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Article abstract

Despite improvements in educational indicators, such as enrolment, significant challenges remain with regard to the delivery of quality education in developing countries, particularly in rural and remote regions. In the attempt to find viable solutions to these challenges, much hope has been placed in new information and communication technologies (ICTs), mobile phones being one example. This article reviews the evidence of the role of mobile phone-facilitated mLearning in contributing to improved educational outcomes in the developing countries of Asia by exploring the results of six mLearning pilot projects that took place in the Philippines, Mongolia, Thailand, India, and Bangladesh. In particular, this article examines the extent to which the use of mobile phones helped to improve educational outcomes in two specific ways: 1) in improving access to education, and 2) in promoting new learning. Analysis of the projects indicates that while there is important evidence of mobile phones facilitating increased access, much less evidence exists as to how mobiles promote new learning.

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Using Mobile Phones to Improve Educational Outcomes: An Analysis of Evidence from Asia

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Abstract

Despite improvements in educational indicators, such as enrolment, significant challenges remain with regard to the delivery of quality education in developing countries, particularly in rural and remote regions. In the attempt to find viable solutions to these challenges, much hope has been placed in new information and communication technologies (ICTs), mobile phones being one example. This article reviews the evidence of the role of mobile phone-facilitated mLearning in contributing to improved educational outcomes in the developing countries of Asia by exploring the results of six mLearning pilot projects that took place in the Philippines, Mongolia, Thailand, India, and Bangladesh. In particular, this article examines the extent to which the use of mobile phones helped to improve educational outcomes in two specific ways: 1) in improving access to education, and 2) in promoting *new learning*. Analysis of the projects indicates that while there is important evidence of mobile phones facilitating increased access, much less evidence exists as to how mobiles promote new learning.

Keywords: Mobile phones; mobile learning; distance learning; educational outcomes; information and communication technologies; new learning

Introduction

For quite some time, the international development community has emphasized the paramount role of education in bringing about sustainable socio-economic development in the South. Goal 2 of the United Nations Millennium Development Goals (MDGs) aims to achieve universal primary education for children everywhere, boys and girls alike, by 2015. Significant challenges remain, however. For example, in southern Asia the enrolment ratio has reached 90%, but there still remain more than 18 million children of primary school age who are not enrolled. Similar challenges confront secondary and tertiary education. In developing countries, on average, only 54% of children of the appropriate age attend secondary school currently (UN, 2008, pp. 13-14). Additionally, more than one-third of the world's adult population – most living in the developing world – has no access to printed knowledge, new skills, and technologies that could improve the quality of their lives (Dhanarajan, 2009, p. 46). Inequalities in access to education continue to

pose major barriers in the developing world, and the delivery of cost-effective and quality education remains a persistent problem.

In the attempt to find viable solutions to these problems, much hope has been placed in new information and communication technologies (ICTs). It is believed that ICTs can empower teachers and learners by facilitating communication and interaction, offering new modes of delivery, and generally transforming teaching and learning processes. Of the many different forms of ICTs, mobile phones are thought, for several reasons, to be a particularly suitable tool for advancing education in developing regions. First, mobile phones are the most prevalent ICT in the developing world, and the penetration rate is rising rapidly. In Asia, mobile penetration has doubled within a short span of time; in 2001, average penetration was 19.7 per 100 inhabitants while in 2005 the penetration rate rose to 40.9 (Orbicom, 2007). Also relevant is the fact that mobile phone ownership is increasingly more common in the lower socio-economic segments of society (Samrajiva & Zainudeen, 2008). Second, mobile phones are an especially good 'leapfrogger' since they use the radio spectrum. There is, therefore, less need for new physical infrastructure such as roads and phone wires, and base-stations can be powered via generators in places where there is no electrical grid (Economist, 2008). Finally, in addition to voice communication, mobile phones allow the transfer of data, which can be particularly useful for delivering educational content over long distances.

The concept of mobile learning (mLearning) – understood for the purposes of this article as learning facilitated by mobile devices – is gaining traction in the developing world. The number of projects exploring the potential of mobile phone-facilitated mLearning in the developing world is steadily growing, spurred in part by the use of mobile technology in the educational sector in the developed world which has expanded from short-term trials on a small scale to large-scale integration. However, there remains a lack of analysis that brings together the findings of the rising number of mLearning projects in the developing world.

With the increasing attention now being given to the role of mobiles in the educational sector in developing countries, there is a need at this juncture to take stock of the available evidence of the educational benefits that mobile phones provide in the developing world. Consequently, this article explores the results of six mLearning projects that took place in several developing countries in Asia – the Philippines, Mongolia, Thailand, India, and Bangladesh – both because most developing-country mLearning interventions are being undertaken in Asia and because developments in Asia seem to indicate that the region could become the global leader in educational uses of mobiles (Motlik, 2008). In exploring how mobile phone-facilitated mLearning contributes to improved educational outcomes, this article examines two specific issues: 1) the role of mobiles in improving access to education, and 2) the role of mobiles in promoting *new learning*, those new learning processes and new instructional methods currently stressed in educational theory. Of note, the projects reviewed deal with both formal and non-formal education as defined by Dighe, Hakeem, and Shaeffer (2009, p. 60).

The structure of the article continues as follows. After the introduction, the article engages with the literature that discusses how mobile technology can address the problems of access

confronting the educational sector as well as mobile technology's role in relation to new learning. The article then examines six pilot projects that involved the use of mobile phones for education in developing countries in Asia, analyzing the pilot projects in order to determine whether the supposed benefits that the literature outlines hold true in the developing world. The article concludes with a discussion of the potential of mobile phone-facilitated mLearning as well as with indications for possible future areas of research.

