by giving teachers access to resources that can contribute to their professional growth and be personalized to their needs (Pierce et al., 2011). For example, a high-school physics teacher might be searching for creative ways to perform hands-on demonstrations of physics concepts that will keep his students engaged. Using iTunes U, this teacher can view lectures by a university professor that include interactive demonstrations the teacher can adapt for his own classroom. Similarly, a teacher

who has been teaching third grade for fifteen years and has recently been reassigned to teach eighth-grade math can assemble an informal refresher course for herself by searching iTunes U for math methods courses taught by instructors from various colleges of education. Many of these courses are available at no cost, and iTunes U also offers free audio and video lectures, virtual tours, and online books and films. More than 800 postsecondary education institutions have active iTunes U sites. National organizations such as PBS and the New York Public Library also provide free content. In most cases, online content repositories like iTunes U can be easily accessed from mobile devices, enabling teachers to use the repositories for professional growth at times and locations best-suited to their schedules.

USING MOBILE TECHNOLOGIES FOR TEACHER SUPPORT

Mobile technologies can also be used to support teachers' day-to-day activities in and outside the classroom. Mobile devices can help streamline teachers' administrative tasks and facilitate communication with parents, students and colleagues. Teachers use the tools offered by many smartphones to support lessons, collect data for assessments and reflect on practice. Mobile technology can also encourage teachers' participation in non-educational projects such as employee wellness programmes. In addition to making a teacher's job easier or more satisfying, the use of mobile devices for teacher support has the added benefit of increasing the potential for mobile learning in PD and instruction. Teachers who are familiar and comfortable with mobile devices are more likely to embrace their use for instructional and PD purposes. Research indicates that teachers' use of mobile devices for personal tasks, such as maintaining an address book or a journal, contributes to their successful use of these devices for planning instruction and collecting resources (Leach et al., 2005). The following sections will describe examples of teachers' use of mobile technologies in three main areas: classroom support, communication and personal support.

CLASSROOM SUPPORT

Mobile devices can be used to facilitate teachers' activities in the classroom. For example, many mobile applications have been developed to support teachers' administrative duties, such as taking attendance. The myriad features and tools offered by mobile devices can also aid instruction in core content areas as well as physical education, music and art. Holly Hayes, a music teacher in Fairfax County Public Schools in Virginia, uses specialized applications on her mobile phone, such as a pitch pipe and a metronome, to support her lessons. Outside of class, she uses her phone to search for videos on the internet to generate ideas for new musical pieces to introduce to her students. Mobile technologies can also help teachers evaluate their own practice. Hayes uses her mobile phone to record videos of her students singing and herself conducting. After class she watches the video on her phone or connects the phone to a computer so she can identify areas in which she can improve (personal communication, 8 December 2011).

Mobile devices can also aid the assessment of student work. For example, a teacher may have just taught a lesson on how early American settlers adapted to their environment in the Great Plains by building sod houses. To reinforce student learning, she asks students to build a

miniature sod house outside. She could assess the students' work by using her mobile device to make notes and take pictures during and after the construction of the house. In addition to using the camera and word-processing features available on most mobile phones, teachers can use mobile applications specifically designed for data collection to conduct surveys, judge competitions and observe experiments.

COMMUNICATION

Mobile devices can facilitate teachers' communication with parents, students and colleagues. School-related announcements sent via text message, for instance, can be delivered more quickly and may be more likely to be read than email messages. Some teachers and school officials send notifications to parents via text messaging or Twitter about student absences, homework, grades, exam schedules, and school delays due to weather or other issues. They may also use text messaging to announce an emergency. In 2007 at Virginia Polytechnic Institute and State University, commonly known as Virginia Tech, a student shot and killed thirty-two people on campus and wounded twenty-five others over a span of several hours. University officials informed students of the incident via email more than two hours after the first shooting occurred, when many students were already on their way to class. The university was sharply criticized for its failure to quickly disseminate information that might have saved lives. Recognizing the need for faster response time, Virginia Tech has since implemented a high-tech alert system that includes text messaging. This system was used four years later, in 2011, when a student from a nearby university entered the Virginia Tech campus and killed a university police officer. Within minutes, the university had issued a text alert warning students and faculty members to stay indoors, and informational texts continued to be distributed at regular intervals for the next several hours (Sampson and Tucker, 2011).

In some cases, mobile devices are used to elicit feedback from parents. For example, in Shelby County Schools in Alabama, educators send parents an email that includes a link to a website where they can respond to a survey designed by the district using the Poll Everywhere application, a customizable audience response system for mobile devices. Parents receive instructions on how to text their responses using a mobile phone, including a number to send the text to and codes that correspond to specific answers to the questions. A separate number is provided for open-ended responses. The author of the survey can view the responses as they are submitted. In some cases, results appear online in an embedded graph or blog, enabling parents to see them as well.

