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What is the Potential Impact of Using Mobile Devices in Education?

by

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Abstract

Mobile devices are becoming ubiquitous in the world today. With the power of portable computing in the hands of everyone and anyone, the time has come to consider using mobile devices for education. While ICT in education has been trialled, results have been mixed. Mobile devices are also ICT devices, so why should we still consider using mobile devices in education and what is its potential impact on the stakeholders. This paper provides an overview of what is out there and explores the opportunities and issues in regards to using mobile devices in education.

Next we look at how the stakeholders in the education system, namely the education providers, the teachers, the students, their parents, and the ministry of education can benefit by successfully deploying classroom curriculum via mobile devices. Many stakeholders in the education system are already struggling to deliver basic education – what is required of them and how they should be supported if we are to convince them to use mobile devices in delivering education.

Mobile devices are already being used by educational institutions in many countries. What type of technology, content, and mobile devices are currently being experimented with? What are the results in terms of student learning outcomes? What do the teachers think? Are the other stakeholders in education satisfied? We look at reports and reflections from several implementations of using mobile devices in education to learn from and move forward.

Regardless of many brilliant anecdotes about using mobile devices in education, mobile devices after all are ICT devices that contain fragile electronic components, need power to operate and connectivity for access. A lot has been learnt from ICT deployment in education and improved upon. However, it is to be noted that fully realized potential of any mobile device and its use in education is entirely dependent upon electrical power, network connectivity and user competency.

Keywords: m-Learning, e-Learning, m-Education, mobile devices in education

Introduction

We have used computers for some time to do almost everything possible and came up with many innovative ways to use computers for teaching and learning in education. Portable computing power came in the form of laptops and netbooks. They allowed us to take our computing power with us carrying it on our shoulders. However, laptops and netbooks could provide us usage for three to four hours maximum before it required connection to electrical power supply. Mobile devices, once fully charged, can provide the same for 48 to 96 hours. Laptops and netbooks require connection to a network for Internet access, which is available at fixed locations in buildings or wireless access points, again at fixed and confined locations. Mobile devices have a network connection available almost (99.999%) of the time in almost every part of developed countries. Mobile devices network availability and penetration is happening at a dramatic pace in developing countries - already there is 68% penetration with an exponential growth of 10% per annum <Source: ITU, 2010 [17]>. The same should apply to education; learning and teaching should be able to take place anywhere whenever the student and the teacher are ready. With such flexibility in the provision of education, there is a possibility in getting everyone educated once the constraints of attending classes at confined time slots and locations are removed.

Mobile devices offer a number of advantages for education in comparison to laptops or netbooks. First, their lighter weight and orientation flexibility makes them far superior for digital reading or accessing of content. Second, their instant-on capability and fast switching among applications allows learning activities to proceed with less delay. Third, their touch screen interface allows a high degree of user interactivity. Fourth, they are much more mobile than laptops, as students can carry them inside or outside a room without having to close and reopen the screen and store them in the carry case and can also use them for mobile data collection or note taking. Fifth, since it is inexpensive to develop apps for mobile platforms, there is a rapidly growing amount of free or low-cost apps for mobile devices, many of which are suitable for education. And finally, mobile devices' long battery life makes them more suitable for a school day (Warschauer, 2011 [39]).

According to research carried out by (Warschauer, 2011 [39]) to investigate the use of iPads in K-12 schools in the US, the following observations were made: In one private school in California, students had daily access to laptops and frequent access to iPads, thus allowing the

researchers to compare the use of the two. In a science class that was observed, students unanimously stated that they prefer using the iPads to the laptops due to the tablets' light weight, mobility, touch screen, and apps. Students used the iPads to read free open source Earth sciences textbook, investigate the elements and the composition of the Earth and galaxy via interactive apps, access the school's e-learning platform, log and analyse lab data, and produce lab reports. The researchers' observations suggested that the iPads were particularly helpful for laboratory work as the students carry the devices around to input data on the move.

An initiative of the Washington state community and technical colleges is called the Open Course Library (OCL). The OCL is a large-scale curriculum redesign effort leveraging a variety of existing Open Educational Resources (OER) as well as original content by the faculty course designers. The State Board for Community and Technical Colleges (SBCTC) is an organization that provides leadership and coordination for Washington's public system of 34 community and technical colleges. Based on the 2010 Annual Enrolment Report, the number of students attending the colleges was 470,000 and climbing. This was the highest enrolment level in SBCTC history, with most of the increase due to growth in eLearning. One reason for this growth is that more students are able to fit school into their busy schedules by attending fully online classes (Caswell, 2011 [7]).