Theories of Mobile Learning

The literature on mLearning points to a variety of benefits that mobile phones could have on the educational sector. For heuristic purposes, the impacts of mobile phones on educational outcomes that are identified in the mLearning literature can be classified into two broad categories. On the one hand, mobiles supposedly impact educational outcomes by improving access to education while maintaining the quality of education delivered. On the other hand, mobiles purportedly impact educational outcomes by facilitating alternative learning processes and instructional methods collectively known as *new learning*.

The Role of Mobiles in Improving Access to Education

In theory, mLearning increases access for those who are mobile or cannot physically attend learning institutions – those who would not otherwise be able to follow courses in a traditional educational setting due to the constraints of work, household activities, or other competing demands on their time. MLearning makes education more accessible in that it enables learners to pursue their studies according to their own schedule. The portability of mobile technology means that mLearning is not bound by fixed class times; mLearning enables learning at all times and in all places, during breaks, before or after shifts, at home, or on the go. Interestingly, however, while mLearning is portable, it is not necessarily associated with physical movement. According to a study conducted by Vavoula, few people actually utilize the time spent in transit to learn (Sharples, Taylor, & Vavoula, 2005, p. 3).

MLearning, as Visser and West (2005) suggest, can also increase access in those situations where cost represents a significant barrier to learning (p. 132). For those in rural or remote areas where environmental and infrastructure challenges hinder other learning modalities, particularly eLearning, mLearning presents great opportunities. For the individual learner, mobile technology is much less cost-prohibitive than other technologies like personal computers and broadband connections that are necessary for eLearning. The ubiquity of mobile phones, moreover, means that educational services can be delivered with learners' existing resources. In as much as mobile technology presents a less cost-prohibitive medium for learning, it represents an important avenue by which to reduce the gap between the haves and the have-nots in contemporary society where access to knowledge and information is increasingly important (VanWeert, 2005).

In regards to cost, the benefit of increased access afforded by mLearning is particularly relevant in the developing country context. Many developing countries are completely bypassing investments in costly, fixed telephone infrastructure for the installation of mobile phone networks

(Motlik, 2008; Sharples, Taylor, & Vavoula, 2007, p. 224; Traxler & Dearden, 2005). Thus, mLearning provides a potential way forward for the expansion of education programs to larger segments of the population rather than via the eLearning model that has been adopted in much of the developed world. MLearning allows a method of educational delivery that could be more cost-effective than eLearning methods, not to mention that the ubiquity of mobile phones means that many people are already familiar with mobile phone applications (Motlik, 2008).

In so much as mLearning exerts an impact on educational outcomes by increasing access, mLearning represents a continuation and improvement of distance learning through increased utility and applicability (Keegan, 2002, p. 7). MLearning, the literature suggests, broadens the availability of quality education materials through decreased cost and increased flexibility while also enhancing the efficiency and effectiveness of education administration and policy.

The Role of Mobiles in Promoting New Learning

Others suggest that the benefits of mobile phones are not merely limited to increased access to educational services. MLearning, they indicate, can also facilitate changes in the character of learning modalities that in turn impact educational outcomes. In this regard, mLearning represents more than a mere extension of traditional forms of education; mLearning facilitates alternative learning processes and instructional methods that the theories of new learning identify as effective for learning.

According to proponents of new learning, mobiles facilitate designs for personalized learning in that they are responsive to difference and diversity in the way learning occurs. They facilitate designs for situated learning by providing learning during the course of the activity – in the field for a botany student, in the classroom for a teacher trainee, or in the workshop for an engineer. In this sense, mLearning also facilitates designs for authentic learning, meaning learning that targets real-world problems and involves projects of relevance and interest to the learner (Kukulska-Hulme & Traxler 2007, pp. 184-86; Traxler, 2007, p. 7).

The supposed value of mobiles also arises from the manner in which they facilitate lifelong learning. Mobiles can support the great amount of learning that occurs during the many activities of everyday life, learning that occurs spontaneously in impromptu settings outside of the classroom and outside of the usual environment of home and office. They enable learning that occurs across time and place as learners apply what they learn in one environment to developments in another (Sharples et al., 2005, pp. 2, 4; 2007, pp. 222-23).

Mobile phones theoretically make learner-centred learning possible by enabling students to customize the transfer of and access to information in order to build on their skills and knowledge and to meet their own educational goals (Sharples et al., 2007, p. 223). MLearning thus exerts a democratizing effect on the learning experience as learners take a greater responsibility for the learning process instead of being passively fed information by an instructor. Whereas in traditional models of education the goal is the transfer of knowledge from teacher to student, mLearning empowers students to actively participate in the learning process to make it a process

of construction and not mere instruction (dela Pena-Bandalaria, 2007). MLearning thus represents learning that is not 'just-in-case,' education for the sake of producing a bank of knowledge, but rather represents learning that is 'just-in-time,' 'just enough,' or 'just-for-me' (Traxler, 2007, p. 5). As a facilitator of new learning, mLearning goes beyond an emphasis on the possession of information to enabling learners to find, identify, manipulate, and evaluate existing information (Brown, 2003, p. 2).