Shelby County also has a district Twitter account and an Edmodo account; the latter is used to post homework, announcements and grades for parents and students. Shelby County teachers are enthusiastic about using Edmodo: approximately 1,100 of the district's 1,831 classroom teachers voluntarily created an account in the first four months after it was introduced. The students whose teachers have Edmodo accounts have reported that they value the ability to access the posted information via their mobile devices. Teachers in the district also use Remind 101, a free text messaging mobile application for teachers, to text parents and students with homework assignments and school announcements (L. Woolley, personal communication, 5 December 2011). Parents seem to appreciate this type of communication from schools and teachers. A 2008 Canadian report revealed that 51% of parents would be interested in having their children's school communicate announcements over their mobile phones (Harris/Decima, 2008).

Some schools and districts are also using Quick Response (QR) codes to allow parents and students to access school-related information with their mobile devices. A QR code is a type of barcode that can store a great deal of digital information and can be decoded quickly by mobile devices. The code's pattern of black and white squares can function as a print-based hyperlink to websites. Using a free QR-reader application, people can access hyperlinked websites simply by pointing their mobile device's camera at the code. In North Carolina's Guilford County Schools, QR codes are included on the district's website to provide parents with links to athletic schedules, parent-teacher conference information, registration deadlines, staff directories, weather-related announcements and school lunch menus (Carr, 2012). Administrators can use Google Analytics or other free tools to view the number of scans, users and website visits, in order to assess the effectiveness of using the codes or gauge the popularity of specific links. In some postsecondary institutions, QR codes are being used to communicate with students. At Misericordia University in Pennsylvania, QR codes are included in print materials sent to prospective students, who can scan a code to link to a YouTube video of a typical day in the life of a Misericordia student (Carter, 2012). At Washington and Lee University in Virginia, new students are greeted by university staff who have QR codes printed on their T-shirts; the codes link to sites ranging from the university's information technology (IT) help desk to tourist websites about local attractions. At this point, the use of QR codes in education is still in its infancy, but as QR codes become more widespread, this type of communication may become more common in schools.

PERSONAL SUPPORT

Mobile devices are also being used to offer personal support to teachers through projects like employee wellness programmes. Nivada Spurlock, district health and wellness coordinator for the Homewood City Schools in Birmingham, Alabama, is understandably concerned about employee health: Alabama has the second-highest rate of obesity in the United States (CDC, 2010). Spurlock has initiated several district-wide employee wellness challenges that use Twitter (personal communication, 3 December 2011). In one challenge, teams based at each school competed to acquire the most 'Patriot Points', which are equivalent to exercise hours. Employees logged their Patriot Points on a website, and each week a student picked a participant's name from a hat. The winner was announced via Twitter and received a gift certificate. Another challenge, called 'Tweet the Streak', required teachers to exercise daily for at least ten minutes and 'tweet' about their activity. All who completed the challenge were entered into a drawing for a gift certificate, and the winner was announced via Twitter. The district is currently implementing the second phase of this initiative, and participation has expanded outside the schools to include some city council members. Spurlock reported that the wellness programme has been a fun way to encourage fitness and model healthy behaviours for students, who say they enjoy being part of their teachers' health challenges. The programme is also making a definite impact on teachers' health; in 2011, the Homewood City School District was listed as one of the healthiest employers in Birmingham (Thibodeaux, 2011). Spurlock attributes the success of the programme in part to the use of mobile technologies and social networking sites like Twitter, which are engaging, easy to use, and encourage active participation.

PROFESSIONAL DEVELOPMENT ON THE INSTRUCTIONAL USE OF MOBILE TECHNOLOGIES

In addition to being used for PD delivery and teacher support, mobile technologies are quickly becoming a topic for PD programmes focused on mobile learning for students. Ideally this type of PD not only helps educators become proficient users of mobile devices but also teaches them how to incorporate mobile technologies into instruction. Approaches to PD on mobile learning include traditional, face-to-face instruction and collaborative learning through PLCs or CoPs, either alone or in combination with face-to-face instruction. Regardless of delivery method, the most effective PD programmes on the use of mobile technologies for instruction will be those that facilitate a shift in teachers' pedagogical ideologies. PD on mobile learning should encourage teachers to be open-minded and to think critically and creatively about the possibilities for using mobile technologies in schools.