Research Objectives

1. This paper intends to inform as to why should we consider using mobile devices in education and what will its potential impact be on the stakeholders.
2. It provides an overview of what is already happening with mobile devices and explores further opportunities and issues in regards to using mobile devices in education.
3. Questions such as what are the costs and benefits of successfully deploying classroom curriculum via mobile devices are addressed.
4. What type of technology, content, and mobile devices are currently being experimented with is also taken into consideration.
5. All these are being done for one purpose, which is student learning outcomes – are we achieving the desired results in student learning outcomes with mobile devices.

Literature Review of Related Work

Donner (2009) [9] in “Research Approaches to Mobile Use in the Developing World: A Review of the Literature” reviews 200 recent studies of mobile phone use in the developing world. He categorises his research into three common themes, with one of them being Mobile Impact on Education. Donner states a good number of studies consider mobile devices as a resource for e-learning in Tanzania (Stone, Lynch, and Poole 2003) and Thailand (Whattananarong 2005). All argue that the mobile’s portability, simplicity, and affordability make it a natural fit for education initiatives in places where PCs and internet connectivity may be scarce.

Kumar et. al. (2010) [24] argue that mobile devices like cell phones are a perfect vehicle for making educational opportunities accessible to rural children in places and times that are more convenient than formal schooling. They conducted a 26-week study to investigate the extent to which rural children will voluntarily make use of mobile devices like cell phones to access educational content. Their results show a reasonable level of academic learning and motivation. Koole (2009) [23] emphasises that there is a tremendous scope for learning with mobile devices and establishes a framework to assist practitioners in designing activities appropriate for mobile learning.

According to Kam et. al. (2008) [21] cell phones are increasingly adopted in the developing world, and an increasing fraction of these phones feature multimedia capabilities for gaming and photos. These devices are a promising vehicle for out-of-school learning to complement formal schooling. In particular, they believe that learning English as a Second Language [ESL] by playing games on cell phones present an opportunity to dramatically expand the reach of English learning, by making it possible to acquire ESL in out-of-school settings that can be more convenient than school.

With mobile devices increasing ubiquity in developing countries, Brown (2003) [6] argues that it is timely to envision a future where the mobile devices play a pivotal role in education in developing countries. According to Brown, while there are as many people using mobile technologies as there are opinions on how mobile technologies will impact on education; the majority agree that m-learning will play a major role in e-learning. Already, there are numerous

applications for mobile technologies in education – from the ability to wirelessly transmit learning modules and administrative data, to enabling learners to communicate with lecturers and peers.

The National Educational Technology Plan of 2010 [35] for the U.S. Department of Education dated March 5, 2010 states “our model of an infrastructure for learning is always on, available to students, educators, and administrators regardless of their location or the time of day.

Anderson (2009) [3], a critic of mobile learning changed his position after buying an iPhone 3G. He writes in the Foreword of *Mobile Learning: Transforming the Delivery of Education and Training* - AU Press, Athabasca University “Every day, the app store offers me yet more ways (including 75 applications categorized under “education”) that this phone [iPhone 3G] can morph itself into a universal and ubiquitous information, education, and entertainment portal”.

Akers et. al (2010) [1] reports the short-term results from a randomized evaluation of a mobile phone literacy and numeracy program (Project ABC) in Niger, in which adult literacy students learned how to use mobile phones as part of a literacy and numeracy class. Students in ABC villages showed substantial gains in numeracy exam scores. There is also evidence of heterogeneity in program effects across regions, suggesting the impact is context dependent. The results were stronger in one region, for women and for participants younger than 45. There was also evidence of persistent impacts: six months after the end of the first year of classes, students in ABC villages retained what they had learned better than the non-ABC students. The effects do not appear to be driven by differences in teacher quality and motivation, nor student attendance.

If we are going to use technology to learn, then, what is the point of investing in new technology when we already own mobile devices? As pointed out by Ally (2009) [2] Rather than acquiring another technology to receive learning materials, people throughout the world will want to access learning materials on their existing mobile devices. As a result, educators and trainers must design learning materials for delivery on different types of mobile devices. The nomadic learner and worker who travel frequently from place to place will similarly use mobile technology to access information and learning materials from anywhere and at anytime. A major benefit of using wireless mobile technology is to reach people who live in remote locations where there are

no schools, teachers, or libraries. Additionally these remote locations have geographic terrains that are difficult for normal networking and cabling infrastructure.