Mobiles can also supposedly facilitate knowledge-centred learning by providing efficient and inventive methods by which students can learn with understanding – meaning that they deepen their understanding of a specific subject matter rather than merely memorizing large amounts of information – and then use this knowledge as a basis for new learning through integration and interconnection. Mobile devices make possible assessment-centred learning as well by enabling the provision of continual feedback throughout the learning process, presenting learners with diagnosis and formative guidance as to what might be improved or what might be learned next. Moreover, in providing prompt feedback, mLearning maintains the appeal of learning and provides a motivating factor that can at times be lacking in traditional modes of education (Geddes, 2004). Mobile phones also facilitate community-centred learning, meaning learning that the learner deems valuable because of its relevance to the surrounding social context; mLearning facilitates learning that can be used to achieve socio-economic goals that respond to problems, such as problems related to health or family care confronting the surrounding community (Sharples et al., 2007, p. 223; Wagner & Kozma, 2005, pp. 83-85).

Given that social interaction is central to effective learning, as indicated by theories of new learning, mobile phones should also impact educational outcomes by facilitating communication. Mobiles permit collaborative learning and continued conversation despite physical location and thus advance the process of coming to know, which occurs through conversations across contexts and among various people. Via mobile technology, learners engage in conversation whereby they resolve differences, understand the experiences of others, and create common interpretations and shared understanding of the world (Nyiri, 2002; Sharples et al., 2007, p. 225-26).

In promoting educational modalities that accord with the theories of new learning, mLearning should offer an appeal aspect that also impacts educational outcomes. MLearning can be particularly appealing for those who have not succeeded in traditional learning environments; it can attract those not enamoured by traditional learning approaches that are generalized and decontextualized in nature. MLearning is also beneficial in that it can provide immediate feedback and thus provide continued motivation for those who are not motivated by traditional educational settings. Moreover, mLearning presents an appeal simply because the use of mobile technology in and of itself presents something new and exciting for a great array of learners (Geddes, 2004, p. 4).

Mobiles, therefore, should impact educational outcomes by altering the character of education and learning because the nature of mobile technology converges with and facilitates new learning. The new learning is personalized, learner-centred, situated, collaborative, ubiquitous, and lifelong. Likewise, mobile technology is increasingly personal, user-centred, mobile, networked,

ubiquitous, and durable (Sharples et al., 2007, p. 224). The literature indicates that the benefits afforded by this convergence should exert a positive impact on educational outcomes.

Methodology

In light of the theories as to how mLearning should solve access problems as well as facilitate new learning, the authors sought to examine the existing evidence so as to confirm, or refute, the purported benefits advanced by the literature. To this end, the authors identified relevant mLearning pilot projects by conducting a search of academic publications and conference proceedings, as well as conducting a general Internet search. The projects were selected according to the following criteria:

1) Projects that demonstrate the use of mobile phones for educational (formal and non-formal) purposes,
2) Projects that were implemented in the low-income/lower-middle income countries of Asia-Pacific,[i]
3) Projects that clearly document results and have evidence, both qualitative and quantitative, such that definitive conclusions can be drawn regarding the impact of mobile phones on educational outcomes via increased access to education and/or via contribution to promoting new learning.

Six projects met the criteria of the search and are discussed in the section that follows (see Table 1 for brief summary). The search revealed that most mLearning projects have been implemented in the developed countries of Europe, North America, and Asia-Pacific; mLearning projects in the developing countries of Asia have been few in number.[ii] Moreover, of the projects undertaken, only a select few were documented in a manner that allows analysis of results. For the six selected cases, project reports and project-related, peer-reviewed publications served as the source for information.

Some key limitations of the study must be taken into consideration when generalizing the findings. Firstly, the study depended on the validity of the data presented by the sources. To minimize this limitation, the authors reviewed the appropriateness of the methodologies for each project in order to ensure, to the best of their knowledge, that they were acceptable. Secondly, the absence of a process of collecting primary data for this study meant that, in some cases, the data resulting from the projects reviewed did not always relate to the research question of this study. Consequently, some of the projects produced only limited information concerning the indicators that this study assessed.

Table 1

Summary of Projects

	Project name	Country	Educational purpose	Technology used
1	Viability of SMS Technologies for Non-formal Distance Education	Philippines	English language and math training	SMS
2	Viability of SMS Technologies for Non-formal Distance Education	Mongolia	English language, emergency care, and endocrinology training	SMS
3	Mobile Telephone Technology as a Distance Learning Tool	Bangladesh	Distance education course via national television	SMS
4	An Experiment in the Use of Mobile Phones for Testing at King Mongkut's Institute of Technology	Thailand	Test-taking	SMS
5	Improving Literacy in Rural India: Cellphone Games in an After-School Program	India	English language training	Cellphone games
6	Learning Communities Enabled by Mobile Technology: A Case Study of School-based, In-service Secondary Teacher Training	Bangladesh	Secondary teacher training	SMS; MMS; tele-conferencing

Case Studies

1. Viability of SMS Technologies for Non-Formal Distance Education in the Philippines

This project led by the Molave Development Foundation Inc. (MDFI) and funded by the International Development Research Centre (IDRC) sought to explore the viability of Short Messaging Service (SMS) technologies for non-formal distance education in the Philippines. The project, dubbed Project MIND, involved a partnership with the Alternative Learning Services (ALS) of the Philippines Department of Education (Batchuluun, Ramos, & Trinona, 2007). Based upon information gathered in pre-project surveys and focus-group discussions, the MDFI created two learning modules in conjunction with the ALS. One module was titled *MIND your English* and included sections on expressing oneself, language and grammar, reading skills, and letter-writing. The other module was titled *MIND your Math* and included sections on fundamentals of mathematics, area and perimeter, and percentage. Each module was designed to incorporate the use of SMS with a workbook. The English module also contained an audio CD containing the workbook exercises in audio form to aid students with proper pronunciation and diction. The

modules were designed such that SMS quizzes and tests had to be passed in order to complete the modules (Ramos, 2008, p. 9).

