United Nations
Educational, Scientific and
Cultural Organization

NOKIA
open access

THE FUTURE OF MOBILE LEARNING

IMPLICATIONS FOR POLICY MAKERS AND PLANNERS

Published in 2013
by the United Nations Educational, Scientific and Cultural Organization
7, place de Fontenoy, 75352 Paris 07 SP, France

ISSN 2227-5029

Authored for UNESCO by: Carly Shuler, Niall Winters and Mark West
Coordinating editors: Mark West and Steven Vosloo
Editing and graphic design: Rebecca Kraut
Cover design: Aurélia Mazoyer

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 published in 2012 and 2013.

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. 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/

ACKNOWLEDGEMENTS

This paper is the culmination of the work of numerous individuals.

Carly Shuler, Niall Winters and Mark West authored the paper. Their work was informed by interviews Ms Shuler conducted with twelve experts who are working at the vanguard of mobile learning (see the Appendix for a complete list). A dedicated advisory board composed of UNESCO and external education specialists also provided important input and recommendations. Mike Sharples and Rebecca Kraut deserve special mention for their many contributions.

This paper is part of the larger UNESCO Working Paper Series on Mobile Learning. Francesc Pedró conceived of the Series, and Steven Vosloo and Mark West worked as coordinating editors.

TABLE OF CONTENTS

INTRODUCTION

Technology has changed our world in ways previously unimaginable. Mobile devices permeate our daily lives, providing unparalleled access to communication and information. By the end of 2012, the number of mobile devices was estimated to exceed the world's population (Cisco, 2012). As the power, functionality and affordability of these devices increase, so does their potential to support learning in new ways. Innovative mobile learning initiatives from around the globe have highlighted this potential (Fritschi and Wolf, 2012*b*; Hylén, 2012; Isaacs, 2012*b*; Lugo and Schurmann, 2012; Roschelle, 2003; So, 2012; West, 2012*b*). In one way or another, many – if not most – of these projects are helping students learn about something important to them. Whether empowering a woman in India with daily audio messages to help convert her knowledge into economic gains, enabling a student in Singapore to bridge the gap between home and school, helping a child in New York gather data to become a 'mini-scientist', or providing a retiree in Bangladesh with access to hundreds of English language audio lessons and quizzes, mobile devices have changed the lives and learning of millions of people in ways inconceivable even a decade ago. Yet despite over fifteen years of research, mobile learning has so far failed to have a significant long-term impact on education. How can this be addressed? What can be done in the *next* fifteen years to build on the achievements of practitioners and researchers to increase educational quality and ensure sustained learning opportunities for all? This report aims to answer these questions directly.

Looking towards the next decade and beyond, it seems clear that the future of mobile learning lies in a world where technology is more accessible, affordable and connected than it is today. However, technology alone, regardless of its ubiquity and utility, will not determine whether mobile learning benefits large numbers of people. Designing effective mobile learning interventions requires a holistic understanding of how technology intersects with social, cultural and, increasingly, commercial factors. The technology itself is undeniably important, but equally if not more important is how people use and view technology, a point that has been largely overlooked. Just because mobile devices carry a potential to, say, help improve the literacy skills of women in resource-poor communities does not mean that these devices will actually be employed towards this end. Indeed, across the world women are far less likely than men to own and use mobile devices, and in many communities women are discouraged from using mobile technology for any purpose, learning included. Mobile devices are often banned from schools and other centres of education, despite considerable and, in many instances, well-established potential to enhance learning. Such bans project a view that mobile devices are antithetical to learning, and this outlook, regardless of its factual validity, impacts the way people interact with technology. Over the next fifteen years, the implementation of mobile learning projects and the pedagogical models they adopt should be guided not only by the advantages and limitations of mobile technologies but also by an awareness of how these technologies fit into the broader social and cultural fabric of communities.

Education and technology can and should co-evolve in mutually supportive ways. While people tend to think of education as perpetually lagging behind technology, there are numerous instances in which education has prompted technical innovation. For example,

some historians argue that Alan Kay's 1968 Dynabook, an early prototype of the laptop computer, came into existence as a means of helping students learn through 'new media'. Kay drew on the theories of well-known learning specialists to inform the design and functionality of the device (Dalakov, 2013). The Massachusetts Institute of Technology's (MIT) Scratch tool, an innovative programming language that allows users to drag and drop code elements instead of typing them, was designed to help students learn authentic programming skills while creating their own interactive stories, games, music and art (BBC, 2012; MIT, n.d.). Software innovators have regularly taken cues from highly specific learning theories. SuperMemo, for example, is an application that attempts to facilitate the movement of information from short-term to long-term memory (Wolf, 2008). It works by drawing on research about memory retention and loss to help users optimize when they study and review information. Education can also dictate hardware design choices. In Russia, the E-OK tablet computer has two screens: one for reading and one for writing. This configuration, and the technology that underlies it, was developed specifically to accommodate educational tasks (Silver, 2012). Many in the education community are working to ensure that changes in technology push pedagogy forward and, conversely, that innovations in pedagogy influence technology. While important developments are already underway, a great deal remains to be done in the coming years to ensure that technology is relevant to education and education is relevant to technology.

With the unprecedented rate of technological change, it may seem nearly impossible to imagine what mobile learning will look like a decade from now, let alone two decades. Yet exploring these questions is an important exercise, as the future will be moulded by the decisions made today. With the right social and political supports and, most immediately, mechanisms to train practitioners to design mobile learning interventions, mobile leaning has the potential to transform educational opportunities and outcomes. This report helps guide the way by highlighting issues and questions likely to steer mobile learning over the next fifteen years and beyond. It begins by presenting an overview of the current state of mobile learning, describing recent mobile learning developments in formal and informal education, seamless learning and educational technology. Based on current trends, the report then makes predictions for the future of mobile learning, forecasting likely technological advances and mobile learning focus areas. Subsequent sections discuss mobile learning in light of Education for All (EFA) goals, both now and in the future, and identify the primary enablers for mobile learning as well as the main barriers to its development. Finally, the report presents the broad, overarching challenges to be met over the next fifteen years, in order for mobile learning to be integrated into mainstream education and impact teaching and learning on a global scale. Ultimately, the report seeks to provide policy-makers and other education stakeholders with a tool to better leverage mobile technologies in the ongoing effort to improve educational access, equity and quality for all.

METHODOLOGY

To promote the development of sound plans regarding the educational use of mobile technologies, UNESCO interviewed a diverse group of experts about the future of mobile learning. These experts – proponents of mobile learning who are directly involved in its research, design, development or implementation – shared their ideas about how mobile learning can advance EFA goals now and in the years ahead.

This report summarizes these interviews as well as relevant literature. It begins by describing the current state of mobile learning and then shifts focus to the future, identifying both opportunities and challenges that are likely to be encountered over the next fifteen years. The report discusses the challenges in relation to EFA goals and establishes a roadmap that can inform the future design, development and implementation of mobile learning projects.

DEFINITIONS AND SCOPE

TIME HORIZON

UNESCO's overarching educational priorities are outlined in the Organization's Education for All goals (UNESCO, n.d.). Adopted by the international community at the World Education Forum in 2000, these high-level objectives set specific targets for improving educational opportunities for learners around the world by 2015. As this deadline approaches, many of the targets are still unmet. UNESCO is currently working on establishing the next set of educational goals, which will incorporate existing objectives as well as establish new ones, with a similar fifteen-year timeline. In an effort to inform this process, this report focuses on the year 2030 as a time horizon.

MOBILE TECHNOLOGIES

While the other papers in this Series tend to focus on mobile phones because of their current ubiquity and affordability, this report discusses mobile technologies more generally. Mobile devices such as tablet computers and wireless touch-screen readers will be significantly more affordable and accessible in the year 2030. Additionally, mobile data will be seamlessly available across all personal devices. Of course, it is extremely difficult to predict what new mobile devices might look like fifteen years from now. For this reason, UNESCO simply recognizes that mobile devices in the future are likely to share core characteristics with their present-day peers: that is, they will be digital, easily portable, usually owned and controlled by an individual rather than an institution, able to access the internet and other networks, multimedia-capable, and able to facilitate a large number of tasks, particularly those related to communication. Thus, for the purposes of this paper, mobile devices include any portable, connected technology, such as basic mobile phones, e-readers, smartphones and tablet computers, as well as embedded technologies like smartcard readers.

EDUCATION

For the purposes of this report, education is not limited solely to learning in formal settings (i.e. schools) but rather refers to all aspects of teaching and learning for all types of learners – children, youth and adults. While physical schools are likely to remain the nexus of formal education, alternative and supplementary learning models and distance learning will become more prevalent as mobile technologies improve and spread. For this reason the paper addresses a wide array of learning contexts. From a policy perspective, the report focuses on both formal and informal learning, while remaining sensitive to the challenge of making large-scale changes to formal education structures.

GEOGRAPHY

This paper considers learners in both developed and developing countries. Because UNESCO's most pressing work concentrates on reaching communities in need, the report pays special attention to the developing world, with an understanding that communities in need can include learners in developed countries as well. However, it is also necessary to study mobile learning trends in the developed world, because these countries are often the first to adopt new technologies.

THE CURRENT STATE OF MOBILE LEARNING

Today, mobile technologies – originally marketed mainly as communication and entertainment devices – have come to play a significant role in economies and society at large. Mobile devices have impacted nearly every field, from banking to politics, and are currently being used to increase productivity in numerous sectors. As these devices become increasingly prominent worldwide, there is a great deal of excitement building around mobile learning. Students and teachers are already using mobile technologies in diverse contexts for a wide variety of teaching and learning purposes, and key educational players – from national education ministries to local school districts – are experimenting with supportive policies to promote innovative mobile learning in both formal and informal education settings. Many of the experts interviewed for this report feel that mobile learning is now on the threshold of a more systematic integration with education both in and outside of schools. Decisions made today will fundamentally influence the character of mobile learning in years to come. To help set the stage for these decisions, the following sections outline some of the most prevalent trends in mobile learning to date. These include innovations in formal and informal education, seamless learning and educational technology.

FORMAL EDUCATION

The presence of mobile devices in formal education systems is growing. Globally, two of the most popular models for mobile learning in schools are one-to-one (1:1) programmes, through which all students are supplied with their own device at no cost to the learners or their families; and Bring Your Own Device (BYOD) initiatives, which rely on the prevalence of learner-owned devices, with schools supplying or subsidizing devices for students who cannot afford them. As might be expected, the 1:1 model tends to be more common in poorer countries and regions, while the BYOD strategy is usually implemented in wealthier communities where mobile device ownership among young people is nearly ubiquitous.