Can mobile technologies support teaching and learning? This was one of the core issues examined by Gaskell & Mills (2010) [11] in their research paper titled “Can we really learn from mobile handheld devices?” They concluded that there is much evidence that mobile technologies are playing an increasing role in education and the use of mobile technologies is increasing in the developed world in a number of areas, for instance in context related education, and how handheld devices can be used for basic language, skills, numeracy and health and safety training and some aspects of teaching and learning across the developing and developed world. The use of handheld technologies provides a major opportunity to enhance access to learning and will enable many institutions to develop learner and administrative support and learning opportunities in ways which will build on current methods.

Valk et. al. (2010) [36] examined 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. They reviewed the evidence of the role of mobile phone-facilitated m-Learning in contributing to improved educational outcomes in the developing countries of Asia by exploring the results of six m-Learning pilot projects that took place in the Philippines, Mongolia, Thailand, India, and Bangladesh. They concluded that the 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.

Mobile devices perform many of the functions of desktop computers, with the advantages of simplicity (being easier to learn and use) and improved access (being usable anywhere, anytime). Houser et. al. (2002) [16]. According to Prensky (2005) [30] Mobile phones are not just communications devices for interaction between people; they are in fact computers that fit in your pocket, are always with you, and are always on. Like all computing devices, mobile phones can be used to learn. So rather than fight the kids coming to school carrying their own powerful learning devices—why not use the opportunity to their educational advantage?

Methodology – Research Strategy

The research mainly focuses on document analysis and is based on the case study research strategy. Secondary research has been done to analyse data from existing journal articles and publications on the topic. This has been achieved with a comprehensive literature review and the following up on a multitude of ongoing research and conferences on the topic. The researcher has read extensively on the topic and contributes on conference panel of the same topic. Also, I did not see a need for primary research as there has been a number of researchers that have collected data regarding the same, but in different context. Therefore I am able to use their data for analysis and conclude my research objectives. As an academic, I have been using ICT in Education for a more than decade and am in a position to provide a practitioner's perspective and experience on the methodology design. A research to see the impact of using mobile devices in education is going to be conducted on my existing first year IT students. This research will be used as a theoretical background to that research. Case studies present data in very publicly accessible ways and may lead the reader to apply the experience in his or her own real-life situation.

As pointed out by Argyrous (2009) [4], “secondary data are an abundant resource for researchers” as the Internet has made vast amount of data available. He also lists the advantages of savings on cost and time, access to quality data that has been tested, access to difficult populations and availability of longitudinal data. Case study research excels at bringing us to an understanding of a complex issue or object and can extend experience or add strength to what is already known through previous research. The case study method has been used to gain an insight on existing literature on using mobile devices in education. Case study research generally answers one or more questions which begin with "how" or "why." The questions are targeted to a limited number of events or conditions and their inter-relationships. To assist in targeting and formulating the questions, researchers conduct a literature review. This review establishes what research has been previously conducted and leads to refined, insightful questions about the problem.

Finally, grounded theory has been used to conclude that there are potential benefits and significant impact of using mobile devices in education as far as student learning outcomes are concerned. Grounded theory is a research method that operates almost in a reverse fashion from traditional research and at first may appear to be in contradiction to the scientific method.

Why Mobile Devices are being Considered for Use in Education and its Impact?

According to the International Telecommunication Union (ITU, 2010), the share of total mobile subscriptions in the developing world increased by one fifth between 2005 and 2010, to stand at 73%. In Africa, penetration rates were projected to reach an estimated 41% at the end of 2010 (compared to 76% globally) leaving a significant potential for growth. The 2011 Horizon Report (Johnson et al., 2011 [19]) places mobile devices as a top technology to watch for in the coming year, occupying the same level as electronic books, in the six featured technologies. And the market has a host of different mobile devices, operating systems, applications and accessories – all with different capabilities, against a backdrop of issues relating to communication coverage, infrastructure and equipment, bandwidth as well as usage costs.