TRADITIONAL APPROACHES

Much of the technology-related PD in North America is still delivered through traditional face-to-face methods, which are usually finite rather than ongoing and generic rather than personalized. Many teachers are frustrated by the limitations imposed by this kind of PD and report that it does not result in changes to their practice (Borthwick and Pierson, 2008; Darling-Hammond et al., 2009; Guskey and Yoon, 2009). For example, a high-school social studies teacher who has been using direct instruction supported by PowerPoint presentations may be excited to receive an interactive whiteboard for her classroom, because she has heard a lot about the opportunities to engage learners with this technology. She attends a training for teachers of all grade levels that demonstrates the technical capabilities of the whiteboard. The teacher leaves the training comfortable and confident about how to operate the device, but since the training offered no suggestions for how it could be used by the students, her primary method of instruction remains unaltered. Instead of standing behind a lectern and advancing slides by tapping on the keyboard of a laptop, she now stands next to the interactive whiteboard and advances slides by touching the board. Because her training was broad and focused on device functionality rather than new instructional practices, the teacher has missed an opportunity to maximize the potential of an innovative technology to fundamentally change teaching and learning in her classroom.

Researchers have reported that traditional forms of PD provide little support for teachers to translate their learning into practice, and have recommended restructuring PD opportunities to promote teachers' interdependence and collaboration rather than their dependence on outside experts (Schmoker, 2006). Nevertheless, most PD is still delivered via face-to-face, one-size-fits-all instruction. In Canada, the Ministries of Education for Alberta and Manitoba and the Manitoba Association for Computing Educators all employ traditional delivery methods for PD focused on mobile technology. In the USA, the New York State Association for Computers and Technologies in Education (NYSCATE) and Saddleback Valley Unified School District in California reported similarly structured PD on mobile learning. The amount of face-to-face instruction offered by these institutions varies: some provide three or four days of PD during the school year, sometimes paired with another three or four days in the summer, while others host a conference or provide a series of workshops. Just as mobile

learning is still in the initial stages of development, so too is PD designed to support mobile learning initiatives, and educators are still experimenting with different approaches. At present, this review found few examples of effective PD on mobile learning that schools and districts could use as models of best practices.

COLLABORATIVE APPROACHES

Teachers in North America indicate that they rarely collaborate with their peers. In a 2010 study, US teachers reported an average of 2.7 hours per week spent on collaboration, and only 16% said that cooperative efforts occurred among staff members in their schools (Wei et al., 2010). However, the US and Canadian education leaders surveyed for this paper said their mobile learning PD programmes often involve a collaborative element. While the methods employed by these districts and schools vary, many of their efforts have focused on empowering teachers to support each other by giving them opportunities to work together as they explore the possibilities for mobile learning (Gray, 2011). Although none of the organizations surveyed have conducted formal studies to determine the efficacy of the specific PD approaches implemented, district coordinators reported receiving positive feedback from teachers about the benefits of collaboration with peers. Teachers reported learning about helpful strategies and solutions from their colleagues that were directly relevant to their situations. They also said that having a formal time dedicated to meeting with peers is equally important as being able to connect with them on an informal, as-needed basis.

Some PD programmes for mobile learning employ a variety of delivery formats, such as face-to-face instruction, participation in PLCs or CoPs, and teacher-initiated PD activities. The Chicago Public Schools in Illinois, St. Mary's School District in Ohio, the Country School in Maryland, Rockdale Independent School District in Texas, and the Alberta Ministry of Education in Canada all reported using PLCs or CoPs, either formally or informally, as part of their PD offerings. PD options included collaborative sessions that ranged from one class period per day to weekly or monthly meetings, as well as an online forum.

ENCOURAGING CHANGES IN PEDAGOGY

Many of the PD programmes reviewed for this paper were developed as part of larger, district-wide mobile learning initiatives. While the topics and delivery methods varied, the most successful programmes shared a common feature: they promoted substantive changes in teaching practice when incorporating mobile technologies into instruction. Teachers were not just taught how to use a specific mobile device but were encouraged to think critically about how mobile technologies can provide new and better opportunities for learning. Rather than adopting mobile technologies wholesale, teachers exploring mobile learning need to consider whether using mobile devices adds value or efficiency to particular lessons or activities, or whether it could be distracting. The goal of any PD programme is to help teachers 'adopt new and arguably better approaches to instruction and/or change the content or context of learning, instruction, and assessment' (Lawless and Pellegrino, 2007, p. 581). For example, PD focused on using mobile technologies for assessment might show teachers how to use formative assessment in situations where it was not previously feasible. Free mobile tools such as polling applications can enable teachers to quickly check for understanding at frequent

intervals throughout a lesson. These mobile applications also provide students with anonymity when they are responding, which might result in a more accurate picture of their comprehension than conspicuous responses – like hand-raising – which are visible to the rest of the class. Another PD session on mobile learning might direct biology teachers to a mobile application that can put interactive simulations of cell division in the hands of every student, eliminating reliance on photographs in a textbook or the need to share a computer.