ONE-TO-ONE PROGRAMMES

The goal of 1:1 programmes is to supply every learner with his or her own mobile device – be it a laptop computer, tablet or smartphone. The advent of cheaper and smaller netbooks, and more recently tablet computers, have helped make this objective more attainable (GSMA, 2011). Many ambitious 1:1 initiatives – notably the One Laptop per Child (OLPC) programme – have been launched to target learners in developing countries and communities in need. OLPC has been severely criticized by development studies researchers, who argue that the programme, with its 'utopian' vision of education, fails to consider the complex social problems faced by learners in marginalized communities and the historical context of technology and development (see for example, Warschauer and Ames, 2010; Ananny and

Winters, 2007). The programme has, however, been successful in promoting the concept of 1:1 computing among policy-makers. In Latin America this model is becoming increasingly widespread, and 1:1 programmes are now the primary focus of many national policies for ICT in education in the region (Lugo et al., 2012). In North America and the United Kingdom, initiatives to provide graduate and final-year undergraduate students with tablet computers are becoming popular (see Taylor et al., 2010, for an example from medical education).

The main barriers to 1:1 programmes are the high costs associated with purchasing and maintaining a device for every student, and the need to work closely with education ministries to ensure effective roll-out. Furthermore, some 1:1 initiatives have focused more on providing access to technology than on training teachers and students to use technology to facilitate learning. For this reason many of these programmes have failed to have a positive impact on education, highlighting the fact that 'although access is important, it is not sufficient' (Valiente, 2010). The great potential of 1:1 seems to be universally accepted, but the question of how best to use that ratio to support learning is still a work in progress.

BRING YOUR OWN DEVICE (BYOD)

One viable way achieve a 1:1 environment is to have students use the mobile devices they already own. This model, known as BYOD, is already causing a major shift in higher education and distance learning by allowing more students to access course materials via mobile technology. As mobile access and ownership increases, BYOD holds promise for learners around the world, although it may look drastically different across various regions and countries. While the strategy has been most popular in countries and communities where smartphone and tablet ownership is widespread, learners and educators have also found ways to capitalize on less sophisticated student-owned technologies. The Nokia MoMath project in South Africa, for example, uses the SMS (Short Message Service) features on standard mobile phones to provide students with access to mathematics content and support (Isaacs, 2012*b*).

While BYOD moves the hardware costs from the school to the learner, it places additional pressure on bandwidth – a critical infrastructure consideration for mobile learning initiatives. Schools or governments implementing BYOD programmes must also have a strategy in place to provide devices to students who cannot afford them, either by buying the devices for the students or subsidizing their purchase. Further issues include security, privacy, adequate professional development for teachers, and a digital divide between students with cutting-edge devices and those with less powerful devices or none at all. For these reasons, examples of successful BYOD initiatives, particularly in primary and secondary institutions, are limited. However, as sophisticated mobile technologies become increasingly accessible and affordable, BYOD may form a central component of mobile learning projects in the future (Norris and Soloway, 2011).

INFORMAL EDUCATION

Mobile learning has developed, to a large extent, outside of formal education contexts, and the vast majority of mobile learning projects are designed for informal learning. Nokia Life

Tools, for example, is an SMS and browser-based subscription service that offers a wide range of information about health care, agriculture and education. The service is currently available in China, India, Indonesia and Nigeria. Currently over 90 million people have used Nokia Life services (Bartlett, 2012). While there is certainly value in mobile learning projects focused on information dissemination, there is also tremendous opportunity to build on the success and reach of programmes like Nokia Life Tools to deliver more complex educational experiences to learners via mobile devices.

SEAMLESS LEARNING

Seamless learning is defined as uninterrupted learning across different environments – including formal and informal settings. In the ideal seamless learning scenario, a learner opportunistically uses various kinds of technologies, capitalizing on the unique affordances of each – the mobility of a smartphone, for example, or the superior keyboard on a desktop computer – to maintain continuity of the learning experience across a variety of devices and settings. Historically, there has been a significant divide between the formal learning that happens inside a classroom and the informal learning that occurs at home or in community environments. Numerous experts are investigating how mobile learning might help break down that barrier and bridge the gap between formal and informal learning.

Researchers in Singapore, for example, have been focusing on mobile technologies to facilitate primary school students' learning across contexts and locations. The Leveraging Mobile Technology for Sustainable Seamless Learning in Singapore Schools (SEAMLESS) project was a three-year longitudinal study that pioneered the use of mobile devices as 'learning hubs' to integrate personal learning tools and provide a single place to store each students' learning history and resources (Looi et al., 2010; Learning Sciences Lab, 2010). The research has resulted in design frameworks to inform practice, as well as the identification of ten dimensions of seamless learning, which include: formal and informal learning, personalized and social learning, learning across time, learning across locations, ubiquitous knowledge access, physical and digital worlds, multiple device types, multiple learning tasks, knowledge synthesis and multiple pedagogical models. This type of holistic approach to learning, facilitated by ubiquitous mobile devices, should be an overarching goal for the future of education.

EDUCATIONAL TECHNOLOGY

Recent innovations in mobile technologies have mostly centred around the creation of digital content, largely in the form of digital textbooks accessed via e-readers, and the development of mobile applications (apps) and software platforms for accessing educational resources via mobile devices.

DIGITAL TEXTBOOKS AND E-READERS

In formal education settings in the developed world, the transition to digital textbooks is one of the most established mobile learning trends. As e-readers and e-reading applications continue to improve, the experience of reading electronically is rapidly becoming more pleasurable and conducive to learning. New approaches to textbook conversion and creation are moving away from mere digital reproductions of printed text to visually rich interfaces that can include multimedia, interactive and collaborative elements (GSMA, 2011).

The next generation of e-readers and tablets will offer new possibilities for teaching and learning. For example, e-books could enable a more social form of study, with a group of students collaborating to read, annotate and compare one or more texts on the same topic, each working from their individual mobile device (Sharples et al., 2012). Future e-books could exploit the tools built into mobile devices – such as voice recorder, camera, timer, GPS (Global Positioning System) locator, accelerometer, compass and tilt sensor – for exploratory learning, guiding the reader through experiments like testing the properties of light using the device's camera or sound using the recorder (Sharples et al., 2012). As tablet and e-reader technologies improve in quality and decrease in price, this movement towards digital textbooks could increase educational opportunities for learners around the world, particularly those who do not currently have access to high-quality physical materials.

MOBILE APPS

Marketplaces for mobile apps have provided an entirely new distribution mechanism for content, stimulating substantial investment in software development for mobile devices. Educational apps are already experiencing significant growth in developed countries. These apps provide new tools for educational activities such as annotation, calculation, composition and content creation. A recent study found that 270 million apps linked to education were downloaded in 2011 – a more than tenfold increase since 2009 (McKinsey & Company and GSMA, 2012).

While a small number of educational apps are mapped to curriculum targets and designed for use in classroom or homework settings, the majority are intended mainly for informal learning (GSMA, 2011). However, as more students use mobile devices in formal education settings, apps will likely become an important part of the mobile learning ecosystem. Not only are developers now able to bypass institutions and sell content directly to learners, but students, teachers and schools alike will be able to make small, incremental investments in micro-sized pieces of content. For example, rather than investing in the same textbook set or software solution for an entire classroom, school, district or country, educators will be able to choose from a variety of apps that are tailored to each individual learner, powering the personalized learning that is expected to characterize formal education in the future.

THE FUTURE OF MOBILE LEARNING

With over 5.9 billion mobile phone subscriptions worldwide, mobile devices have already transformed the way we live. But even though people around the globe rely heavily on mobile technology, educators and policy-makers have yet to tap its full potential to improve learning. The next decade and beyond could be transformational in incorporating mobile technologies in both formal and informal education to better meet the needs of learners and teachers everywhere. The following sections describe some of the technological advances most likely to impact mobile learning in the future, and highlight key focus areas in the development of mobile learning over the next fifteen years.

TECHNOLOGICAL ADVANCES

In the next fifteen years, technology will change in numerous ways that can be leveraged for education. It is important that educators understand these innovations so as to influence their development rather than simply react to it. As noted earlier in this report, ideally technology and education will co-evolve, with educational needs driving technological progress as well as adapting to it. Outlined below are some of the technological advances most likely to impact teaching and learning from a global perspective.

1. Technology will be more accessible, affordable and functional

While unforeseen technological innovation is certain, the advances that will have the greatest impact on education will likely stem from a continuation of the current and most important trends in technology evolution – namely improved functionality, connectivity and memory at lower costs. Increased availability and penetration of 'smart' mobile devices and cloud-based services with advanced functionalities will open up a world of new possibilities for mobile learning solutions, allowing the types of initiatives that are currently happening to be replicated on a large scale. Many experts imagine a day where every learner in the world has access to a powerful touch-screen tablet device and can afford both the hardware and the connectivity that enables fast and seamless access to the internet and/or other networks.

2. Devices will be able to collect, synthesize and analyse massive amounts of data

According to IBM (n.d.), 90% of the data in the world today has been created in the last two years alone. Increasingly, data is being collected in a multitude of forms: from personal data to institutional data, most information is being recorded. This vast global data set is commonly referred to as 'big data'. In the education sector, big data can come from many sources: profiles of student work, assessment results, attendance records, GPS coordinates, time spent on particular tasks or assignments, and information produced or used by students, including texts, pictures, videos or music. In the future, devices connected to the cloud will have the capacity to synthesize significantly larger amounts of data and begin analysing them for patterns. Mobile devices will be able to quickly manage

and process data sets much larger than current tools can handle. This increased ability to collect, synthesize and analyse data will enable new opportunities in areas such as learning analytics and learning profiles.

3. *New types of data will be available*

Many mobile devices already have a number of different types of sensors which can, for example, sense sound through a microphone, location through GPS, and movement, speed and direction through an accelerometer. Current uses of these sensors include mobile apps that analyse sleep patterns and monitor vital signs. Not only will these sensors become increasingly accessible in the future, but new and more complex sensors will emerge. New types of data, combined with the growing amount of data collected through mobile technology, will enable closer relationships between learners and their devices. Devices will 'know' their owners and be intimately and intelligently connected to them, enabling more personalized and contextual learning through mobile technology.

4. *Language barriers will be broken down*

Given recent advances in natural language recognition – including Apple's Siri application, Nuance's Dragon software and Google's Google Voice message transcription service – mobile devices may soon be able to successfully and seamlessly translate spoken language as well as text with a high degree of accuracy. If translation apps improve significantly, learners will have access to a far wider range of educational resources and content. This will not only help learners who speak regional or minority languages gain access to majority-language materials, but will also allow majority-language speakers to take advantage of resources available only in minority languages.

5. *Screen size limitations will disappear*

Currently screens on mobile devices are, by necessity, small. Unless applications are built specifically with mobile devices in mind, images and text may be either too small and cause eye-strain, or too large and require constant scrolling. This limiting factor can pose a challenge to mobile learning. In the near future, however, the size of the device in-hand and the device in-use will be different. For example, flexible display technologies, such as those showcased by Samsung at the 2013 International Consumer Electronics Show (CES), will allow users to fold a tablet-sized screen in half or roll a large screen into a small cylinder for easy portability (Dudley-Nicholson, 2013). Projectors or glasses, such as the recently announced Google Glass augmented reality spectacles, will be able to display much larger screens than those physically available on a device, with excellent resolution and 3D capabilities (The Telegraph, 2013). This could, for example, allow a learner to see a large and detailed image in its entirety or better facilitate long-form reading.