From Text Books to e-Books

Let's start with a very basic foundation of education: the text book. Most people instinctively believe in the power and importance of books in education, and in fact recent research quantifies that benefit: having access to a library of books is roughly the equivalent of three (3) or more years of schooling (Brooks, 2010 [5]). The good news about books is that teachers and children all know how to use them – there's no training required. But the bad news is that they often don't get where they need to. According to Ross, 2010 [32], half of the classrooms across six countries studied in Sub-Saharan Africa have no textbooks at all, because of cost and logistical issues. And this is true for many developing countries. As Trucano notes in his World Bank Blog on ICT Use in Education [33], "Only 1 out of 19 countries studied (Botswana) has adequate textbook provision at close to a 1:1 ratio for all subjects and all grades." Books just aren't getting to Sub Saharan Africa and many others in other parts of the world.

In January 2011, e-book sales surpassed those of text books in the US (Electronista, 2011 [10]). The cost of mobile devices will become lower than textbook costs, and continue to fall. And this trend will continue as more and more publishers turn to e-book publishing which is cheaper for the publishers and cheaper for their readers. Authors are now able to self-publish into e-Books as well with an array of free software available to do that. City libraries and University libraries

around the world are digitising their collection of text books to e-books as their member and students are no longer confined by geographical distances. Most of their readers would like to access books from the comfort of their homes or from wherever they are instead of physically travelling to the library. Museums' are digitising centuries old text books to preserve them. Academics and researchers can now carry hundreds of e-books on their 2 gram USB drives instead of carting 200 kilograms of text books in boxes.

Effective use of multimedia, interactive multimedia will become core elements of new e-Books and e-Courses. The multimedia elements will enable to students to understand the concepts being taught via audio and video. With traditional text books, many of which are written in English and studied by non-English speaking students, what they could not comprehend via word and sentences are conveyed via multimedia. There have been some excellent first attempts from HMHEducation [15] in producing e-Books and e-Courses, and they will improve as the market matures. Houghton Mifflin Harcourt <<http://www.hmheducation.com/>> introduces the world's first educational app for schools developed exclusively for a touch screen mobile device with cutting edge Apple iPad® technology. This revolutionary mobile platform combines direct instruction, ongoing support, assessment, and intervention—enabling teachers to personalize instruction for each and every student.

These mobile devices were initially designed for users with broadband connections in developed countries, but their impact on the developing world may well be even more profound due to the relative lack of access to books, and the ever-increasing popularity of mobile phones: it's getting hard to find a part of the world where kids don't have access to mobile phones, and with that, some kind of power supply to keep them recharged. Most importantly, e-books on mobile devices offer something that is customary to the teachers and the students. Teachers already know how to integrate books into their classrooms, and students already know how to use mobile phones. But what really adds value to this model is: now students can read not only the books that are required in their classrooms but get additional information and knowledge as and when required, even when they are reading it away from the classroom. A connected 24/7 teacher is now available with more information and knowledge than their human teacher.

The Post-PC Era: From Computers to Mobile Devices

By now it should be obvious that as computing power has increased, size and price has decreased. From mainframe computers of 1970s that was the size of a room and could ADD 2 + 2 and give an answer of 4 in two minutes, we have a computing device that fits into the palm of our hands and does everything while costing almost nothing. The computing environment started off with distributed computing platforms where organisations were doing their own computing within their own networks and moved to centralised computing when the need for online electronic transactions between business-to-customers [B2C], business-to-business [B2B] and business-to-government [B2G] became apparent.

Now with cloud computing technology and widespread use of mobile devices for computing power and connectivity, once again the computing platform is becoming centralised. Cloud computing infrastructure and applications are able to interact with users who have mobile phones, Tablet PCs, OLPC [one-laptop-per-child], and other mobile devices. Users of mobile phones and devices are not required to store data and information on their devices. Whatever data and information they need are stored with their cloud service providers. When the need arises to use that data or reference that information, access is obtained via their mobile service provider as long as they are within the network connectivity range. Access to data and information is not confined to any location, and that is the essence of cloud computing (Goundar, 2011 [13]). The primary computing platform has changed from a central computer server doing everything and controlling all to a multiple functionality mobile device that builds on the existing power of desktop computing network to enable computing applications never possible before.