Research indicates that for technology to be effectively integrated into instruction, changes are required in one or more of the following areas: (a) teacher attitudes and beliefs; (b) content knowledge; (c) pedagogical knowledge; and (d) instructional resources, technology or materials (Fullan and Stiegelbauer, 1991). Leny Schad, chief information officer at Katy Independent School District in Texas, said the district encouraged mobile learning by facilitating a shift in teachers' pedagogical ideologies (personal communication, 26 October 2011). In a pilot programme, the district provided smartphones to fifth graders during the 2009–10 school year. Prior to implementing the programme, teachers spent two years participating in PD that focused on thinking critically about how technology can change the way they teach and lead to better student outcomes. The district consciously positioned the mobile learning initiative not as a technology initiative but as one tied to curriculum and instruction. During their PD sessions, teachers analysed the curriculum's scope and sequence, looking for areas where technology could improve instruction. The programme was considered a success; after the first year, students who had been given smartphones significantly improved their test scores in math and science on the state standardized achievement test in comparison with students who were not part of the mobile learning pilot programme. Canby School District in Oregon implemented a similar pilot project. Joe Morelock, director of technology and innovation for the district, said that one of the key elements of the pilot's success was the focus on PD. Teachers participated in PD for two years preceding the pilot as well as during the programme itself. The PD helped teachers think critically about how technology could change their practice, which in turn had a positive impact on the programme's overall effectiveness (J. Morelock, personal communication, 26 October 2011).

While pre-service teacher training differs from in-service PD, it is worth noting that training new teachers on the instructional use of mobile technologies can have a positive effect on mobile learning efforts in schools and districts. Researchers recommend using mobile learning in pre-service teacher education programmes in order to make it easier for educators and administrators to integrate mobile technologies into instruction in the future (Ally, 2009). Teachers tend to teach the way they were taught, so modelling effective mobile learning strategies when training new teachers is especially important (Britzman, 1991; Lortie, 1975; Phelps and Cherin, 2003). When their professors use mobile devices for instruction, pre-service teachers have the opportunity to observe concrete examples of pedagogical strategies for mobile learning and to consider mobile learning from a student's perspective. If teachers feel they have benefitted from mobile learning themselves, they may be more likely to integrate mobile technologies into their own classrooms in the future.

FACTORS AFFECTING MOBILE LEARNING FOR TEACHERS

DRIVERS

According to the literature review and interviews conducted for this paper, the main factors driving the incorporation of mobile technologies into PD are teacher attitudes and interest, credentialing requirements, standards for teaching and learning, and cost considerations.

TEACHER ATTITUDES AND INTEREST

Many teachers are eager to engage in mobile learning because of the flexibility it provides. Without mobile technologies, participation in PD necessitates attendance at an event or at least access to a computer; with a mobile device, teachers can access online PD from any location that has wireless connectivity. Mobile devices enable access to online courses and other types of PD opportunities – such as PLCs and CoPs, social networking sites, and content repositories – at any time, so that teachers can structure their professional growth according to their schedules and preferences.

Teachers' use of mobile learning to access PD opportunities may in turn increase the demand for PD on using mobile technologies for instruction, as teachers see how mobile devices can play a role in facilitating their own professional learning. Although some teachers view mobile devices primarily as a distraction for students and are reticent to incorporate mobile learning into their classrooms, many educators believe that mobile technology should be leveraged for instructional use. These teachers are curious about the potential of mobile technology to improve learning, and many have expressed a desire for PD specifically focused on integrating technology and mobile learning into their instructional strategies and practices (Darling-Hammond et al., 2009).

REQUIREMENTS AND STANDARDS

Teachers in the United States and Canada generally need credits or continuing education points for credential recertification. However, in some states and provinces, these requirements have been reduced or eliminated because schools or districts cannot financially support the necessary PD activities, and teachers cannot afford to pay for continuing education courses themselves. Mobile technologies open doors to alternative low-cost or no-cost PD, such as online courses or participation in online PLCs, that can be used to fulfil recertification requirements.

In addition, many national, state and provincial education standards specifically address the need for digital literacy and technological proficiency for both teachers and students. For

instance, the International Society for Technology in Education developed the National Education Technology Standards for Teachers, which provide a framework for using technology to enhance teaching and learning. Although these standards do not explicitly mention mobile devices, they recommend that teachers use digital tools and new technologies to collaborate and communicate with students, peers, parents and community members, and also to locate, analyse, evaluate and use information resources to support teaching and learning. The standards encourage and set the stage for teachers' use of mobile devices in both PD and instructional contexts. In the United States, the US Department of Education's National Education Technology Plan explicitly identifies mobile technologies as an important component of education (USDOE, 2010). One of the Department's priorities is to support efforts to ensure all students and educators have 24/7 access to the internet, and to encourage states, districts and schools to adopt policies that leverage the technologies students already have. For teachers to follow through with these technology expectations and help students reach the standards established for them, they must become familiar with mobile devices and learn how to integrate them into their curriculum. PD on mobile learning is critical to achieving this competency.