6. *Energy sources and power capacity will improve*

Limitations in energy and power capacity can be barriers to mobile learning programmes, particularly in developing countries where access to electricity is often unreliable or prohibitively expensive. Drastic improvements will be made in this area as batteries become smaller, cheaper, longer lasting and faster to charge, and as new energy sources emerge. The University of Illinois, for example, is working on a lithium ion battery that

fully charges in two minutes (The Economist, 2011). Solar cells are increasingly viable sources of energy as they become smaller, more efficient and cheaper to produce. Researchers are working on alternative energy sources, ranging from kinetics-based solar and wind power to power through the human heartbeat. As energy sources and power capacity improve, infrastructure issues in many of the world's poorest areas will be less of an impediment to mobile learning.

It is important to note, however, that the communities most in need, in both developed and developing countries, are often the last to access technological innovations for learning. As the pace of technology development increases, this disparity must be addressed to ensure that learners living in poor and underserved areas are not left behind.

MOBILE LEARNING FOCUS AREAS

In the next fifteen years, mobile learning will undoubtedly become more integrated with mainstream education. Just as computers are now viewed as a crucial component to learning in the twenty-first century, mobile technologies will soon become commonplace in both formal and informal education, and gradually even the term 'mobile learning' will fall into disuse as it is increasingly associated with learning in a more holistic rather than specialized or peripheral sense. As the links between technical and pedagogical innovations improve, mobile technology will take on a clearly defined but increasingly essential role within the overall education ecosystem. The following sections outline the anticipated focus areas for mobile learning development in the foreseeable future.

DISTANCE EDUCATION AND EXPERIENTIAL LEARNING

One of the most noticeable recent trends in technology-enhanced learning has been the expansion and proliferation of Massive Open Online Courses (MOOCs). It is likely that this trend will continue, given the political support it has received and the openness of universities to embrace these courses as a way of increasing student numbers. Over the coming years, mobile technologies will enable MOOCs and other forms of distance education to offer more personalized assessment and tutoring. Distance learning will be able to extend into fields that typically require *in situ* learning, such as medicine and many forms of vocational training. Learners will be able to collect data on their practice and share and discuss information with professors, tutors, mentors and peers via mobile technologies. Gamification – the use of game mechanics in a non-game context to engage users – may also become more popular in distance education (Wikipedia, 2013). The practice of rewarding points to people who share experiences and information on social networking sites like Facebook could be applied to MOOCs as a way of motivating experienced participants to mentor and support newcomers. All of these types of interactions can and will be facilitated by mobile technologies.

Mobile technology will also enable the expansion of experiential and location-based learning, which refers to learning within and about locations – for example on field trips, tours of heritage sites and museums visits. Much research has already been conducted in this area, particularly in the UK. Walker (2010), for example, has suggested ways in which technology

can help museum visitors manage the information they encounter through well-designed and structured mobile learning activities. In the coming years, advances in this type of experiential learning will continue, especially as embedded and increasingly sophisticated location-aware technologies become more common in mobile devices.

AUTHENTIC AND PERSONALIZED LEARNING

The current trend towards authentic and personalized learning will continue over the next fifteen years with the aid of mobile devices. Mobile technology can support learners in exploring the world around them and developing their own solutions to complex problems while working in collaboration with peers under the guidance of skilled teachers. New sensor technologies on mobile phones, coupled with new visualization technologies in the classroom, will open up insights into physical phenomena that will be particularly useful for science learning. Already there are a number of applications that use the image-capturing capabilities of smartphones and other mobile devices to, for example, help students studying botany identify different types of trees and plants they encounter in their day-to-day lives (Leafsnap, 2011). In recent years, much research has focused on the use of mobile data collection tools in epidemiology – such as Imperial College London's (2013) EpiCollect application and Nokia's (2012) Nokia Data Gathering project – which allow for the collection and real-time analysis of new kinds of data sets.

The personalization features of mobile technologies will allow learners of differing abilities and at different stages of development to progress at their own pace. Learning technologies that use artificial intelligence (AI) will become more widespread in education and will be increasingly available on mobile devices. As this is an emerging field, initial uses of AI in mobile learning in the coming years may focus on relatively simple or straightforward activities. Educators will need to ensure that this is balanced by personalized interventions that support more complex and multidimensional opportunities for learning. This will enable the development of new forms of personalized support for mobile learners. The effective design, development and implementation of personalized learning strategies require vast resources and massive investments from national education ministries. Yet this investment is likely to be worthwhile, as personalized learning holds the potential to fundamentally transform models of teaching and learning and make education more relevant, engaging, authentic and effective for students everywhere.

NEW FORMS OF ASSESSMENT

In the next fifteen years, mobile technologies will play an increasingly important role in educational assessment. Advances in how learning practices are recorded and evaluated, using different types of data collected across multiple settings and contexts, will allow researchers to monitor the various activities learners engage in and better determine the effectiveness of mobile learning interventions. Mobile technologies will also enable more self-evaluation and reflection throughout the learning process. Learners will be able to collect data to help them understand and describe their own learning practices. This data can be used to compile 'portfolios of practice' which, in conjunction with more traditional forms of summative assessment, will give learners, teachers and researchers a more holistic sense of a learner's progress over time. Self-assessment will also be used increasingly in the evaluation

of mobile learning projects, bringing students' perspectives on their own learning to the fore. Researchers will be provided with credible accounts of what elements of a project were most useful to students, and the contexts in which these elements were useful, to gain a richer and more in-depth understanding of how mobile devices support learning (Pawson and Tilley, 1997).

MOBILE PROGRAMMING

Over the next fifteen years, students will not just use mobile devices to assist their education but will learn to program the devices themselves, developing, building and tailoring mobile applications to suit their individual desires and needs. In the process they will learn about computational thinking – the key concepts underlying approaches to programming and problem-solving – and gain vital skills for participating in the twenty-first century global economy. Indications of this trend can be seen through the emergence of mobile development labs (or tech hubs) across Sub-Saharan Africa (BongoHive, n.d.), and a recent focus on increasing the number of female software developers through coding communities such as AkiraChix (2011) in Kenya. In Europe, the rise of mobile programming in education is evidenced by the growing popularity of mobile applications for social change, such as Apps for Good (2012); projects that support young people's coding skills, including CoderDojo (2012); and cheap computing alternatives, like Raspberry Pi (n.d.). The challenge for policy-makers is to maintain the current level of excitement around new programming opportunities, and to encourage the integration of mobile programming with formal education, not only in the field of computer science but also in the wide range of disciplines in which computational thinking plays a role.

GLOBAL SOCIAL INTERACTION

Already in classrooms around the world, joint projects with students at other schools or in other countries, facilitated by mobile technologies, are increasingly used as a means of exposing learners to a variety of cultures and perspectives. British Council's Schools Online project, for example, part of the larger Connecting Classrooms global education programme for schools, supports partnerships between schools in the UK and developing countries using technology (British Council, n.d.). International oral history projects can also be aided by mobile technologies, as audio and visual recordings can be easily produced, edited and uploaded using mobile devices. As these types of projects increase over the next fifteen years, mobile technologies will enable greater levels of international collaboration, including the collective compilation of vast global databases for educational purposes.

MOBILE LEARNING AND EDUCATION FOR ALL (EFA)

In 2000, the international community agreed to work towards a set of goals to improve educational quality, access and equity around the world. UNESCO's Education for All agenda seeks to provide quality basic education for all children, youth and adults by bringing together governments, development agencies, civil society and the private sector. EFA aims to accomplish six distinct goals by 2015 (UNESCO, 2000):

1. Expanding and improving comprehensive early childhood care and education, especially for the most vulnerable and disadvantaged children.

2. Ensuring that by 2015 all children, particularly girls, children in difficult circumstances and those belonging to ethnic minorities, have access to and complete free and compulsory primary education of good quality.

3. Ensuring that the learning needs of all young people and adults are met through equitable access to appropriate learning and life skills programmes.

4. Achieving a 50 per cent improvement in levels of adult literacy by 2015, especially for women, and equitable access to basic and continuing education for all adults.

5. Eliminating gender disparities in primary and secondary education by 2005, and achieving gender equality in education by 2015, with a focus on ensuring girls' full and equal access to and achievement in basic education of good quality.

6. Improving every aspect of the quality of education, and ensuring excellence so that recognized and measurable learning outcomes are achieved by all, especially in literacy, numeracy and essential life skills.

As mobile technologies advance and the concept of mobile learning gains traction worldwide, these goals are a useful starting point for aligning mobile learning objectives with the wider UNESCO policy agenda.

CURRENT EFA GOALS

Currently, few mobile learning initiatives aim to promote EFA goals generally, and even less are designed to address them directly. This section suggests a way forward by highlighting current exemplars of mobile learning that support EFA goals, and making recommendations for building on these efforts over the next fifteen years. However, due to the high-level nature of the EFA goals, it can be challenging to discuss in detail how such a broad agenda can be advanced by mobile learning. Instead, the report identifies four key themes that run across the

goals: access, life skills, gender equality and learning outcomes. The following sections consider each theme in relation to mobile learning activities both now and in the future.

ACCESS

WHERE ARE WE NOW?

In current mobile learning projects, access is primarily defined as access to educational opportunities through the dissemination of content. There are many examples of these types of programmes aimed at learners both in and out of school. BridgeIT is a global mobile learning initiative originally started through an alliance between Nokia, the International Youth Foundation, the Pearson Foundation and the United Nations Development Programme. It has created a sustainable, scalable and replicable platform for delivering educational videos aligned with science, mathematics and English language curricula to classroom TV sets through mobile phones. In the Philippines, where the project is called Text2Teach (T2T), contemporary multimedia content is provided to schools where textbooks are often out of date. Since its launch in 2003, T2T has served more than half a million students in 555 schools in 9 provinces of the Philippines (Deriquito and Domingo, 2012). More than 1,500 teachers have also been trained, not only in math, English and science subjects, but also on how to use the T2T tools for teaching.

Perhaps the most well-known access-oriented project is One Laptop Per Child. Some of the criticisms of OLPC – namely that it fails to account for the complex social, cultural and technological contexts in which it works – have already been articulated earlier in this report. Nevertheless, the programme has been highly influential in promoting 1:1 computing and has raised awareness about the importance of access to personal mobile devices among policy-makers worldwide.

WHAT DO WE NEED TO DO IN THE NEXT 15 YEARS?

In designing mobile learning projects to increase educational access, educators should address two key issues: (i) the conceptualization of access and (ii) access sustainability.