The impact of the SMS-based modules was assessed by way of the ALS Accreditation & Equivalency (A&E) high school examination, successful completion of which represents the equivalent to a high school diploma. The MIND your English and MIND your Math modules aligned respectively with part II of the ALS A&E exam titled *Communication Skills in English*, and part III titled *Problem Solving and Critical Thinking*. A group of students enrolled in the ALS was selected and, in turn, split into an SMS sub-group and a non-SMS control group. Those in the experimental group followed the Project MIND SMS modules, while those in the control group did not. Both groups took the A&E exam (Ramos & Trinona, 2009, p. 245).

The A&E exam results (see Table 2) reveal that the mean percent correct score of passers in the SMS group was marginally higher than those in the non-SMS group. The difference between the two groups was slightly greater in regards to the mean percent correct for parts II and III. Most remarkable is the difference in the range of the mean percent correct for parts II and III, with the lowest scores for the SMS group being significantly higher than the lowest scores of the non-SMS group. This difference in the range, the authors of the project suggest, may also account for the large difference in the overall passing rate between the two groups (Ramos, 2008, p. 24; Ramos & Trinona, 2009, p. 245).

Table 2

Results of ALS Accreditation and Equivalency Exam for Parts II and III (Adapted from Ramos, 2008, p. 24)

	Difference in scores (+ denotes higher score for SMS group than non-SMS group)	Score range	
		SMS group (N = 142)	Non-SMS group (N = 135)
A&E overall passing rate	+13.78		
A&E mean percent correct (PC) score of passers	+1.06	70-88	70-88
Mean percent correct (PC) in part II - *Communication Skills in English*	+5.00	56-98	30-96
Mean percent correct (PC) in part III - *Problem Solving and Critical Thinking*	+2.32	44-90	36-90

Findings regarding improved access and promotion of new learning.

Several program and hardware problems arose during the testing phase of the project (Ramos, 2008, pp. 25-27). The SMS server card did not function originally with the PC host, a problem that was quickly resolved by transferring the SMS hardware to another PC. There were also some

problems with the handling of student records and access to the SMS server because of the malfunctioning of the data encoding system that ensured that only mobile phones registered in the system could access the SMS quizzes. Some students switched phones and others dropped out without advising their teachers, causing problems because the SMS system required updates to ensure that new numbers were not blocked. At the start of the project, the volume of incoming messages also led to delays in the auto-reply system. Student errors in entering improper keywords also led to problems with the quizzes. Evident, then, is the fact that careful planning is necessary to ensure that mLearning does in fact deliver on its promise of increased access to educational services and to ensure that technological factors do not hinder the effective design and implementation of mobile phone-facilitated mLearning.

The ALS students that followed the SMS modules indicated that the modules enabled them to pursue their schoolwork according to their own schedule. Interestingly, however, given the short length of the modules, all students, except one, finished the modules within one day. Except for two students who spent roughly the same amount of money for transportation, the SMS materials actually cost more than previous modes of learning. Yet, all students indicated that the flexibility afforded by the modules made the additional money worthwhile. Some students even pointed to the added benefit of being able to do their lessons during breaks, meaning that they could still work and gain an income. Overall, students expressed interest in following modules covering other subject areas as well as modules containing more advanced information. The authors of the project conclude that cost is still a relevant factor for mLearning; a balance must be struck between providing increased education without becoming more costly than the student or learning institution is willing to pay (Ramos & Trinona, 2009, p. 254).

Students expressed excitement regarding the use of mobiles for learning (Ramos, 2008, pp. 25-27). One mentioned that the learning process was akin to answering trivia questions where feedback as to whether the answers were right or wrong was immediate and thus also allowed revisiting the error.

All students except two did not make use of the audio CD since they realized that it had the same content as the written module material. Those that did make use of the audio CD, however, appreciated learning the proper pronunciation of the words. Rather than submitting answers at intervals, all the students went through the modules and recorded their answers and sent them in together at the end. Students reported no major problems with the content of the course, stating that the modules were easy to follow. According to the students, the lessons were basic, but they served as a good refresher prior to the ASL A&E exam. The students also mentioned that the SMS modules were helpful because they could revisit material, unlike typical in-class modules that cannot be brought home. Additionally, students underscored that they appreciated the input of teachers who could respond to questions and technical issues.

The results of the ALS A&E exam seem to indicate that SMS-based learning was particularly beneficial for those students whose grades were situated at the lower end of the spectrum. While the average scores of those that used SMS-learning were not much different from those that did, the difference between the lowest scores of the range of these two groups was substantial. The

reason for the improvement in the scores of the lowest achievers is not clear from this individual pilot project, although respondents did indicate in the post-project focus group discussions that SMS-based learning made learning attractive.