COST CONSIDERATIONS

According to the Center on Budget and Policy Priorities, a policy think tank based in Washington, DC, US states experienced large budget shortfalls from fiscal years 2009 through 2012; in the 2013 fiscal year, which begins in July 2012, twenty-nine states have already projected budget gaps totalling US\$47 billion (McNichol et al., 2011). Because of these shortfalls, which directly affect education funding at the federal, state and local levels, the funding available for PD opportunities in the USA has been greatly diminished (Pierce et al., 2011). As more schools and districts in North America face budget cuts, increasing access to less expensive forms of PD is particularly important (McNichol et al., 2011). PD delivered via mobile devices can cost significantly less than in-person sessions, especially in terms of compensation for substitute teachers and the PD trainer.

ENABLERS

Many of the efforts to integrate mobile technologies into PD can be traced to the rapid growth in the availability of mobile devices. In the first half of 2011 alone, 150 new smartphone models were launched, and the number of mobile phones in North America continues to grow (Johnson, 2011). Most teachers in North America already own smartphones or other mobile devices, which greatly facilitates the incorporation of mobile learning into PD activities (Bjerede et al., 2010; CWTA, 2010; Rainie, 2011). The ubiquity of mobile devices and their relatively low cost increases the likelihood that teachers will use them to access PD opportunities. Several companies and organizations that develop PD programmes are gradually moving toward online and mobile approaches.

BARRIERS

The representatives of state and provincial education departments surveyed for this paper identified several factors that inhibit the development of PD related to mobile learning or prevent educators from using mobile technologies to participate in PD. The primary barrier to mobile learning in PD is a lack of financing, time and leadership. Other barriers include resistance to change and overly prescriptive credentialing requirements that undermine the legitimacy of non-traditional forms of PD.

While mobile devices are typically less expensive than computers or laptops, they frequently require data plans, which constitute an added expense for schools that provide devices to teachers and students. Mobile devices may offer access to online PD that is less expensive than face-to-face sessions, but teachers might first have to attend in-person PD activities focused on how to use mobile technologies in order to participate in online PD. Expenses associated with in-person PD events include compensation for substitute teachers and PD trainers, reimbursement for participant travel, meeting room rental fees and equipment expenses. Also, as budgets become more strained, teachers' workloads often increase. For example, an administrator with a reduced budget might be forced to eliminate 20% of the teaching positions in the school. The result would be an increase in the student to teacher ratio and a reliance on the remaining teachers to assume additional roles, such as yearbook advisor, crosswalk guard or committee chair. As teachers take on additional work and responsibilities, the amount of time they can devote to PD decreases.

A lack of focused leadership at the school, district or state and provincial levels can also hinder efforts to incorporate mobile technologies into instruction. For example, teachers might participate in high-quality PD focused on mobile learning, but a district ban on using mobile phones in school would prevent these teachers from being able to use what they had learned. In order for PD on mobile learning to be successful, it should be aligned with school-wide reform efforts and technology use plans that are supported by school and district leaders.

Inertia is also a barrier to reform. In many schools and districts, PD has always been a stand-alone event, and it may seem easier to continue that way, even if it is not effective (Borthwick and Pierson, 2008; Darling-Hammond et al., 2009). For example, it is not uncommon for educators to participate in PD that is not aligned with school improvement goals or teachers' interests and needs. PD activities are often single events with no follow-up, making them unlikely to result in improved practice. With regard to pre-service training, research indicates that teachers are likely to teach using the methods modelled by professors in their teacher education programmes (Britzman, 1991; Lortie, 1975; Phelps and Cherin, 2003). If mobile learning was not sufficiently addressed in their training programmes, they are unlikely to implement it in their classrooms without some kind of intervention.

Rigid credentialing requirements also inhibit the use of mobile learning for teachers by failing to recognize alternative forms of PD as valid. Recertification and continuing education requirements are typically met by teachers documenting the number of hours they spend at in-person PD or engaged in formal online courses. The requirement to accrue a specific number of hours within a certain period of time drives teacher participation in traditionally structured PD sessions and courses. Even though PLCs and CoPs may offer high-quality professional learning opportunities, participation in these kinds of PD is often not accepted by

districts or credentialing boards. Hours of attendance at a workshop or engagement in an online course are quantifiable, while participation in online professional communities typically does not occur consecutively or for extended blocks of times, making this kind of engagement difficult to measure. Although mobile technologies can increase access to high-quality professional communities, participation may be thwarted because this type of PD is not perceived as credible and does not count toward recertification. Many educators and PD experts understand the value of PLCs and CoPs, but the administrators who manage and monitor credentialing and continuing education need to find ways to quantify such engagement.

SUCCESS FACTORS

Analysis of the input provided by district, state, provincial and national education leaders revealed four key components of effective PD that incorporates mobile learning. To be successful, PD should: (1) be intensive, ongoing and connected to practice; (2) focus on student learning and address the teaching of specific subject-area content; (3) align with school improvement goals; and (4) build strong working relationships among teachers (Darling-Hammond et al., 2009). Mobile technology has the potential to facilitate PD experiences that incorporate each of these components.