Many existing mobile learning projects are based on a one-dimensional concept of access. While access to information is a necessary first step towards increasing learning opportunities, particularly in areas where very few educational materials are available, too often mobile learning efforts stop here. Indeed, the lack of activity in this area was highlighted by a recent UNESCO mobile learning report:

> In spite of the potential of mobile learning to help achieve UPE [Universal Primary Education], research for this review found little evidence of the use of mobile phones to expand access to formal primary schooling for children who are not [presently] in school. (Isaacs, 2012*b*, p. 21)

There is a good deal of educational research to draw from when conceptualizing access in relation to formal education. For example, since 2006 the Consortium for Research on Education Access, Transitions and Equity (CREATE), funded by the UK Department for International Development, has worked to understand the different dimensions of access, with a focus on meaningful learning, sustained access and equitable access provision. Simply put,

access to education is about much more than access to content. To frame it in this way misses much of the complexity of what education and learning are about and how they should be supported. Significant work remains to be done to determine how mobile learning can support learners' educational development over time, particularly within formal education structures.

Sustainability of access is also an important issue when considering mobile learning strategies. On the one hand, programmes based on technologies that are unavailable to most learners without funding or subsidies will be less sustainable than those that rely on technologies already owned by learners. New mobile technology should be integrated with current technologies and practices, and mobile learning programmes should be co-designed with communities to best address their specific needs. India's Barefoot College, which uses low-end mobile phones, radio and personal computers (PCs) to help train women in solar engineering, health care, water testing and social activism, is a good example of this practice (Williams, 2011). The top-down imposition of unsustainable technologies by well-intentioned researchers and NGOs should be avoided outside of clearly framed and highly targeted trials. On the other hand, however, with the rapid pace of technological innovation, programmes designed for more basic technologies may quickly become outdated or obsolete. As more sophisticated technology becomes available over the next fifteen years, designers of mobile learning projects will need to find a balance between capitalizing on the prevalence of low-end technology to provide sustainable access in the present and the immediate future, and leveraging the potential of high-end technology to ensure sustainable access in the long term.

LIFE SKILLS

WHERE ARE WE NOW?

One of the key successes of mobile learning has been its promotion of life skills, including literacy and numeracy. For example, BBC Janala is a Bangladeshi programme for citizens who want to improve their English language skills in order to get a better job and participate in the global economy. Launched in 2009 by the BBC World Service, the initiative harnesses multimedia technology to provide affordable education to potentially millions of people in the Bangladeshi-speaking community. The BBC Janala project includes low-cost mobile subscriptions, television drama and game shows, and lessons in the leading national newspaper. The programme, which targets learners from low-income socio-economic groups, has been tremendously popular, reaching 3.5 million users within the first year alone.

A second example of mobile learning to promote life skills is the Nokia Mobile Mathematics (MoMath) project in South Africa, which uses mobile phones to provide students in Grades 10–12 with access to mathematics content and support. The math content – aligned with the country's national curriculum and approved by the Department of Education (DOE) – is freely available to participating learners and teachers who have received appropriate training to support students. During the pilot phase of the project, content and learning interventions were accessed via a low-cost proprietary chat platform hosted by a private company called MXit that is popular among South African youth; since 2012 there has also been a browser-based version of the service available online. South Africa's local mobile network operators support free access to the platform, which learners use to complete math exercises, take tests

sent by their teachers and participate in competitions. Since the project commenced in 2008, it has expanded to reach 50,000 learners, 800 teachers and 200 schools in 4 provinces of South Africa. Later in 2013 the service will be opened for informal learning to all South African people, and a version of the project will be implemented in Tanzania. A separate pilot project aimed at facilitating teacher development will also be launched in Senegal. Preliminary findings in South Africa suggest that the primary educational objective of improving math performance is being reached. An evaluation of the project in 2010 revealed a 14% increase in mathematics competency, with 82% of learners using the service outside of school hours, during holidays and weekends (McCormack, 2010). The successful implementation of the programme was a result of its diverse partnership model that included official support and active involvement from the DOE nationally and provincially, a local NGO, three major mobile network companies, Nokia, a local textbook publisher, and the chat platform company MXit (Isaacs, 2012*b*).

WHAT DO WE NEED TO DO IN THE NEXT 15 YEARS?

As increasingly powerful mobile devices become widely available, they will offer new opportunities for teaching and learning life skills, particularly literacy and numeracy. Recent research in language learning provides an interesting preview of what this might look like. Scholars have developed a mobile application, called miLexicon, which supports users in learning a new language anywhere and at any time (Underwood et al., 2012). Learners use the app to collect words and phrases they come across in everyday life. Then, from within miLexicon, they use their preferred resources (e.g. dictionaries, social media and email) to research, practice and share this vocabulary. Within the next fifteen years, mobile applications like miLexicon will proactively guide and support learners through activities appropriate to different settings to facilitate useful and lasting learning. For example, a mobile app might use location detection technology to remind learners to practice new food-related vocabulary while at a restaurant. The development of such learning apps requires a combination of strong pedagogical design skills, artificial intelligence techniques to support personalization of the learning experience, and knowledge of user experience (UE) to develop robust interfaces.

GENDER EQUALITY

WHERE ARE WE NOW?

Many mobile learning interventions focus on empowering women, particularly those involved in small businesses (GSMA mWomen, n.d.). Initiatives like the Pink Telephone Project in Cambodia have been successful in creating networks of females who support each other and their communities (Sophasawatsakal, 2012). Text4baby, a free mobile health education service in the United States, is closely aligned with the EFA goal of expanding and improving early childhood care, as well as empowering women. The programme targets the 1.5 million women who give birth each year while receiving assistance from Medicaid – the primary funding source for medical and health-related services for people with limited income in the USA. The Text4baby service provides personalized and scientifically reviewed health tips, reminders and information about community resources, delivered via SMS text messages to the mobile phones of subscribing women. Many of these women lack access to the internet and other sources of health information, but the vast majority of them do have a mobile

phone, and a reported 80% of Medicaid beneficiaries use text messaging (Text4baby, 2011). What is unique about this initiative is not the use of SMS to spread educational messaging to a community in need, but the successful public-private partnerships that have enabled the project to reach hundreds of thousands of mothers. Partnerships, particularly those that bridge different sectors, are often touted as an answer to social problems. However, good models of such partnerships are few and far between, as it can be extremely difficult to get different agencies, companies and sectors to work together effectively. In the case of Text4baby, the National Healthy Mothers, Healthy Babies (HMHB) Coalition initiated the effort, tapping into their extensive network of partners to provide a variety of focused services and expertise. Voxiva, a global provider of mobile health services, created the text-messaging platform. Experts at the Center for Disease Control oversaw content development. CTIA-The Wireless Association, a non-profit advocacy group, worked with wireless carriers to transmit messages free of charge. Grey Healthcare Group handled the branding and marketing, with MTV as a media sponsor. The US government has supported the programme through numerous agencies, championing the service and funding programme evaluations. Numerous corporate partners, including Johnson & Johnson, have made multiyear, multimillion dollar funding commitments. The involvement of over 500 organizations, each uniquely and expertly contributing to the project, is clearly a key factor in the success of this initiative.

WHAT DO WE NEED TO DO IN THE NEXT 15 YEARS?

Over the next fifteen years, improving the lives and learning of women and girls, as well as men and boys, will continue to be an international development goal. Currently more research is needed on how mobile learning can be designed to support female learners, particularly those living in underserved communities with minimal access to educational resources or technology. Designers of mobile learning interventions will require a better understanding of current mobile phone use and its potential to increase educational opportunities in the long term, as well as an increased awareness about the everyday difficulties faced by women and girls in many developing countries. A recent cross-country analysis from Ghana, Kenya and Mozambique, conducted by the Institute of Education at the University of London and ActionAid International, provides an example of how the context of girls' lives affects their learning opportunities:

> While increasing numbers of younger girls are enrolling in schools, in the later years of primary school girls' enrolment drops, most markedly in the Kenyan schools where the number of girls in the last class of primary school in 2009 was almost ten times lower than in the first year. Poverty intersects with gendered inequalities in creating barriers to schooling for girls, with girls missing out on schooling because of household chores and childcare, farm work, inability to pay school fees, early pregnancy and marriage. In the schools themselves, particularly in the project areas in Kenya and Ghana, there is a shortage of well qualified women in teaching and management positions, and gendered attitudes favouring boys, gendered division of labour, and poor conditions and resources hinder girls' capacity to enjoy, achieve and thrive in school. (Parkes and Heslop, 2011)

Given these stark realities, the development of mobile learning projects that support women and girls both in and outside of formal education systems should be a priority for educators and policy-makers over the next fifteen years and beyond.

LEARNING OUTCOMES

WHERE ARE WE NOW?

Learning outcomes refer to what students should be able to achieve after undertaking a particular learning activity, for example a course module. However, mobile learning outcomes are often difficult to define or measure, because learning occurs in any number of settings and often informally. Moreover, much mobile learning happens in collaboration with other educational activities. While this complexity offers many new opportunities for learning, it also complicates the task of gathering data on the impact of mobile learning projects. Vavoula and Sharples (2009) have discussed this issue, citing the unpredictability of mobile learning, including the dynamic nature of the setting, unexpected interactions and unplanned events. These factors create challenges for determining learning outcomes at the outset of a project:

> When evaluating learning in a traditional classroom, researchers generally have access to information about these context elements before, during and after the learning experience. Thus, they can inspect the classroom and interview the teacher and learners in advance of a lesson to discover the objectives, methods, lesson plan and tools. To evaluate a school museum visit or field trip, the researcher can visit the site and inspect the lesson plan, but will generally not know in advance the route that each student will take. For personal or family visits to museums or other learning sites, neither the objectives nor the trajectory may be known in advance. Learning objectives may arise as a response to interactions with the environment and learning trails may be guided by curiosity or unplanned events. The learners themselves may not be known in advance, for example when evaluating the learning experience of museum visitors randomly selected at the museum entrance. Personal mobile learning embraces any learning event where people, individually and collectively, continually create micro-sites for learning out of the available physical and social resources. In considering this generic case, the setting, objectives, methods and processes may all be unpredictable. (ibid., p. 55)

Laurillard (2012*b*) has focused on the need to design new ways of learning with technology to achieve specific outcomes. As with other technology in education initiatives, this is a complex process. Educational research argues that less emphasis needs to be placed on trying to quantify exactly what a particular intervention achieves. Instead, energy should be directed towards expanding educational offerings that appeal to and will benefit learners in myriad ways and settings, and investigating how their learning practices, rather than their learning outcomes, change and develop over the course of the intervention. At mobile learning's present stage of development, what is most important is offering new kinds of learning opportunities that were not available previously, rather than just making marginal improvements to traditional education.

WHAT DO WE NEED TO DO IN THE NEXT 15 YEARS?