According to Steve Jobs, Apple sold its one millionth iPhone 3G, just three days after its launch, and they now sell ten mobile devices for every one laptop or desktop computer sold (Contacto, 2011 [8]). Mobile digital devices rocketed to popularity around ten (10) years ago with the release of the iPod. Mobile computing went conventional with the release of the iPhone in 2007. With the release of the iPad just one year ago, we are now seeing a significant shift in the dynamics of computer purchase and practice – moving away from desktops and laptops to iPads and other mobile devices (Pinola, 2011 [28]). Their cost relative to laptops along with the promise of

mobile computing has raised tremendous interest in iPad use in education. Pinola, 2011 [28] reports that global laptop sales have collapsed, from pre-iPad double-digit growth rates to just 1 percent in the first quarter of 2011. Deutsche Bank analyst Chris Whitmore estimated that around 30% of iPad owners are using it as a laptop replacement, rather than as a supplement. Morgan Stanley analysts also confirmed this trend in September 2010, reporting that the iPad cannibalized 25% of the laptop market since the tablet was first announced (Pinola, 2011 [28]).

According to Gliksman, 2011 [12] from iPads in Education, an online network that provides guidance on educational usage of iPads, allowing users to ask questions and gain from others' experiences; "mobile devices may have an impact now and in the future in the following way: 1). Form factor [easy to handle when compared with laptops and notebooks]; 2). Long battery life and instant-on [lasts longer without power connection and has instant connectivity]; 3). Price [costs twice as less and decreasing dramatically]; 4). Touch interface [no clumsier mouse or touchpad]; 5). Improved digital reading [crisp quality of the display]; 6). Integrating multimedia [images, audio and video], and 6). Collaboration [educational value of social networking].

Gliksman, 2011 [12] also discusses the Immediate Future of Mobile Devices in Education, and notes:

- The mobile apps market will mature and we'll move from single task, short session apps to more sophisticated offerings. The release of GarageBand and iMovie are the first steps in that direction.
- The barrier to entry for creating and distributing e-Book content will become lower. Increasingly, teachers and communities will create their own e-Book content.
- Social reading is an imminent phenomenon that combines the reading of e-Books with social networking. When reading e-Books, users can connect to friends and other readers, asking questions and sharing notes or opinions. Apps such as Inkling <<http://www.inkling.com/>> are a bold first step in that direction to promote social collaboration.
- While the iOS browser is adequate it still lags behind desktop offerings. As mobile continues to expand we can expect a consolidation of desktop and mobile systems and browsers resulting in better mobile web editing, more collaboration tools and support for a wider range of web technologies that support the use of mobile devices in education.

Using Mobile Devices in Education and its Impact on the Stakeholders

There are many stakeholders in the education system, namely the education providers [schools, colleges, teacher training institutions and universities], the teachers [class teachers, subject teachers, heads of departments, and principals], the students [primary, secondary, and tertiary], their parents [as individuals, in school boards, and in school management committees], the ministry of education, the government [politicians and their policies], and funding agencies. All stakeholders need close collaboration if they want to benefit from successfully deploying classroom curriculum via mobile devices. Many stakeholders in the education system are already struggling to deliver education as it is – let us look at what is required of them and how they are to be supported if we are going to use mobile devices in delivering education.

The Education Providers

When stakeholders move from using computers in education to using mobile devices in education, there will be many economic advantages for the education providers. Education providers can also expect improved student learning outcomes, satisfied teachers - with technology for support and assistance, and happy parents. To start of with: there will be no need to have dedicated computer labs, specific computer desks, chairs and computer lab space – which also means no IT support required, no IT staff needed, no servicing, repairs and maintenance of computers required. All other associated costs like networking equipment, ISP connections, air conditioning and huge power bills will be saved. However, subscription will be paid to the mobile phone network provider, which in many cases will be insignificant when compared to computer networks to the internet. In many cases students with mobile devices will already be subscribed to a network service provider, if not, then schools normally get subsidised packages or are totally subsidised by their governments. Mobile devices, now available in abundance, are cheaper and simpler to use. New mobile apps rely on new input and output methods and allow a new population of non-expert users to use the device more cheaply and simply.

For those education providers that were constrained by funds and expertise to use computers in education – using mobile devices in education seems like their saviour. Nalder, 2011 [25] reasons that education providers using ICT in Education have struggled to:

1. Find the time to provide basic computer technology skills training to staff or
2. Get past the time intensive operating systems and user interface lessons or
3. Keep technology repaired and working so that it's available in the first place.

Nalder, 2011 [25] argues that education providers using mobile devices may now be able to:

1. Spend staff training time on improving pedagogy.
2. Spend valuable student lesson time on using technology instead of wasting time learning to use technology first and then the lessons.
3. Spend less money on supporting existing technology and more on supporting its use in classrooms.