2. Viability of SMS Technologies for Non-Formal Distance Education in Mongolia

This project involved a partnership with two organisations based in Ulaanbaatar, Mongolia, the English for Special Purposes Foundation (ESPF) and the Health Sciences University of Mongolia (HSUM) (Batchuluun, Ramos, & Trinona, 2007). The ESPF created an English language module that consisted of a workbook, dictionary, and audiocassette, with SMS messages required for completion of the module. They tested the module with a group of bank tellers and a group of restaurant servers. Similarly, the HSUM developed a module with sections on emergency care for pregnant women and endocrinology, which they tested among a group of obstetricians and gynecologists. Evaluation of the modules was conducted via comparison of pre- and post-tests (Ramos, 2008, pp. 18-19).

The results of the ESPF quiz (see Table 3) reveal a difference in the mean scores of the pre- and post-tests, as do the results of the HSUM quiz (see Table 4). According to the project's authors, this indicates that the SMS-based distance education curriculum facilitated an increase in the knowledge of those students that participated in the study (Ramos, 2008, p. 28).

Table 3

ESPF SMS Quiz Results (Adapted from Ramos, 2008, p. 28)

	Bank tellers	Servers
No. of students who completed module	15/15	10/10
No. of questions	20	11
Mean scores pre-test	12.33	5.70
Mean scores post-test	16.00	9.00
Net difference	+3.67	+3.3

Table 4

HSUM SMS Quiz Results (Adapted from Ramos, 2008, p. 28)

	Endocrinology	Emergency
No. of students who completed module	18/18	19/19
No. of questions	10	14
Mean scores pre-test	5.50	7.28
Mean scores post-test	9.56	7.63
Net difference	+4.06	+0.35

Findings regarding improved access and promotion of new learning.

The ESPF focus group participants indicated that the SMS modules were helpful, although they pointed to problems with message delays (Ramos, 2008, pp. 29-30). They mentioned that the booklets and audio CDs were useful in improving listening skills, pronunciation, and familiarity with new words. The participants also expressed their desire to learn more via SMS; they emphasized that they enjoyed distance learning because it allowed greater freedom of schedule, even though most still did their lessons at the last minute. Participants of the HSUM group also indicated that the flexibility of the modules was a great benefit.

The HSUM focus group participants revealed that they were excited about the use of SMS for learning and that they found SMS-based learning more interesting than learning via paper-based tests. They also appreciated the instant feedback on the tests, mentioning that feedback for paper-based quizzes has a much longer delay (Ramos, 2008, p. 29).

3. Mobile Telephone Technology as a Distance Learning Tool in Bangladesh

This pilot project (Islam, Ashraf, Rahman, & Rahman, 2005) investigated how mobile phones could be used to introduce interactivity and thus overcome the problems plaguing traditional distance education in Bangladesh, including a lack of interaction between presenter and student, a lack of feedback during presentations, no monitoring of student progress throughout the course, and no evaluation of teaching quality. Given that the cost of Internet bandwidth is high and that there is a lack of infrastructure to facilitate chat room technology or video conferencing, mobile phones presented a promising alternative.

The project simulated a typical distance education course broadcast on the Bangladesh national television network, but included the added dimension of interaction between instructor and students via SMS technology. Fifty-two students were divided into two groups: the control group, in a room face-to-face with the instructor, and the experimental group, in a room with a projection screen on which they could watch the instructor. Those in the latter group could raise and respond to questions via SMS. To determine outcomes, the two groups were each given the same pre-test and post-test, with the face-to-face group answering the questions by pencil and the other group answering via SMS.

Findings regarding improved access and promotion of new learning.

A t-test of the post-test scores reveals that mobile-based learning was at least as effective as face-to-face learning. This result, according to the project's authors, indicates that mobile-based learning provides a feasible alternative, one that might be particularly attractive given educational access issues in Bangladesh.

The project documentation reviewed contains no qualitative findings related to new learning except to mention that video recording revealed excitement amongst the group that used mobile phones. Related studies (Alam & Islam, 2008; Islam, 2008; Islam, Rahman, Razzaq, Sayed, & Zaman, 2006) have tracked students' interaction during similar pilot projects, revealing that participation rates were high among those students who took part in mobile phone-facilitated distance education pilot courses.[iii] Feedback from student participants in these related studies also reveals that they very much enjoyed the interactivity and that they found the immediate feedback a great motivator.

4. An Experiment in the Use of Mobile Phones for Testing at King Mongkut's Institute of Technology, Thailand

This project (Whattananarong, 2004) explored the effects of mobile phone use for testing at King Mongkut's Institute of Technology North Bangkok. Accordingly, 56 students who were registered in the Department of Technological Education were tested with similar tests from a test bank by the traditional paper and pen method as well as by simulated audio-mobile and visual-mobile methods. The visual-mobile simulated method involved the projection of questions on a screen, to which students responded by sending their answers via SMS. The audio-mobile simulated model involved a tape recorder that played the questions out loud, to which students then responded by SMS. All students therefore had three sets of scores. A control group and experimental group were selected from the participants, and scores from the traditional method were compared to those of the mobile-based methods.

Findings regarding improved access and promotion of new learning.

Results (see Table 5) indicate that there was no significant difference between the test scores from the three methods, with the visual-phone simulation having a slightly closer correlation to the traditional testing method than the audio-phone simulation. The project therefore reveals no negative effects in the use of mobile phones for testing, meaning that mobile phones could be used as a technology for educational reform in Thailand and for increasing access to educational services. An exploration of student's perceptions of the benefits and limitations of mobile phones for testing did, however, reveal that students were concerned about the potential challenge posed by the small screen size of mobile phones.