To date very little research has successfully used mobile devices to collect information about learning practices. More research is needed that looks at mobile learning practices and then associates that information with learning outcomes. Over the next fifteen years, researchers should use participatory approaches to work with learners in co-determining learning outcomes, using the rich sets of data that will likely be collected from a new generation of mobile devices. In particular, the use of mobile data to support formative assessment will become increasing viable, as teachers will be able to quickly and easily collect information

from students via mobile devices at all stages of the learning process. However, this will require investments in professional development, as teachers will need to know how to design appropriate assessment tools that make use of these new data sets. This will require a shift from current assessment approaches, which in many education systems emphasize rote learning and recall, to approaches that evaluate exploration, inquiry and collaboration through the analysis of data collected when students use their mobile devices.

EFA IN THE FUTURE

UNESCO is currently working to articulate a new set of educational priorities for the post-2015 development agenda. The following themes, based on the likely impact of mobile learning on education in the future, maybe be useful for informing the next iteration of EFA goals.

1. New roles for learners and teachers

Facilitated by the increasing functionalities of mobile devices and global connectivity, learners in the future are likely to have more opportunities to construct their own knowledge and shape their own learning experiences. New technologies will provide unprecedented access to formal online courses, open-access journals and rich peer-reviewed content. Students will take on a more active role in determining what and how they learn, while teachers will act as curators and guides, helping students navigate and benefit from the dizzying number of educational resources accessible via mobile technologies.

2. Continuity of the learning experience

The ubiquity of mobile technologies will spark breakthroughs in strategies to scaffold learning across a wide variety of settings, thus bridging the gap between the formal learning that happens in schools and the informal learning that occurs in a variety of places throughout a learner's day. Increasingly, mobile learning will support continuity of the learning experience across different environments, and educators will be expected to update their pedagogical practices to allow for greater integration with informal learning.

3. Big data and learning analytics

The ability to collect and analyse vast amounts of learner-generated data will be a major factor in the development of mobile learning over the next fifteen years. Researchers engaged with online learning, intelligent tutoring systems, virtual labs, simulations and learning management systems are currently exploring ways to better understand and use learning analytics to improve teaching and learning and further progress towards Education for All (Bienkowski et al., 2012). However, this new access to big data comes with a number of ethical considerations, such as data ownership and privacy. Policy-makers will need to ensure data is used safely and productively to help improve education systems and advance specific learning objectives while protecting learners' rights.

ENABLERS AND BARRIERS

The following sections highlight some of the key factors that will enable the development of mobile learning over the next fifteen years, as well as the barriers to be overcome before mobile technologies can be integrated into mainstream education.

ENABLERS

Many of the experts interviewed for this report feel that the world is rapidly approaching a tipping point for mobile learning. After twenty years of research and experimentation, educators are getting closer to a time when they can capitalize on the full potential of mobile technologies to improve teaching and learning. This expected progression is propelled by a combination of both technological advances and societal shifts. Some of the key factors that will continue to drive the expansion of mobile learning include decreased societal resistance to the idea of using mobile phones in formal education, increased numbers of successful mobile learning projects that can serve as exemplars for large-scale initiatives, growth in global education spending in general and mobile learning spending in particular, greater pressure on educational institutions to provide high-quality education at low cost to larger numbers of students, the rise of online education and distance learning, and the cultivation of new procurement and distribution channels for digital learning resources.

DECREASED SOCIAL RESISTANCE

As recently as a few years ago, public sentiment surrounding the use of mobile technologies in education was largely unenthusiastic, with many educators and parents concerned that mobile devices cause distractions in schools and lead to other harmful behaviours like cheating, 'sexting' – sending sexually explicit text messages – and cyber-bullying (Shuler, 2009). Though researchers have been exploring the benefits of mobile learning for quite some time, until recently much of the education community remained sceptical. However, the experts interviewed for this paper reported that they have observed a significant shift in this resistance. As new models of mobile learning emerge, many countries and institutions are increasingly promoting the use of mobile devices in schools and other educational settings. Simultaneously, devices are becoming cheaper and more accessible, and educators and learners alike are more familiar and comfortable with using such devices for a wide variety of purposes. Resistance to mobile learning will continue to decrease over the next fifteen years, as educators, students and parents all become more accustomed to using mobile technologies in their daily lives. In fact, a recent university graduate entering the teaching profession in the year 2030 will have been born around 2007 – the same year the iPhone was released. If teachers are increasingly comfortable with mobile technology and use it to facilitate learning in their own lives, they will be more likely to use mobile learning with their students.

SUCCESSFUL MOBILE LEARNING MODELS

A diverse array of mobile learning projects worldwide have demonstrated the potential of mobile technologies to foster new teaching and learning practices. These projects – many of which are outlined in other reports from this UNESCO Series (Deriquito and Domingo, 2012; Dykes and Knight, 2012; Fritschi and Wolf, 2012*a*–*b*; Hylén, 2012; Isaacs, 2012*a*–*b*; Jara et al., 2012; Lugo and Schurmann, 2012; So, 2012; West, 2012*a*–*b*) – provide instructive models of mobile learning which are increasingly being scaled and replicated. Global organizations, ranging from UNESCO to industry associations such as the GSMA and corporations like McKinsey & Company, are investing significant resources into exploring how the ubiquity and rapidly expanding functionality of mobile technologies can be leveraged to promote learning. As these efforts continue, more exemplars of successful mobile learning projects will be available as models for educators, policy-makers and others.

ECONOMIC INCENTIVES

The education market in general, and the mobile learning market in particular, are becoming increasingly appealing to business investors. It is projected that global spending on education today accounts for approximately US$4 trillion, with the market for mobile learning products and services just a fraction of that amount at US$3.4 billion in annual sales. By 2020, global spending on education is expected to double, reaching US$8 trillion, with mobile learning's share of the market projected to expand significantly to US$70 billion through specialized product offerings and a growing market for devices (GSMA, 2011).

In order promote continued investment in mobile learning, the GSMA recommends that a 'sustainable and robust business case' needs to be developed (GSMA, 2010, p. 5). While from a corporate point of view a discussion of business opportunities is appropriate, from an education perspective it raises the question of whether the goal of increasing access for poorer populations can be addressed while pursuing a strong business case. Considering this question is important, because research has shown that many aspects of educational achievement and participation, including access to secondary school, are correlated to household income (Lewin, 2007). If the 'value' of mobile learning becomes strongly market-driven, then those with lower household incomes risk being excluded. These challenges will remain over the coming years, and policy-makers will need to find a way to reconcile a market-driven rationale with the social justice mandate promoted by Education for All.

PRESSURE ON EDUCATIONAL INSTITUTIONS

As the world becomes increasingly competitive, educational institutions are under significant pressure to increase the quality of teaching and learning for growing numbers of students. For example, according to one of the experts interviewed for this report, India has 1.2 million engineering students but only has the institutional capacity to provide a high-quality education to 50,000 of them. The gap between the demand and supply for well-trained teachers is so large that traditional models are under serious strain (UNESCO, 2012*a*). Simultaneously, the cost of education, especially higher education, is increasing at rates that are not sustainable. Technology integration is seen as one strategy for driving costs down

while maintaining or increasing quality. As more people come to recognize the utility of smartphones and other widely available mobile technologies, they will expect educational institutions to better leverage technology to expand affordable access to high-quality education.

RISE OF ONLINE EDUCATION AND DISTANCE LEARNING

One way in which educational institutions can expand their reach without increasing costs is through online education and distance learning. Although online education has existed for a long time, its scale and scope has expanded dramatically in the past five years. The Khan Academy, for example, is a non-profit educational organization with the mission of 'providing a high quality education to anyone, anywhere'. The website, which supplies a free online collection of more than 3,900 video 'micro-lectures' stored on YouTube, claims to have delivered over 230 million lessons to date (Khan Academy, 2013). Another example is EdX, a new joint partnership between MIT and Harvard University that offers online classes for free in an effort to extend educational opportunities to greater numbers of students and help build a global community of online learners. Several other prominent US universities have joined the project, including the University of California's Berkeley campus, Georgetown University, Wellesley College and the University of Texas System, one of the largest public university systems in the USA (EdX, 2013). Projects such as these are providing learning opportunities to huge numbers of people – many of whom access content via mobile devices. In a recent report, Laurillard (2012*a*) noted that as student numbers increase, online distance learning becomes more cost-effective, especially when it is designed to support peer learning:

> A teacher might currently spend three hours preparing materials for six two-hour tutorials during which she will teach a total of 24 students. By contrast, the same teacher could spend eight hours preparing web resources for 48 students to work online in independent groups, and then 15 minutes with each group helping them sum up what they have learnt. The conventional approach has taken 15 hours of her time for 24 students. The technology-enhanced learning approach has taken 11 hours and helped 48 students. (ibid., p. 38)

By the year 2030, many speculate that formal education systems could be drastically different than they are today (UNESCO, 2012*c*). While physical schools will remain central hubs of learning, new models of education delivery are likely to adopt mobile technologies as a means of serving previously unreachable student populations. For example, mobile learning solutions may be especially beneficial to institutions that cater to youth and adults who for physical, social or economic reasons cannot attend regular formalized classes.

NEW PROCUREMENT AND DISTRIBUTION CHANNELS

It is extremely expensive to roll out physical educational resources such as textbooks, particularly in areas with unreliable infrastructure and poorly organized systems of education. In countries like Nigeria, classroom teachers often face a dearth of quality learning materials. A paucity of relevant resources available in local languages is also an issue. Mobile technologies can offer solutions to both of these problems. By allowing users to access a wide array of educational resources through digital portals, mobile devices provide an alternative to traditional models of procurement and distribution. The technology also allows content

developers to build resources intended for highly specific groups at a lower cost than printed materials. New marketplaces such as those for mobile apps have drastically changed the distribution stream, creating more channels through which all types of educators, ranging from classroom teachers to trade experts to retired professionals, can disseminate valuable knowledge and resources.

BARRIERS

Though mobile learning may be at a tipping point, there are still considerable barriers that will need to be overcome if mobile technologies are to be fully integrated into education on a large scale. These include negative perceptions about mobile learning held by some educators, policy-makers and others, reinforced by examples of mobile learning failures; limited examples of sustainable and scalable projects; a dearth of localized and culturally relevant initiatives; and issues related to digital access rights, including censorship and privacy concerns.

NEGATIVE PERCEPTIONS AND MODELS OF FAILURE

Though opposition to mobile learning is not as entrenched as it was previously, many educators are not convinced that mobile devices have significant potential to transform learning – and often rightly so. Because the majority of mobile learning initiatives have been small-scale and short-lived, many teachers have not yet witnessed the benefits of mobile learning in their own classrooms. Furthermore, some teachers have had negative experiences with mobile learning interventions. While these negative experiences often stem from inadequate preparation, there are many instances in which mobile learning has been inappropriately integrated into lessons and, consequently, done very little to advance learning – in the worst cases even detracting from it. Often initiatives are so focused on getting mobile devices into the hands of learners that the question of how, precisely, this technology will improve learning outcomes is sidelined. This lack of planning has resulted in some well-documented failures which have tainted perceptions of mobile learning among educators as well as policy-makers. These failures pose a real danger to the future of mobile learning. Until mobile technology and the accompanying pedagogy are embraced teachers, mobile learning will not thrive in formal settings.