RECOMMENDATIONS

Schools, districts and organizations planning to implement formal or informal PD programmes that focus on mobile learning or use mobile technology as a delivery format should follow some basic guidelines to increase the effectiveness of their efforts. The following recommendations are based on a review of the relevant literature and the examples and models described in this paper.

1. *Move from one-size-fits-all to personalized PD*

Mobile technologies allow teachers to personalize their professional learning and to access new types of PD that may be more effective than traditional, one-size-fits-all training sessions. Using mobile technologies, teachers can access online courses, social networking sites, PLCs and CoPs, and content repositories, all of which allow for more customization of teachers' professional growth. For example, when professional learning takes place on a social networking site, teachers select the topics according to their interests and needs. In PLCs and CoPs, participants can individualize their experience by seeking out resources and advice specific to their school environment, grade level, content area and individual students' needs.

2. *Focus on pedagogy and content rather than technology*

Teachers consistently express their desire for PD that is specifically focused on their content areas and grade levels rather than on learning to use technological tools. Because they are striving to integrate technology and mobile devices into instruction, teachers want PD that addresses technology use and content from a pedagogical perspective (Darling-Hammond et al., 2009). School and district leaders who have implemented successful PD programmes focused on mobile learning emphasized the importance of PD that encouraged a shift in teachers' pedagogical ideologies to ensure effective integration of mobile devices into instruction.

3. *Use mobile technologies for PD during naturally occurring downtime*

While teachers may find it difficult to devote long stretches of time to PD, they are likely to have naturally occurring downtime in and outside of school that can be used for PD. Mobile devices can be used to access PD opportunities for short intervals of time, and many mobile applications are being designed to deliver PD in small increments. Facilitated by the proliferation of smartphones, this PD delivery model is becoming increasingly popular in business. For example, in 2008, Accenture – a global management consulting, technology services and outsourcing company – noticed that employees were having difficulty finding a full hour to dedicate to training. The company developed a learning solution that allowed employees to participate in meaningful training during periods of downtime as short as ten minutes (Vanthournout and Koch, 2008). Using small increments of time to engage in PD requires a shift in mindset; educators and administrators must challenge preconceived notions of what PD looks like and acknowledge that professional learning can occur even when teachers are not engaged for multiple or consecutive hours. This is not to say that accessing PD activities in small increments can stand alone as substantive PD; rather, using a mobile device can supplement other PD experiences by increasing access to learning activities that are well-

suited for short amounts of time. For example, a teacher might be waiting in a doctor's office, thinking about how he can help his students understand the mathematical concept of slope. During the twenty minutes while he waits, he might use his mobile device to search on Teacher Tube or Khan Academy for videos he can use with his students when he returns to the classroom. In another example, a special education teacher who is waiting in the parking lot for her son to finish baseball practice can use her mobile device to log into her Facebook account to check the status of an inquiry she posted to the Facebook group for teachers of students with autism. Seeing that several teachers have responded to her question, she is eager to try their recommendations in class and comforted to know she has ongoing access to her peers through this group.

4. *Provide time for collaboration among teachers*

Planning instruction collaboratively is a very effective PD experience for teachers, because their work can be job-embedded, address immediate concerns, and align with the school's priorities and goals. However, collaboration usually requires that all participating teachers be in the same place at the same time, which can be difficult to coordinate. Mobile technologies and web-conferencing applications can allow teachers to participate in meetings and collaborate virtually when they cannot be on-site and do not have access to a computer.

CONCLUSION

Because of the ubiquity of mobile devices in North America, mobile technologies have the potential to influence education in ways that other technologies cannot. The enthusiasm for mobile learning is palpable: educational blogs, mainstream education media, and education conferences and workshops have all recently featured mobile learning as a topic for discussion and debate. However, this interest in mobile learning has yet to translate into widespread practice. This review found that teachers in North America are using mobile technologies, albeit minimally, to improve instruction and enhance their PD experiences. However, there is currently a paucity of research on using mobile technologies for PD and teacher support, and little data on the efficacy of mobile learning for students. As educators look for guidance on using mobile devices for in-service training and support, they must rely on existing research on technology integration and effective PD practices, adapting and modifying current models to account for the enhanced flexibility, portability and functionalities offered by smartphones and other Wi-Fi-enabled mobile devices.