Table 5

Test Scores by Testing Method (Adapted from Whattananarong, 2004)

	Traditional method *N* = 28	Audio-phone method *N* = 28	Visual-phone method *N* = 28
Mean score (/40)	31.7500	31.5357	31.7857

Project-related documentation reviewed does not provide discussion that allows analysis of how mobile phones promote alternative learning processes and instructional methods that the new learning theories identify as effective for learning.

5. Improving Literacy in Rural India: Cellphone Games in an After-School Program

This project (Kam, Kumar, Shirley, Mathur, & Canny, 2009) explored the role of mobile phones in expanding the reach of English language learning to out-of-school settings, thus complementing formal schooling. The pilot project took the form of an after-school program consisting of children from rural, low-income families. A qualifying test ensured that students had the basic numeracy to utilize the mobile keypad as well as basic ESL literacy so that the program could target more advanced English than the alphabet. A Hindi language test was also conducted since success in acquiring a second language is correlated to literacy in one's native language.

With the assistance of an Indian ESL teacher, a curriculum was devised that aligned with local ESL learning needs and represented the equivalent to the material that a qualified teacher could cover in eighteen hours with rural children in a classroom setting. The cellphone games devised thus targeted listening comprehension, word recognition, sentence construction, and spelling and

were broken into various levels. The program consisted of 2-hour sessions that spanned 38 days from late December 2007 to early April 2008.

Assessment was based on pre- and post-tests, which specifically targeted spelling. Findings reveal an overall average increase in the score results between the pre- and post-tests; the mean pre-test score was 5.2 out of 18 while the mean post-test score was 8.4 out of 18, with the average post-test gains being 3.4. Interestingly, disaggregation of the students into high-gains and low-gains learners (those with post-test gains higher than the mean of 3.4 classified as high-gains learners) reveals that high-gains learners not only scored high on the post-test, but also outscored the low-gains learners on the pre-test, Hindi test, and qualifying test (see Table 6). Post-test gains show a high correlation with grade levels and a medium correlation with age, meaning that high-gains learners were generally older and in more advanced grades at school than low-gains learners.

Table 6

High-Gains vs. Low-Gains Learners in Terms of Test Scores (Adapted from Kam et al., 2009)

		Qualifying test (out of 50)	Qualifying test, spelling section (out of 6 words)	Hindi literacy test (out of 18)	Pre-test (out of 18)	Post-test (out of 18)
Low-gains learners (*n* = 15)	Mean	42.9	1.2	6.3	3.5	4.8
	Min.	37	0	0	0	2
	Max.	46.5	4	14	10	12
High-gains learners (*n* = 9)	Mean	47.1	3.4	12.0	7.4	14.4
	Min.	43.5	2	10.5	2	6
	Max.	49	6	14	13	18

Findings regarding improved access and promotion of new learning.

The authors of the project imply that the rationale for their pilot project was to explore the potential that mobile phones present for out-of-school learning. Particularly, they indicate that mobile phones provide the platform for a modality of learning that can complement formal education, one that can prove more convenient for low-income children who often have to stay at home to help their families. The project's authors also indicate that mLearning can provide enhanced learning for children in public schools in India plagued by teachers who lack adequate qualifications or who put little effort into teaching because of sentiments that pay is insufficient. However, the pilot project was structured as an after-school program, which still required students to come to a central location. Given that participation rates among some students were low, including high-gains learners, the pilot project does not fully demonstrate the potential of mLearning for improved access to educational services. Moreover, in the documentation

reviewed, the authors of the project do not reflect on possibilities for further expansion of the mobile edutainment program beyond a situated after-school program.

For all participants, a high correlation existed between post-test gains and qualifying test scores, while post-test gains had a lower correlation with Hindi literacy levels and pre-test scores. This implies that the greatest predictor of success in spelling the words presented in the cellphone games was the existing level of spelling proficiency and the grade enrolled in at school rather than the number of sessions attended. The findings thus indicate that rural children who have a stronger academic foundation are better able to take advantage of the benefits afforded by mobile phone-based learning. This observation, the authors of the project indicate, is consistent with the findings of He, Linden, and MacLeod (2008) whose study with rural and urban low-income children in India showed that weaker students gained more from teacher-directed pedagogical intervention, while stronger students were able to benefit more from a self-paced, machine-based approach to English learning.

The findings of this project seemingly contradict the claims of the mLearning literature, mentioned previously, that mLearning can benefit those learners who have not performed well in traditional educational settings. Yet, the authors of the project stress that the findings do not completely discount mLearning for low-income children. Rather, they suggest, these findings have important implications for educational design of mLearning programs. More attention and research must go into how mLearning software can provide the support needed by children with less academic preparation. In regards to the particular software employed in this pilot project, the authors of the project indicate that the software could be redesigned to track learner performance to ensure that the program is personalized to individual learners' level of knowledge and need for feedback.

6. Learning Communities Enabled by Mobile Technology: A Case Study of School-Based, In-Service Secondary Teacher Training in Rural Bangladesh

This pilot project (Pouezevara & Khan, 2007a, 2007b) sought to determine whether mobile phone-supported distance education could serve as an effective modality for in-service secondary teacher training in Bangladesh. The impetus for the project arose from recognition that the existing 14-day face-to-face training program, which requires rural teachers to travel to one of the government's teacher training colleges for the duration of the training session, presents challenges for teachers who cannot easily leave their many commitments at school, at home, and in the community.