LIMITED EXAMPLES OF SCALABILITY AND SUSTAINABILITY

Despite the increasing ubiquity of mobile devices and a growing appreciation of their potential to improve education, widespread and sustained mobile learning in formal settings remains mostly an aspiration. Most mobile learning projects to date have been experimental in nature, focusing on exploring how mobile technologies can support new and innovative teaching and learning practices. These initiatives are usually short-term, small-scale pilot projects, which lack the capacity to reach large numbers of learners over long periods of time. There are surprisingly few examples of mobile learning that have impacted thousands of learners, although many of the projects described in this report provide exemplars for the

future. In general, experts interviewed for this report were disappointed by the lack of well-financed, coherent, large-scale or highly visible efforts in mobile learning. In order for mobile learning to have a widespread impact, feasibility and scale are essential. One key challenge is to better ensure that projects acknowledge the realities and limitations of existing education and ICT infrastructures, as well as the social and cultural contexts of different countries and regions, in order to support project sustainability over time.

DEARTH OF LOCALIZED INITIATIVES

While mobile access is high in developed and developing countries alike, the types of devices being used and the infrastructure surrounding these devices are often drastically different, as are the educational needs and gaps that can be addressed with technology. Approaching mobile learning from a global perspective can be hazardous, because different regions and communities require different interventions which reflect and account for local and cultural idiosyncrasies. Additionally, mobile learning often relies on the availability of high-quality content. Though significant advancements are expected in translation technology, the current of dearth local language content, such as video and mobile apps, is likely to remain an issue.

CENSORSHIP AND PRIVACY CONCERNS

The future of mobile learning depends on a globally connected world in which information is freely accessible to all. There are already instances of governments around the world restricting access to information and suppressing discussion among citizens, frequently blocking specific sites and sometimes shutting down internet access for entire regions. Generally speaking, censorship negates or limits mobile learning opportunities. On the other side of this spectrum, mobile learning developments that involve big data and learning analytics raise critical issues around data access, ownership and privacy. Capitalizing on the opportunities offered by such data will require a delicate balance between the right to knowledge and the right to privacy.

Realizing the potential of mobile learning is a complex endeavour. Clearly much progress has been made in the last two decades, but more work is needed over the next fifteen years to reap the full benefits of mobile learning on a global scale. This section identifies the broad challenges faced by mobile learning advocates, both in terms of using mobile learning to accomplish EFA goals and developing mobile learning more generally, to encourage its integration into mainstream education and support international education agendas now and in the future. These challenges include building strong multisector partnerships to foster widespread uptake, linking mobile learning analytics to learning theory, training teachers in mobile learning design and promoting mobile learning for all.

BUILD STRONG MULTISECTOR PARTNERSHIPS

One of the key criticisms of mobile learning projects is that they are small-scale, with results based on localized pilots. Implementations that go beyond the pilot stage will require input from practitioners, educational researchers, teacher trainers, software and hardware developers, telecommunications companies, education ministries and other education stakeholders essential to the mobile learning ecosystem. No one sector will be able to achieve effective implementation on its own. Policy-makers must play a key role in promoting multisector partnerships, which are needed to connect disparate efforts, drive innovation and ensure the expansion of successful projects. Ideally strong partnerships should be in place before pilot projects are even designed, so that different sectors are working together from as early in the process as possible.

The success of the Nokia MoMath and Text4baby programmes described in earlier in this report can be attributed largely to their rich and diverse partnerships between organizations in a wide variety of sectors, including local and national governments, NGOs and telecommunications companies. Other examples of effective projects that have worked in this way include the Mobile-based Literacy Programme in Pakistan – a partnership between UNESCO Islamabad, Nokia, Mobilink and the Bunyad Foundation – and the Google SMS Tips project in Uganda, a joint effort by Google and MTN, a South Africa-based multinational mobile telecommunications company. The next fifteen years should see partners becoming more pedagogically ambitious, building, for example, on research completed by the Personal Inquiry project, which helps students work together to research issues that affect their lives (Anastopoulou et al., 2012).

It is important to note that while partnerships between the public and private sectors are crucial to the future of mobile learning, profitability should not be the key determinant for investment. It is essential that the work done by independent researchers is built upon rather than appropriated by commercial interests seeking to profit from the widespread adoption of particular educational technologies. The quality of educational opportunity must be the underlying consideration for growth.

LINK MOBILE LEARNING ANALYTICS TO LEARNING THEORY

Learning analytics refers to the measurement, collection, analysis and reporting of data about learners and their contexts, for the purpose of understanding and optimizing learning and the environments in which it occurs (LAK, 2011). Mobile learning analytics – the study of how learners use mobile technologies – has received relatively little attention over the past fifteen years. However, as it becomes easier to collect information from learners through mobile devices, mobile learning analytics can and should be used to further the development of theories about how people learn. Mobile devices can automatically record data about each person's patterns of use, to give learners feedback on their progress and provide educators and policy-makers with diagnostic information. As technological innovations make it easier to collect larger and more diverse data sets, a key challenge will be to develop methods for analysing those data sets and linking them to learning practices and learning theory. Policy-makers will also need to ensure that protocols are in place to collect and work with this data ethically, in a way that furthers educational research while at the same time protects learners' rights to privacy and digital ownership.

TRAIN TEACHERS IN MOBILE LEARNING DESIGN

Realizing the potential of mobile learning will require new roles for teachers and superior capacity for teacher training (Deriquito and Domingo, 2012; Dykes and Knight, 2012; Fritschi and Wolf, 2012*a*; Isaacs, 2012*a*; Jara et al., 2012; West, 2012*a*). One of the strongest barriers to the development of mobile learning is the lack of trained practitioners who can effectively incorporate mobile technologies into their classroom practice. Current teachers, as well as those entering the profession, need training and professional development in the innovative design of mobile learning interventions. Policy-makers should develop strategies to support teachers in deepening their understandings of the complex relationships between mobile technology, pedagogy, design and implementation. UNESCO and Nokia have recently taken steps in this direction with the Teacher Development with Mobile Technologies Project, which investigates how mobile technologies can be integrated with national teacher training systems in ways that improve the quality of teaching practices on a large scale (UNESCO, 2012*b*). Similar projects will be required in the coming years if educators are to truly embrace mobile technologies as a means of advancing student learning.

PROMOTE MOBILE LEARNING FOR ALL

In line with the Education for All agenda, the concept of 'mobile learning for all' focuses on the need to develop mobile learning interventions for those of all learning abilities around the world, irrespective of their current access to formal education (Winters, 2013). Mobile learning has great potential to support people who are currently marginalized from education due to socio-economic circumstances or disabilities. For example, recent research has highlighted how tablet computers can enable new forms of interaction for people with autism (Hourcade et al., 2012), while many projects discussed in this report have demonstrated the

potential of mobile learning to bring educational materials and support to resource-poor communities. One key measure of success in the promotion of mobile learning for all will be the development of mobile learning interventions that are designed to directly address the EFA goals.

As commercial interests play an increasingly important role in educational technology over the next fifteen years, policy-makers will need to make sure that equity of opportunity is not eclipsed by a market-driven agenda. The tension between these two agendas can already been seen. As noted by the GSMA '[c]ontent and the provision of it costs money and it is not yet clear who should pay – governments, local authorities, the consumer or other' (GSMA, 2010, p. 24). If it is the consumer, this could have serious implications for educational equity. In the worse-case scenario, the main beneficiaries of mobile learning are those who can afford to pay for educational content and access to technology and connectivity. In economically motivated ventures, content, and potentially curriculum as well, will be dictated by what consumers view as popular or valuable:

> There is greater and more immediate value in vocational forms of mLearning where the end user is paying for the service. Health education, language lessons and general life skills are seen by mobile customers as valuable and worth paying for. (GSMA, 2010, p. 30)

This raises questions about how to serve communities that do not exert as much influence on the global economy, and how to support research in academic disciplines not seen as valuable to a majority of mobile customers. Policy-makers will need to ensure that marginalized communities are not excluded from mobile learning opportunities, and that initiatives are designed to address the needs of all learners, not just those who can pay for services.

Finally, information sharing will be crucial to the promotion of mobile learning for all. Over the coming fifteen years, mobile learning researchers should build a more complete and nuanced picture of what has worked and in which contexts. Across the world, successful projects have been implemented in very different sectors: by and large, the developing world has taken the lead on large-scale projects in numeracy and literacy, such as Colombia's national mobile-based literacy programme (Lugo, 2012), while Europe and North America have led the way in pedagogical innovation (Sharples et al., 2007). Developing countries have also tended to focus on more commercially viable mobile learning programmes that employ traditional pedagogical approaches and widely available technologies already used by large numbers of people, whereas developed countries often experiment with more pedagogically and technologically innovative projects. Over the next fifteen years, policy-makers should make an effort to bring these two communities of expertise together and establish mechanisms and venues for exchanging knowledge and experience.

QUESTIONS FOR THE FUTURE

While the future is sure to hold significant technological shifts accompanied by new learning opportunities, the educational community needs to capitalize on these opportunities to shape a future in which mobile technologies help facilitate learning for all. Just because mobile technology will be more accessible, affordable and powerful does not necessarily mean it will be used productively or to its full potential. Outlined below are important questions to be addressed if mobile learning is to transform from a field of uneven and scattered innovation into a dynamic force for educational impact.

- Has the education community recognized the vast potential that lies within informal learning spaces, and is it leveraging the ubiquity of mobile technologies to afford new breakthroughs in bridging school, after-school and home environments?

- Aside from the traditional model of education, what other types of education systems have emerged, and how are mobile devices being used to support them?

- What skills are needed in a modern world, and is the education community capitalizing on the full range of tools available to help impart these skills?

- Do teacher training programmes consider the unique value that a teacher adds in a world where enormous amounts of information are immediately available to all learners (Johnson et al., 2012)? How do we effectively train educators to use mobile technologies to advance and ensure high-quality learning?

- How do we build capacities for learners to exercise greater control and choice over their own learning?

- Are model initiatives in the field of mobile learning effective, not only in terms of results but also in terms of scale and impact?

- Have mobile learning solutions proven their value to learners and their families, so that parents and other gatekeepers become increasingly willing to invest in mobile devices (GSMA, 2012)?

It is important to consider these questions and others raised in this report, because the decisions made by policy-makers and education stakeholders today will determine what mobile learning looks like tomorrow. With clear and well-informed strategies in place, mobile learning can and will make positive contributions to teaching and learning and help increase educational access, equity and quality for all.