Many developing countries do not have or can not afford the level of electricity supply required by computers, or the money to buy enough computers for their students and to subscribe to the Internet. Given such constraints, they readily embrace cheaper mobile devices such as mobile phones which require less infrastructure, support and skill.

Digital classroom curriculum creation offers two significant business enablers for sustainable education futures: 1). the marginal cost of replicating digital learning materials is near zero, and 2). sharing course design and development costs among institutions is cheaper than doing this alone. Therefore, it is possible to provide affordable access to high quality learning materials and eBooks, even for learners who may not have reliable or low-cost access to the Internet. Moreover this would not necessarily require new money or investment as it would be done by teachers who are already on the taxpayer's payroll.

Mobile devices are on track to become the main technology for use in education in the future. It is going to advance, improve, and become enhanced with each generation of students learning with them. Students who are learning with mobile devices today will become teachers in time to come.

The Teachers

Teachers are probably the most important and critical factor at the moment of the movement towards using mobile devices in education. What is lacking today are the skilled teachers that can take a mobile device and incorporate it from the paper-based or blackboard based classroom lessons, into student-centric learning deployed via mobile devices. But have we included the mobile device teaching into our existing teacher training curriculum. Are our teachers training institutions and universities teaching our future teachers on how to use mobile devices for teaching in the classroom or are we going to burden them after they graduate and start teaching. As suggested by Weinberger, 2011 [40], add no burden - the failure of almost all educational technology initiatives can usually be traced to the additional burden placed on the teacher. Ideally, teachers' burdens should be reduced by technology.

Teachers require training to understand how to teach differently. How methods like student-centric learning can be applied to the classroom, and shown how this learning style will increase educational outcomes. Yet who is investing in teacher training? If you look around, Ministers of Education get excited about shiny, flashy things, not human capacity building. And who can blame them? It's a lot easier to show off a technology implementation than a trained teacher, and children and their voting parents can see a quick difference with a computer that isn't so noticeable with a trained teacher (Vota, 2011 [38]).

So regardless of how amazing the mobile device technology is, until we invest in trained teachers who know how to use technology to improve their teaching activities, we are not going to make much difference with the current generation of teachers and learners. We also need parents and politicians who are focused on learning outcomes and not the new mobile device technology and what it can do, because regardless of how many applications or how easy the technology is, I fear that using mobile devices in education initiative will be wasted (Vota, 2011 [38]).

The issues that face developing countries using mobile devices in education are very different from those in the developed countries. In the developing countries, there is no training available for teachers on how to use technology to teach or to improve students learning.

The Students

Mobile devices are undoubtedly an exciting way to interact with technology, especially, when they are touch screen enabled. The intimacy and immediacy of the personal screen and the ease of use and intuitive design of modern touch screen operating systems greatly eases user fears and facilitates user adoption. This ease of use is exciting technologists and educators, both of whom are thinking of new ways to use technology like the mobile devices in educational systems of the developing world.

In an interview, a teacher at a residential school specifically for the disabled (both mentally and physically) in rural Transkei in South Africa shared an anecdote. She pointed to a crude sketch of an ATM that they used to teach basic life skills to their students and said that it often took years before the children were able to get their numbers right. However ever since they all got mobile phones (they receive special grants from the South African government) they had all figured out their numbers, how to maximize the use of their phones and often showed her how to use hers or top up her airtime or some such assistance. She said she'd been teaching for 35 years and had never seen anything like it, until the mobile phones came (Bhan, 2011 [4]).

Another interesting set of users for mobile devices are the senior citizens. They found using computers very hard as it required them to learn many things and remember them all. For example, if a user wanted to word process a letter, the user first had to learn the operating systems, then the word processing application, and then could do the letter. They didn't find this very productive, and thus shied away from using computers. With mobile devices, they basically have to remember just a few buttons like the call [green] button or the end [red] button to make phone calls or to send and receive text messages. With touch screen mobile devices and user friendly mobile interfaces it is easier for them to interact with.

Similarly there is a movement of consumers who are embracing mobile devices due to their simpler, more personalised nature. Generally these are older users such as the 99 year old Virginia Campbell of Oregon, USA, for whom an iPad was her first ever computer, and one she was able to use unaided. She has been writing limericks as well as reading books again after

having not been able to for ten years due to poor eyesight. So what does this mean for education? If Virginia can overcome encumbrances older than the PC era to take advantage of the lower entry level of skill and IT support that Post-PC devices provides, as well as go on to explore new applications and uses suited to her personalised needs, then anyone, including Education can (Nalder, 2011 [25]).