According to the research conducted for this paper, mobile technologies are rarely used to deliver PD, nor are they commonly integrated into the PD workshops offered in North America. This review found some evidence of PD focused on the instructional use of mobile technologies, although this practice is still emerging. To date, the use of mobile technologies has not had a significant impact on the way PD is structured or designed, but it has changed how PD opportunities can be accessed. Mobile devices can provide an additional access point for PD and can support access that occurs in small increments of time. Teachers using mobile devices also have increased access to less formal types of PD, like online PLCs and CoPs, that are not place-bound or time-bound. Mobile technologies may serve as a catalyst to increase participation in these kinds of informal PD activities, which have the potential to provide ongoing, personalized and collaborative learning opportunities. For example, a teacher can use a mobile device to participate in a PLC that convenes online, enabling her to personalize her PD activity by self-selecting the groups she wants to join. Her mobile device gives her access to these groups any time and anywhere, allowing her to solicit advice from peers and implement their recommendations quickly. Although her exchanges with peers in the PLC might be brief, they are job-embedded, as she is able to access the PLC through her mobile device during the course of her regular workday.

As is often the case when a new technology enters the education sector, claims about the benefits of mobile learning are widespread. While these claims are not necessarily unfounded, educators must look for research-based evidence to guide their efforts. Because little data currently exists on the use of mobile technologies for teaching and PD, educators need to think critically when developing mobile learning programmes and carefully evaluate the efficacy of the programmes they implement.

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APPENDIX A: Interviews conducted

- Kristin Adkins, Director, Wireless Reach, Qualcomm
- David Byer, Senior Manager, Education Leadership and Policy, Apple
- Karen Cator, Director of Educational Technology, US Department of Education
- Leslie Conery, Deputy CEO, International Society for Technology in Education
- Robert Craven, Coordinator, Education Technology, Saddleback Unified School District, California
- Matthew Dunleavy, Assistant Professor, Radford University, Virginia
- Julie Evans, CEO, Project Tomorrow
- Melinda George, Vice President and COO, National Commission on Teaching and America's Future
- Lucy Gray, Project Director, Leadership for Mobile Learning initiative, Consortium of School Networking
- Holley Hayes, Choral Director, Fairfax County Public Schools, Virginia
- Bradley Hull, Deputy Executive Director, National Association of State Boards of Education
- Rich Kaestner, Project Director, Mastering the Moment, Total Cost of Ownership, and Calculating the Value of Investment initiatives, Consortium of School Networking
- Joellen Killion, Deputy Director, Learning Forward
- Hilary LaMonte, Director, Connected Online Communities of Practice, Consortium of School Networking
- Kyle Menchhofer, Technology Coordinator, St. Mary's School, Ohio
- Bailey Mitchell, Chief Technology and Information Officer, Forsyth County School District, Georgia
- Joe Morelock, Director, Technology and Innovation, Canby School District, Oregon

- John Orban, System Administrator, The Country School, Maryland
- William Rankin, English Professor and Director of Educational Innovation, Abilene Christian University, Texas
- Sharon Robinson, President and CEO, American Association of Colleges for Teacher Education
- Leny Schad, Chief Information Officer, Katy Independent School District, Texas
- Nivada Spurlock, Health and Wellness Coordinator, Homewood City Schools, Alabama
- Lauren Woolley, Technology Program Area Specialist, Shelby County Schools, Alabama
- Lewis Wynn, Technology Coordinator, Rockdale Independent School District, Texas

APPENDIX B: Survey instrument

Thank you for assisting the Consortium for School Networking (CoSN) and the United Nations Educational, Scientific and Cultural Organization (UNESCO) in our study on the use of mobile technologies in North America.

For the purposes of this survey, 'mobile technology' refers only to mobile phones or iPod touches. Tablets (e.g. iPads, Kindles, Galaxy Tabs) are not being considered.

It will take approximately 10 minutes to complete this survey.

Thank you!

*Denotes required question

1. Is your state department of education actively supporting the use of mobile technologies in education through policies or programs? (Check all that apply.)*
 - Do not know
 - No, not really
 - Yes, through initiatives by institutions and engaged individuals
 - Yes, through specific projects or programs with dedicated public funding
 - Yes, through specific projects or programs with dedicated private funding
 - Yes, through state department of education initiatives including specific measures and incentives
 - Yes, otherwise; please specify here. (Please enter an 'other' value for this selection.)
 2. Please provide some contact details or websites that could provide additional details about the programs or projects being carried out and list what agencies/organizations are involved, sources of funding, etc.
 3. Are you aware of any initiatives promoted by districts or local education agencies (LEAs) that actively support the use of mobile technologies in education?*
- Yes
 - No

4. Please identify the district/LEA's primary contact and email address, and give a brief description of the program, subject area(s), and grade level(s).*

5. Can you specify the level of activity for each of the following educational subsectors?

- Low: There is some activity, but it is in an early stage of development, probably with scattered activities rarely going beyond one particular school or institution.
- High: There are programs or activities that have reached a critical mass of schools or learners and have become publicly noticeable.
- Very high: There are programs or activities that can be said to be widely used by schools or learners.