The project revised the training curriculum from a 2-week face-to-face workshop to a pilot 6-week distance education program consisting of 12 units. According to the program design, each unit would consist of three main activities. First, each trainee would independently read and then reflect on the background materials provided, initiating communication with the trainer regarding the content as necessary. The trainee would then facilitate peer-learning sessions in which the

trainee would gather colleagues from within the school to discuss training concepts and to observe the classroom practices of colleagues. Each unit would end with a conference call, which involved the trainer and trainees from all the various schools as well as other colleagues in those schools, in order to discuss questions and outcomes arising from the peer group sessions.

An integral component to the program design was the use of mobile phones, which were made available to the trainees. The mobile phones, as called for in the project design, would allow the trainer to diffuse reminders, motivational messages, and assessment questions to the trainees via SMS as well as allow trainees to communicate with the trainer in order to pose questions, request materials, or respond to assessment questions. The mobile phones would also enable the conference calls at the end of each unit. Finally, the mobile phones would allow trainees to communicate amongst each other and with the smartphone capabilities to share multimedia examples of best practices.

To measure the outcomes of the project, the pre- and post-tests scores of the mobile phone-supported distance education study group were compared to the scores on the same tests of a control group that followed the face-to-face training program. These tests, standard to all the in-service teacher training workshops, consisted of two components, one that covered pedagogic knowledge and another that covered subject knowledge. Further qualitative information regarding the impact of the training program was gleaned from call logs and daily journals, in which participants were required to document their daily activities and thoughts, as well as from follow-up interviews and questionnaires.

Post-tests scores indicate that there were gains for both the study and control groups (see Table 7). Part two scores reveal little difference between post-test gains of the two groups. For part one, the control group made greater post-test gains in math, with the reverse true for Bangla. Despite the large difference in gains for the math teachers of the two groups, the project's authors indicate that comparison of the part one post-test scores exhibits no significant difference between the control and study groups.

Table 7

Post-Test Gains by Group (Adapted from Pouezevara & Khan, 2007a, p. 31)

Part one - pedagogy		
	Math teachers	Bangla teachers
	Post-test gains	
Control	10.45	4.15
Study	3.33	8.50
Part two – subject knowledge		
	Math teachers	Bangla teachers
	Post-test gains	
Control	1.98	1.50
Study	1.78	1.56

Findings regarding improved access and promotion of new learning.

The program design unfolded in a slightly different manner than anticipated. Participants did not use the MMS capabilities, most likely due to the fact that the clips that trainees created were too long to be transmitted over the network. Some participants also expressed difficulty with sending SMS messages because SMS could only be sent using English characters, and they were not comfortable with the English alphabet. Thus, the project incorrectly assumed that the trainees would easily adapt to these more advanced mobile functions when the trainees actually required instruction and support. In regards to the language issue, the authors of the project suggest that the use of mobile phones for teacher training might be more successful with English teachers because they have a familiarity with English characters (Pouezevara & Khan, 2007b, p. 5-6).

The feedback from participants provided the greatest indication of the benefits of mobile phone-assisted distance education. Evaluations revealed high satisfaction with the content and effectiveness of the training program. Trainees particularly valued the distance education approach as it was flexible and independent, thus allowing them to stay with their schools and families during the training period. For the schools and the Ministry of Education, this learning modality also had the added benefit of being less costly (Pouezevara & Khan, 2007b, pp. 5-6).

Contrary to original expectations, the conference-calling feature was not used because the phone model selected for the project, despite the claims of the mobile phone provider, could only connect three locations at a time and because the sound quality was not adequate for discussions. This development, suggest the authors of the project, demonstrates the necessity of adequate infrastructure and hardware for the success of mLearning. The scheduled conference call time was instead used for one-on-one communication between the trainer and trainees. Most time spent using the mobile phones included one-on-one communication with trainees in other schools to discuss the content of the program, demonstrating that the curriculum design promoted learning by enhancing interaction and collaboration between teacher trainees and by encouraging debate and deliberation regarding course ideas and their application (Pouezevara & Khan, 2007b, pp. 4-5).

Participants identified as beneficial the program design that required shared responsibility between trainer and trainee in the training program, making the program more learner-centred and participatory. In this regard, the use of mobile phones transformed the learning process from a process of instruction to collaborative construction; trainees were required to actively participate in the learning process. Participants also appreciated the situated nature of the learning modality. Distance education enabled them to immediately apply their training in the classroom, and the mobile phones provided the added benefit of enabling participants to immediately solve problems and answer questions that arose during the process by communicating with the trainer and with other trainees. If given the choice, 16 of 18 trainees said they would choose the distance version of the training program, indicative of the fact that many participants changed their attitudes towards technology-assisted training over the duration of the program (Pouezevara & Khan, 2007a, pp. 28-36; 2007b, pp. 4-5).

The authors of the project indicate that the project was not conclusive in determining whether the program was more effective with the use of mobile phones than had it been carried out as a traditional distance-learning course without the technology. Trainees, they indicate, learned much simply from the printed materials as well as discussion with and feedback from colleagues in their school. Also, the project's authors add, the project originally overestimated the value of the technology since it was the simplest function of the phones that was used – the ability to communicate one-on-one with the trainer and other trainees. Nonetheless, the authors of the project state that mobile phones did offer added value for students. The mobiles enabled immediate experimentation with and application of lessons learned in the classroom. The mobile phones facilitated on-demand communication between trainer and trainees; they also enabled discussion and shared problem solving between trainees thus both overcoming the isolation typical of most distance learning and improving content understanding and application. What is needed to truly determine the value added by the use of mobile phones, suggest the authors of the project, is a study that could compare a study group using the same curriculum design with a control group using only print-based materials (Pouezevara & Khan, 2007b, pp. 6-7).