REFERENCES

AkiraChix. 2011. *AkiraChix*. Nairobi, Author. http://akirachix.com (Accessed 7 February 2013.)

Ananny, M. and Winters, N. 2007. Designing for Development: Understanding the One Laptop Per Child in its Historical Context. *Proceedings of the IEEE/ACM International Conference on Information and Communication Technologies and Development*. Bangalore, India, pp. 1–12.

Anastopoulou, A., Sharples, M., Ainsworth, S., Crook, C., O'Malley, C. and Wright, M. 2012. Creating personal meaning through technology-supported science learning across formal and informal settings. *International Journal of Science Education*, Vol. 34, No. 2, pp. 251–273.

Apps for Good. 2012. *Apps for Good*. London, CDI Europe. http://appsforgood.org/ (Accessed 4 February 2013.)

Bartlett, K. 2012. Amazing new learning with Nokia Life Education partnerships. *Conversations by Nokia*. http://conversations.nokia.com/2012/03/30/amazing-new-learning-with-nokia-life-education-partnerships (Accessed 30 September 2012.)

BBC. 2012. Programming project comes to primary schools. *BBC News*, 17 April 2012. London, Author. http://www.bbc.co.uk/news/technology-17740143 (Accessed 5 February 2013.)

Bienkowski, M., Feng. M. and Means, B. 2012. *Enhancing Teaching and Learning Through Educational Data Mining and Learning Analytics: An Issue Brief*. Washington, DC, U.S. Department of Education, Office of Educational Technology. http://www.ed.gov/edblogs/technology/files/2012/03/edm-la-brief.pdf (Accessed 30 September 2012.)

BongoHive. n.d. *Hubs in Africa*. Lusaka, Author. https://africahubs.crowdmap.com (Accessed 7 February 2013.)

British Council. n.d. *Connecting Classrooms*. London, Author. http://schoolsonline.britishcouncil.org/programmes-and-funding/linking-programmes-worldwide/connecting-classrooms (Accessed 8 February 2013.)

Cisco. 2012. *Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update, 2011–2016*. San Jose, Calif., Author. http://www.cisco.com/en/US/solutions/collateral/ns341/ns525/ns537/ns705/ns827/white_paper_c11-520862.html (Accessed 30 September 2012.)

CoderDojo. 2012. *CoderDojo*. Dublin, Author. http://coderdojo.com/ (Accessed 4 February 2013.)

Dalakov, G. 2013. The Dynabook of Alan Kay. *History of Computers*. http://history-computer.com/ModernComputer/Personal/Dynabook.html (Accessed 30 January 2013.)

Deriquito, M. and Domingo, Z. 2012. *Mobile Learning for Teachers in Asia: Exploring the Potential of Mobile Technologies to Support Teachers and Improve Practice*. Paris, UNESCO. http://unesdoc.unesco.org/images/0021/002162/216284E.pdf (Accessed 30 January 2013.)

Dudley-Nicholson, J. 2013. Samsung reveals flexible display screens at CES. *news.com.au*, 10 January 2013. Sydney, News Limited. http://www.news.com.au/technology/samsung-reveals-flexible-display-screens-at-ces/story-e6frfro0-1226550811419 (Accessed 7 February 2013.)

Dykes, G. and Knight, H. R. 2012. *Mobile Learning for Teachers in Europe: Exploring the Potential of Mobile Technologies to Support Teachers and Improve Practice*. Paris, UNESCO. http://unesdoc.unesco.org/images/0021/002161/216167E.pdf (Accessed 30 January 2013.)

EdX. 2013. *EdX*. Cambridge, Mass., Author. https://www.edx.org/ (Accessed 9 February 2013.)

Fritschi, J. and Wolf, M. A. 2012*a*. *Mobile Learning for Teachers in North America: Exploring the Potential of Mobile Technologies to Support Teachers and Improve Practice*. Paris, UNESCO. http://unesdoc.unesco.org/images/0021/002160/216084E.pdf (Accessed 30 January 2013.)

————. 2012*b*. *Turning on Mobile Learning in North America: Illustrative Initiatives and Policy Implications*. Paris, UNESCO. http://unesdoc.unesco.org/images/0021/002160/216083E.pdf (Accessed 30 January 2013.)

GSMA. 2010. mLearning: A Platform for Educational Opportunities at the Base of the Pyramid. London, Author. http://www.gsma.com/mobilefordevelopment/wp-content/uploads/2012/04/mlearningaplatformforeducationalopportunitiesatthebaseofthepyramid.pdf (Accessed 6 February 2013.)

————. 2011. *Mobile Education Landscape Report*. London, Author. http://www.gsma.com/connectedliving/wp-content/uploads/2012/03/landscape110811interactive.pdf (Accessed 30 September 2012.)

————. 2012. *Shaping The Future – Realising the potential of informal learning through mobile*. London, Author. http://www.gsma.com/mobilefordevelopment/wp-content/uploads/2012/05/mLearning_Report_230512_V2.pdf (Accessed 30 September 2012.)

GSMA mWomen. n.d. *GSMA mWomen Programme*. http://www.mwomen.org/wiki/GSMA_mWomen_Programme (Accessed 1 February 2013.)

Hourcade, J. P., Bullock-Rest, N. and Hansen, T. 2012. Multitouch tablet applications and activities to enhance the social skills of children with autism spectrum disorders. *Personal and Ubiquitous Computing*, Vol. 16, No. 2, pp. 157–168.

Hylén, J. 2012. *Turning on Mobile Learning in Europe: Illustrative Initiatives and Policy Implications*. Paris, UNESCO. http://unesdoc.unesco.org/images/0021/002161/216165E.pdf (Accessed 30 January 2013.)

IBM. n.d. *Bringing big data to the enterprise*. Armonk, NY, Author. http://www-01.ibm.com/software/data/bigdata/ (Accessed 7 February 2013.)

Imperial College London. 2013. Projects. *Bioinformatics Support Service*. London, Author. http://www3.imperial.ac.uk/bioinfsupport/projects (Accessed 4 February 2013.)

Isaacs, S. 2012*a*. *Mobile Learning for Teachers in Africa and the Middle East: Exploring the Potential of Mobile Technologies to Support Teachers and Improve Practice*. Paris, UNESCO. http://unesdoc.unesco.org/images/0021/002163/216358E.pdf (Accessed 30 January 2013.)

————. 2012*b*. *Turning on Mobile Learning in Africa and the Middle East: Illustrative Initiatives and Policy Implications*. Paris, UNESCO. http://unesdoc.unesco.org/images/0021/002163/216359E.pdf (Accessed 30 January 2013.)

Jara, I., Claro, M. and Martinic, R. 2012. *Mobile Learning for Teachers in Latin America: Exploring the Potential of Mobile Technologies to Support Teachers and Improve Practice*. Paris, UNESCO. http://unesdoc.unesco.org/images/0021/002160/216081E.pdf (Accessed 30 January 2013.)

Johnson, L., Adams, S. and Cummins, M. 2012. *NMC Horizon Report: 2012 K-12 Edition*. Austin, Tex., The New Media Consortium. http://www.nmc.org/pdf/2012-horizon-report-K12.pdf (Accessed 1 February 2013.)

Khan Academy. 2013. *Khan Academy*. Mountain View, Calif., Author. https://www.khanacademy.org/ (Accessed 9 February 2013.)

LAK. 2011. *1st International Conference on Learning Analytics and Knowledge 2011*. Banff, Alta, Author. https://tekri.athabascau.ca/analytics/about (Accessed 11 February 2013.)

Laurillard, D. 2012*a*. Streamline: Enhance teachers' productivity with new tools for designing teaching and learning. S. Northen (ed.), *System Upgrade: Realising the vision for education*. London, Technology Enhanced Learning Research Programme, University of London. http://telit.org.uk/ (Accessed 4 February 2013.)

————. 2012*b*. *Teaching as a Design Science: Building Pedagogical Patterns for Learning and Technology*. London, Routledge.

Leafsnap, 2011. *Leafsnap: An Electronic Field Guide*. New York/College Park, Md./Washington, DC, Columbia University/University of Maryland/Smithsonian Institution. http://leafsnap.com/ (Accessed 4 February 2013.)

Learning Sciences Lab. 2010. *Leveraging Mobile Technology for Sustainable Seamless Learning in Singapore Schools*. Singapore, National Institute of Education, Nanyang Technological University. http://lsl.nie.edu.sg/projects/leveraging-mobile-technology-sustainable-seamless-learning-singapore-schools (Accessed 5 February 2013.)

Lewin, K. M. 2007. *Improving Access, Equity and Transitions in Education: Creating a Research Agenda*. CREATE Pathways to Access, Research Monograph No. 1. Brighton, UK, Consortium for Research on Educational Access, Transitions and Equity (CREATE), University of Sussex. http://www.create-rpc.org/pdf_documents/PTA1.pdf (Accessed 1 February 2013.)

Looi, C. K., Seow, P., Zhang, B., So, H. J., Chen, W. and Wong, L. H. 2010. Leveraging mobile technology for sustainable seamless learning: a research agenda. *British Journal of Educational Technology*, Vol. 41, No. 2, pp. 154–169.

Lugo, M. T. and Schurmann, S. 2012. *Turning on Mobile Learning in Latin America: Illustrative Initiatives and Policy Implications*. Paris, UNESCO. http://unesdoc.unesco.org/images/0021/002160/216080E.pdf (Accessed 30 January 2013.)

McCormack, R. 2010. Nokia 'MoMath' mobile learning project empowers SA Learners. *Nokia.sa Blog*. http://ringaz.nokia.co.za/sustainability/nokia-%E2%80%98momath%E2%80%99-mobile-learning-project-empowers-sa-learners (Accessed 30 September 2012.)

McKinsey & Company and GSMA. 2012. *Transforming learning through mEducation*. Mumbai, India, McKinsey & Company http://mckinseyonsociety.com/downloads/reports/Education/mEducation_whitepaper_April%201_vFINAL.pdf (Accessed September 30 2012.)

MIT. n.d. *Scratch*. http://scratch.mit.edu/ (Accessed 30 January 2013.)

Nokia, 2012. *Nokia Data Gathering*. Espoo, Finland, Author. http://projects.developer.nokia.com/ndg (Accessed 4 February 2013.)

Norris, C. and Soloway, E. 2011. Learning and Schooling in the Age of Mobilism. *Education Technology*, Vol. 51, No. 6, pp. 3–10.

Parkes, J. and Heslop, J. 2011. *Stop Violence Against Girls in School: A cross-country analysis of baseline research from Ghana, Kenya and Mozambique*. Johannesburg, ActionAid International. http://www.actionaid.org/sites/files/actionaid/svags_-_a_cross_country_analysis_of_baseline_research_from_ghana_kenya_and_mozambique.pdf (Accessed 1 February 2013.)

Pawson, R. and Tilley, N. 1997. *Realistic Evaluation*. London, Sage.