Ison et. al. (2004) [18] initiated a project aimed to test the hypothesis that m-learning strategies and mobile phone technology could motivate and support the retention of disengaged youth in learning programs and aid the development of lifelong learning skills through supporting collaborative, networked learning environments. It aimed to include m-learning strategies in a blended approach, incorporating learning delivery in community, workplace and/or institutional contexts. This project targeted 15–19 year-old students who have not previously succeeded in traditional classroom-based learning, and examined the option of mobile learning (m-learning) for vocational education and training (VET) providers. The project recognised that mobile phone use has become a pervasive communication tool among youth culture, and created recommendations and guidelines for VET providers on using this communication technology to support a sustainable learning culture with disengaged youth. Mobile phone Short Message Service (SMS) prompting was found to be very successful in both enhancing student participation and motivating them to meet deadlines for assessment. Both of these contributed to improved learning.

Mobile Device Technologies Currently Being Used in Education

TeacherMate handheld computer system is designed to support the teacher. TeacherMate system was developed by Innovations for Learning, a Chicago-based nonprofit organisation. According to Weinberger, 2011 [40] who is the Executive Director of Innovations for Learning: 1). effective education requires individualized instruction, and 2). technology can greatly assist teachers in individualizing instruction. These ideas have led to the development of TeacherMate, which creates an effective system of individualized instruction that is affordable, replicable and scalable. To achieve this goal they have focused on the following principles: focus on supporting the teacher in the classroom; support the existing curriculum [from paper-based to teachermate];

add no burden to the teacher [adding burden will lead to failure - teachers' burdens should be reduced by technology]; and the device needs to be affordable (Weinberger, 2011 [40]).

Worldreader (Risher, 2011 [31]) is currently working with 500 teachers and students across three grade levels in Ghana to measure the impact of e-readers, and the effects have been pretty dramatic. According to Risher, 2011 [31], they have loaded e-readers with about 80 books each – a combination of local textbooks and storybooks have been digitized along with international books donated by Random House, including the entire Magic Tree House series. That's 40,000 books already delivered – nearly impossible to contemplate without the use of e-readers. If Worldreader's experience so far is any guide, e-readers are set to transform the developing world, both in – and outside the classroom. But this change won't be driven by e-readers by themselves – it will be driven by human curiosity, ever-increasing connectivity, enlightened self-interest, and a gentle push from organizations like Worldreader < <http://www.worldreader.org/>>. But beyond that, two-thirds of the children are downloading an average of one free book a week, along with numerous free samples, free trial subscriptions to magazines like Popular Mechanics, and more. At the moment, Risher's team are measuring the children's reading levels, and are conducting mid-term evaluations. Preliminary results based on the number of books downloaded and read so far, we expect to see some remarkable progress in a short amount of time.

"**School of One**" in New York highlights so many of the possibilities related to "smart" teaching with mobile devices. This school is a fascinating example of using mobile devices in education. The students' individualized instruction plans are produced by a "Learning Algorithm" that the teachers plug with data. This in turn leads the teachers to come up with individualized "playlists" of lessons that meet the students' abilities and interests at the needed pace. Although this model would not work in many places, it does provide important details on the resources and inputs required for cutting edge integration of mobile devices and truly "smart" teaching (Kipp, 2011 [22]).

BBC Janala Project - one interesting use of mobile phones in education in developing countries can be found in Bangladesh, where the BBC World Service Trust and BBC Learning English have implemented the Janala Project, an initiative that is providing English language lessons to citizens via their mobile phones as part of the wider English in Action program in Bangladesh,

funded by the UK's Department for International Development (UKAid). Audio lessons and SMS services turn the mobile phone into a powerful low-cost learning device for people previously denied the benefits of English education. While it is still in its early stages, the service appears to have found an audience: To date over two million audio lessons have been accessed (listened to), 177,000 short audio have been taken and stories and feedback recorded. In addition, over 100,000 audio lessons have been downloaded from BBC Janala mobile internet site (some observers consider this rather remarkable, given the difficulties for many to access the mobile internet and the fact that it has not been advertised). <source: <http://www.bbcjanala.com/>>