	Non-existing	Low	High	Very High
Elementary school	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Middle school	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
High school	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Post secondary	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

6. Do you have any additional comments?

7. Are there indications that your state/province will become an active supporter of mobile learning in the near future? (Check all that apply.)*

- Yes, by explicitly stimulating initiatives in this field
- Yes, by introducing subsidy programs or project funding
- Yes, by developing a dedicated action plan
- Yes, otherwise
- No, not yet, but it could well develop into a priority in the medium term
- No, we do not expect this to become a priority

8. Do you have any additional comments?

9. Is your state department of education actively trying to prevent the use of mobile technology in education?*

- Yes
- No
- Don't know

10. Does this policy refer to any particular (or all) of the following subsectors?

- Elementary school
- Middle school
- High school
- Postsecondary

11. Please specify the nature of the policy or action.

12. Within each of the following categories, please list the names of individuals/entities that you believe contribute to the use of or prevention of use of mobile technology in education in your state/province.

	Use	Prevention of use
The state department of education	<input type="text"/>	<input type="text"/>
Regional educational authorities	<input type="text"/>	<input type="text"/>
Local education authorities	<input type="text"/>	<input type="text"/>
Telecom providers	<input type="text"/>	<input type="text"/>
Cell phone/hardware makers	<input type="text"/>	<input type="text"/>
Teachers	<input type="text"/>	<input type="text"/>
Students	<input type="text"/>	<input type="text"/>
Parents	<input type="text"/>	<input type="text"/>
Education specialists/ scholars	<input type="text"/>	<input type="text"/>
Other (please specify)	<input type="text"/>	<input type="text"/>

13. There are social, economic and political factors influencing public policies and social attitudes about mobile learning. Given the circumstances, the same factor could be seen at one point as a driver and at another point as a barrier. For example, this could be the case regarding connectivity costs, teacher training, policy support, and so on.

With reference to your state/country and the use of mobile technologies in education, what would you consider to be the main...

Drivers:

Enablers:

Barriers:

Success factors:

14. Is there reference to the use of mobile technologies in education in any state/province or regional educational strategy, educational technology plan or similar documents?*

- Yes
- No

15. Please specify the title of the document, the nature of the reference, and a URL where it can be accessed.

16. In your state/province, has the education ministry/department of education (or a different area of government) defined a clear strategy or policy regarding the use of mobile technology in education?*

- Yes, in operation
- Yes, in development
- Not yet, but under discussion
- No, with no preparations yet
- No, we do not anticipate this in the near future
- Don't know

17. Please identify and describe any state/province-level policies or sample policies disseminated to the local schools regarding the use of mobile technologies.

18. Why is learning with mobile technology a consideration or an option in your state/province? And, if learning with mobile technology is not actively encouraged, or if it is not an option, why not?

19. Do you have any additional comments?

20. Can you provide examples of professional development that focuses on using mobile technologies in the classroom or for teacher support (in your own or in other states/provinces or districts/LEAs in your state)?*

- Yes
- No

21. Please provide information about this professional development effort. (e.g. a brief description, title of the offering, name of organization/instructor, location, grade level, etc.)

22. Are the examples of professional development on using mobile technologies with students MOST OFTEN offered as a standalone topic or are they integrated into other initiatives/topics (i.e. mobile technologies for 21st century skills or mobile technologies for middle-school science teachers)?*

- Standalone topic
- Integrated into other initiatives/topics

23. Can you provide examples of educators using mobile technology to participate in professional development? (Note: these examples may range from informal participation in social networking groups to formal trainings that use mobile phones to respond to polls during the session.)*

- Yes
- No

24. Please provide information about this professional development effort (e.g. a brief description, title of the offering, name of organization/instructor, location, grade level, etc.)

25. What are the barriers that inhibit the delivery of professional development related to mobile learning or that hinder participants from using mobile technologies to participate in professional development?

26. Please provide the following information about the person completing this survey.*

Name:

Organization:

Title:

State:

Thank you for taking our survey. Your response is very important to us.

Today there are over 5.9 billion mobile phone subscriptions worldwide, and for every one person who accesses the internet from a computer two do so from a mobile device. Given the ubiquity and rapidly expanding functionality of mobile technologies, UNESCO would like to better understand their potential to improve and facilitate learning, particularly in communities where educational opportunities are scarce.

This paper examines how mobile learning can support teachers and improve their practice in North America. It reveals important lessons for policy-makers and other stakeholders seeking to better leverage mobile devices to assist the work of educators. Four additional papers review how mobile technologies are being used to help teachers in other regions of the world: Africa and the Middle East, Asia, Europe, and Latin America. A 'Global Themes' paper synthesizes findings running across the five regional papers.

Complementing the papers about teacher support is a separate set of six papers which describe illustrative mobile learning initiatives and their implications for policy. These papers are also organized geographically.

Two 'Issues' papers will be added to the Series later in 2012. One will anticipate the future of mobile learning, and another will articulate considerations for creating policy environments in which mobile learning can thrive.

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