Conclusion

Analysis of these projects indicates that while there is important evidence in the developing world that mobile phones impact educational outcomes by facilitating increased access, much less evidence exists as to how mobiles impact educational outcomes by promoting new learning. Regarding increased access, feedback from participants in the Philippines and Mongolia projects indicates the convenience of greater flexibility of schedule that mLearning affords. Likewise, participants in the Bangladesh teacher training program underscored the benefits of being able to stay with their families and in their schools for the two-week training period. The mobile phone-based teacher training program also enabled the Bangladesh Ministry of Education to extend access to quality training in a more affordable manner. Of greatest significance, however, is the fact that, as specifically shown by the Philippines, Bangladesh SMS, and Thailand projects, mobiles can reduce barriers to education while attaining educational outcomes that are, at minimum, comparable to those of traditional educational methods.

The projects also reveal, however, that there remain important issues that must be taken into consideration for future mobile phone interventions to indeed facilitate improved access to education. As participants in the Thailand project mentioned, technological issues such as screen size can remain a barrier to effective mLearning. Technical difficulties experienced in the rollout of the Philippines and Mongolia projects also reveal that the quality of the software and hardware is instrumental to the success of mLearning modalities. Furthermore, language barriers and unfamiliarity with advanced smartphone functions among participants in the Bangladesh teacher training project show that inadequate training can impede the benefits of mLearning interventions. Of particular relevance to the viability of mLearning in the developing country context, the Bangladesh teacher training project demonstrates that the state of mobile infrastructure directly affects the success of mLearning interventions; certain technological functions integral to the project design could not be used in the end because of inadequate

infrastructure. Additionally, as the authors of the Philippines project suggest, cost remains a relevant factor. MLearning is not always less expensive for the individual learner, as the mLearning literature might suggest, perhaps due to the fact that most of the mLearning literature addresses the developed world.

The findings of the projects are mixed in regards to the extent to which mLearning promotes new learning. Feedback from participants indicates that mLearning enables learner-centred education, particularly in comparison to traditional distance education models. MLearning provides increased interaction, as demonstrated, for example, by the first Bangladesh project discussed. Several projects also reveal the motivational factor of the immediate feedback that mLearning makes possible. Additionally, participants, particularly those in the Philippines and Mongolia projects, indicated that they enjoyed the appeal factor stemming from the use of a novel technology.

Yet only the Bangladesh teacher training pilot project demonstrates the benefits of mLearning that stem from the facilitation of contextualized, situated, constructive, and collaborative learning. Teacher trainees were able to immediately apply lessons learned within their classrooms, and, in turn, to discuss results of the newly applied techniques with trainers and other trainees. The collaborative program design based around the use of mobiles also encouraged constructive learning via interaction and participation on the part of the trainees. The other projects reviewed do not provide evidence of these supposedly important aspects of mLearning. This is interesting, given that, as previously mentioned, the mLearning literature particularly highlights the value of mLearning in offering this potential. The important findings of the Bangladesh teacher training project, therefore, necessitate further exploration in the context of the developing world regarding the potential impact that mobile phone-facilitated mLearning can have on educational outcomes via the promotion of new learning.

The projects reviewed also produce some contradictory evidence in regards to the benefits of mLearning for those who have not succeeded in traditional educational settings. The Philippines project seems to indicate that mLearning, and the new learning that it facilitates, affords great opportunities for such learners. The India project, to the contrary, seems to indicate that those with a weaker academic foundation are less able to take advantage of the benefits provided by mobile phones and would rather benefit from a more teacher-centric educational approach. Such discrepancy necessitates future investigation.

Although the projects reviewed point to a positive role with respect to mobiles as a tool to either access educational materials or deliver more learner-centred curriculum, future research should investigate the opportunity cost of investing in mLearning compared to the costs and benefits of other investments in the educational sector. It is possible that investments in educational infrastructure and materials, as well as more traditional teacher training, might yield more significant beneficial educational outcomes. However, due to the absence of such comparative studies, it is impossible to tell. Moreover, very little research in the developing world has looked at comparing the costs and benefits of the different technologies used to deliver educational services – traditional technologies like television and radio, or newer ones such as computers and

mobiles – in order to ensure that governments have the appropriate information to make wise investments. The current debate about the relevance of the One Laptop Per Child initiative (OLPC, n.d.) for developing countries, for example, has put the need for rigorous studies of the comparative value of various technological investments in the educational sector at the forefront of information systems research agendas.

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[i] The authors chose to focus on Asia as currently most developing-country interventions in education using mobile phones are being undertaken in Asia, exploiting the relative ubiquity of the technology in the region. Early indications suggest that Asia can be the global leader in the development of educational uses of mobiles (Motlik, 2008). This study sought to explore the potential of mobile phones in contexts of poverty and relatively under-developed educational sectors, and, therefore, projects were limited to low and lower-middle income countries, following the World Bank classification (World Bank, n.d).

[ii] For a comprehensive review see Frohberg, Göth, and Schwabe (2009).

[iii] Further discussion of these related projects is not included in this article as the documentation reviewed includes no findings, such as pre- and post-test comparison, that might point to the impact of mobile phone-facilitated mLearning on actual educational outcomes.

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