Raspberry Pi. n.d. *Raspberry Pi®*. http://www.raspberrypi.org/ (Accessed 4 February 2013.)

Roschelle, J. 2003. Unlocking the learning value of wireless mobile devices. *Journal of Computer Assisted Learning*, Vol. 19, No. 3, pp. 260–272.

Sharples, M., Taylor, J. and Vavoula, G. 2007. A Theory of Learning for the Mobile Age. R. Andrews and C. Haythornthwaite (eds), *The Sage Handbook of Elearning Research*. London, Sage, pp. 221–47.

Sharples, M., McAndrew, P., Weller, M., Ferguson, R., FitzGerald, E., Hirst, T., Mor, Y., Gaved, M. and Whitelock, D. 2012. *Innovating Pedagogy 2012: Open University Innovation Report 1*. Milton Keynes, UK, The Open University. http://www.open.ac.uk/blogs/innovating (Accessed 30 September 2012.)

Shuler, C. 2009. *Pockets of Potential: Using Mobile Technologies to Promote Children's Learning*. New York, The Joan Ganz Cooney Center at Sesame Workshop. http://www.joanganzcooneycenter.org/wp-content/uploads/2010/03/pockets_of_potential_1_.pdf (Accessed 1 February 2013.)

Silver, J. 2012. Classroom Disruptor: the proprietary tablet PC that's changing Russian schools. *Wired Magazine*, wired.co.uk, 24 February 2012. http://www.wired.co.uk/magazine/archive/2012/03/features/classroom-disruptor?page=all (Accessed 30 January 2013.)

So, H. J. 2012. *Turning on Mobile Learning in Asia: Illustrative Initiatives and Policy Implications*. Paris, UNESCO. http://unesdoc.unesco.org/images/0021/002162/216283E.pdf (Accessed 30 January 2013.)

Sophasawatsakal, C. 2012. Pink telephones – using technology to empower women in Cambodia. *Oxfam Policy & Practice Blog*, 7 March 2012. Oxford, UK, Oxfam. http://policy-practice.oxfam.org.uk/blog/2012/03/pink-telephones-in-cambodia (Accessed 4 February 2013.)

Taylor, J., Dearnley, C., Laxton, J., Coates, C., Treasure-Jones, T., Campbell, R. and Hall, I. 2010. Developing a mobile learning solution for health and social care practice. *Distance Education*, Vol. 31, No. 2., pp. 175–192.

Text4baby. 2011. *Text4Baby plans to reach 1M moms by 2012*. Alexandria, Va., National Healthy Mothers, Healthy Babies Coalition (HMHB). http://www.text4baby.org/index.php/news/143-text4baby-plans-to-reach-1m-moms-by-2012 (Accessed 30 September 2012.)

The Economist. 2011. *Highly charged*. London, Author. www.economist.com/node/18437910 (Accessed 30 September 2012.)

The Telegraph. 2013. Google Glass Will Sends Sounds Straight Through Your Skull. *Business Insider*, 3 February 2013. New York, Business Insider Inc. http://www.businessinsider.com/google-glass-skull-sound-2013-2 (Accessed 7 February 2013.)

Underwood, J., Luckin, R. and Winters, N. 2012. Managing resource ecologies for mobile, personal and collaborative self-directed language learning. *Procedia – Social and Behavioral Sciences*, Vol. 34, pp. 226–229. http://dx.doi.org/10.1016/j.sbspro.2012.02.045 (Accessed 4 February 2013.)

UNESCO. n.d. *Education for All by 2015*. Paris, Author. http://portal.unesco.org/education/en/ev.php-URL_ID=42579&URL_DO=DO_TOPIC&URL_SECTION=201.html (Accessed 5 February 2013.)

————. 2000. *The Dakar Framework for Action. Education for All: Meeting our Collective Commitments*. World Education Forum, Dakar, Senegal, 26–28 April 2000. Paris, Author. http://unesdoc.unesco.org/images/0012/001211/121147e.pdf (Accessed 4 February 2013.)

————. 2012*a*. *EFA Global Monitoring Report 2012. Youth and skills: Putting education to work*. Paris, Author. http://unesdoc.unesco.org/images/0021/002180/218003e.pdf (Accessed 4 February 2013.)

————. 2012*b*. *Teacher Development with Mobile Technologies Project*. Paris, Author. http://www.unesco.org/new/en/unesco/themes/icts/m4ed/teacher-support-and-development/teacher-development-with-mobile-technologies-project/ (Accessed 11 February 2013.)

————. 2012*c*. *UN System Task Team on the Post-2015 UN Development Agenda: Education and skills for inclusive and sustainable development beyond 2015*. Thematic Think Piece. Paris, Author. http://www.un.org/millenniumgoals/pdf/Think%20Pieces/4_education.pdf (Accessed 4 February 2013.)

Valiente, O. 2010. *1-1 in Education: Current Practice, International Comparative Research Evidence and Policy Implications*. OECD Education Working Papers, No. 44. Paris, OECD Publishing. http://dx.doi.org/10.1787/5kmjzwfl9vr2-en (Accessed 30 September 2012.)

Vavoula, G. and Sharples, M. 2009. Meeting the Challenges in Evaluating Mobile Learning: A 3-level Evaluation Framework. *International Journal of Mobile and Blended Learning*, Vol. 1, No. 2, pp. 54–75.

van Dijk, J. 2005. *The Deepening Divide: Inequality in the Information Society*. London, Sage.

Walker, K. 2010. Designing for meaning making in museums: Visitor-constructed trails using mobile digital technologies. Ph.D. thesis, Institute of Education, University of London, UK. http://www.lkl.ac.uk/people/kevin/phd/phd_final.pdf (Accessed 7 February 2013.)

Warschauer, M. and Ames, M. 2010. Can one laptop per child save the world's poor? *Journal of International Affairs*, Vol. 64, No. 1, pp. 33–51. http://www.gse.uci.edu/person/warschauer_m/docs/Warschauer_bluelines.pdf (Accessed 4 February 2013.)

West, M. 2012*a*. *Mobile Learning for Teachers: Global Themes*. Paris, UNESCO. http://unesdoc.unesco.org/images/0021/002164/216452E.pdf (Accessed 30 January 2013.)

————. 2012*b*. *Turning on Mobile Learning: Global Themes*. Paris, UNESCO. http://unesdoc.unesco.org/images/0021/002164/216451E.pdf (Accessed 30 January 2013.)

Wikipedia. 2013. *Gamification*. http://en.wikipedia.org/wiki/Gamification (Accessed 7 February 2013.)

Williams, G. 2011. Disrupting poverty: Barefoot College is empowering women through peer-to-peer learning and technology. *Wired Magazine*, wired.co.uk, 7 March 2011. http://www.wired.co.uk/magazine/archive/2011/04/features/disrupting-poverty (Accessed 6 February 2013.)

Winters, N. 2013. Mobile learning in the majority world: A critique of the GSMA position. S. Price, C. Jewitt and B. Brown (eds), *The Sage Handbook of Digital Technology Research*. London, Sage.

Wolf, G. 2008. Want to Remember Everything You'll Ever Learn? Surrender to This Algorithm. *Wired Magazine*, Issue 16.05, 21 April 2008. http://www.wired.com/medtech/health/magazine/16-05/ff_wozniak?currentPage=all (Accessed 30 January 2013.)

APPENDIX: LIST OF INTERVIEWEES

For the purposes of this report, interviews were conducted with the following experts, who are directly involved in the research, design, development or implementation of mobile learning projects.

- Jan Chipchase, Executive Creative Director of Global Insights, Frog Design
- Keri Facer, Professor of Education, Manchester Metropolitan University
- Anoop Gupta, Distinguished Scientist, Microsoft Research Group
- Mathew Kam, Assistant Professor, Carnegie Mellon University
- Leo Karkkainen, Distinguished Scientist, Nokia Research Center
- Paul Kim, Assistant Dean for Information Technology and CTO, School of Education, Stanford University
- Chee-Kit Looi, Professor, National Institute of Education, Nanyang Technological University
- Marcelo Milrad, Professor of Media Technology at the Department of Computer Science, School of Computer Science, Physics and Mathematics, Linnaeus University
- Miguel Nussbaum, Professor and Head of the Computer Science Department, College of Engineering, Catholic University of Chile
- Mike Sharples, Chair in Educational Technology, The Open University
- John Traxler, Professor, University of Wolverhampton
- Steve Vosloo, Programme Specialist, UNESCO

Pundits are quick to remind us that we live in a 'mobile era', defined by 'mobile commerce', 'mobile communication' and even 'mobile revolutions'. But what of 'mobile learning'? While powerful, affordable and increasingly ubiquitous mobile technologies have already begun to change teaching and learning, sometimes in profound ways, many experts feel that serious transformation is just around the corner. Early signs suggest they may be right. Increasingly, students and teachers are using mobile devices to access rich educational content, untether learning from schools, facilitate productive communication and streamline once-laborious tasks. A number of countries have already launched ambitious initiatives to provision mobile devices directly to learners in order to improve educational quality and make learning more personal, accessible and relevant.

Yet as policy-makers seek to capitalize on the unique educational advantages of mobile technology in the here and now, they must also plan for the future. What are the technology trends most likely to impact learning in the next five years? Ten years? Fifteen years? And how can we best prepare for this future? This paper – part of the UNESCO Working Paper Series on Mobile Learning – addresses these questions by identifying the areas in which mobile technology is expected to play a key role in expanding educational opportunities. The paper provides policy-makers a roadmap for evaluating how mobile devices – both those that exist today and those that are anticipated in the future – can be enlisted to meet urgent educational needs. The report concludes by examining the challenges likely to determine the success or failure of mobile learning in the years ahead. Cumulatively, the paper gives policy-makers the information they need to keep one eye on the horizon and one eye on the ground as they prepare for a future in which mobile technology and education will be far more intertwined. Developing plans and making quality decisions today will help ensure that the full potential of mobile learning is leveraged to improve educational access, equity and quality for all.

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

UNESCO WORKING PAPER SERIES ON MOBILE LEARNING

Illustrative Initiatives and Policy Implications

- Turning on Mobile Learning in Africa and the Middle East
- Turning on Mobile Learning in Asia
- Turning on Mobile Learning in Europe
- Turning on Mobile Learning in Latin America
- Turning on Mobile Learning in North America
- Turning on Mobile Learning: Global Themes

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

- Mobile Learning for Teachers in Africa and the Middle East
- Mobile Learning for Teachers in Asia
- Mobile Learning for Teachers in Europe
- Mobile Learning for Teachers in Latin America
- Mobile Learning for Teachers in North America
- Mobile Learning for Teachers: Global Themes

Key Issues to Consider and Implications for Policy Makers and Planners

- Mobile Learning and Policies
- The Future of Mobile Learning

United Nations
Educational, Scientific and
Cultural Organization
Education
Sector