Drona – Mobile Learning Management System: provides not just an m-Learning environment, but also helps users to create their own mobile applications, as and when required. Drona won the World Summit Awards (WSA) in the category of m-Learning & Education, 2010. Given that the penetration of broadband is poor in developing countries, mobile phones have surfaced as a better mechanism for learning and collection of information - Drona is a mobile learning management system. It allows users to author content ranging from texts to images, audio and video. Different types of courses can be created, such as learning slides, multiple choice questions, multiple response questions, true/false type assessment, surveys, and feedback. With Drona, users are truly liberated from the confinement of classrooms and computers, thus providing high accessibility and convenience. In addition, Drona is extremely user-friendly in terms of both course development and management, as well as of end-usage. Furthermore, Drona Analytics allows tracking and reporting of different parameters, with different access for administrators, managers, trainers and end-users respectively. <source: <http://www.wsa-mobile.org/winner/drona>>

BridgeIT Project in Tanzania provides access to digital video content in classrooms 'on-demand' via cellular technology, teacher training and ongoing support, and learner-centered lesson plans and teacher's guides. It is a USAID funded 3 – year pilot project with significant leverage support from private and public sectors involving 150 schools in 17 districts from 7 regions in Tanzania. The BridgeIT Project aims to significantly increase educational quality and student achievement in maths, science and life skills through the innovative use of cellular and digital technology.

Potential Problems with Using Mobile Devices in Education

Nyaggah, 2011 [27] argues that three factors need to be in place for a platform of this nature [using mobile devices in education] to scale in new emerging markets across the developing world:

1). The Infrastructure – all mobile devices need to be powered up. There's little access to grid power and green energy is expensive in many parts of the developing world. That said, a family has to decide whether to use the little money they have for a solar pack to power a (probably donated) mobile devices or buy food. Distributing mobile devices at a huge cost to taxpayers in developed and developing countries is the easy part. Once the device is powered up there's a need to download content onto it. While mobile penetration and coverage is pretty good in some parts of the developing countries, the same isn't true of other parts. The danger of mobile devices in developing countries that can't be powered up and onto which no content can be downloaded would seriously undermine any efforts.

2). The Technology - Mobile devices have come a very long way, very fast. However, I am yet to see one that can take the punishment of a school child's school bag, dust and fluid damage. M-Edge <source: <http://www.medgestore.com/>> has made admirable attempts but theirs is a retrofit solution. I would love to see devices that are built from the ground up to be rugged. Devices that are not designed for the realities of rural developing countries will need to be replaced or repaired extremely often. This is really just a design challenge that can be easily overcome but one that needs research to solve properly.

3. Content & Curators - publishers in developing countries have been characteristically suspicious of digital publishing and content for these platforms are hard to get. However, getting content created or ported to this platform and distributed somehow is probably the easy part. How do the teachers (the curators) use the technology to help children learn better? Not enough attention is being paid to this and yet this seems the only way to keep this kind of technology going. And again teachers become the focal point of this technology. In some countries, it might be mobile devices that become the preferred platform. While exploring the potential to use the

technology, we need to ensure teachers can teach best with whatever technology they have to use wherever they are. Who knows what new device or platform will evolve into the next pen and paper? Teachers will be still here, invest in technology that helps them become better at teaching.

The advantage of not having to manage mobile devices has its own disadvantages. The technology is not in place, at least not yet to manage mobile devices via a remote network by anyone, so each teacher or student would have to create their own user accounts and manage their own apps. Since mobile devices will be used for anywhere, anytime teaching and learning – there would be a lot of frustrated users when they face the challenge of configuring their mobile devices. That would be a real challenge for teachers and students, but with technology anything is possible.

Hills, 2011 [14] looks at the socio-economic impact of ICT in the education sector and relates how it is changing the cultural environment in which the learning occurs. According to her, ICTs subtly reinforce a particular dominant cultural position from which students produce and design their online texts and course understandings - often through the use of particular operating systems and particular tools. Increasingly these tools and systems reflect the values of the culturally dominant, financially stable, digitally literate, white, male, middle classes (higher classes really - if you need the latest laptops and apps to download your courses - an Apple for the teacher would seem to be appropriate here - but at what cultural cost?).

Through the proliferation of online programmes in our schools and universities other courses that maybe more culturally sensitive, based on building negotiated relationships and utilise and practice human to human communication are sometimes ignored, marginalised or trespassed upon in the eagerness of learning sectors to 'update' and 'future forward' their learning courses. Students with sophisticated and expensive ICT tools, those with sound online learning skills and access to broadband will be well served in the schools and Universities that push the on-line learning, technologically linked classrooms in the 'brave new world'. But what is on offer to the increasingly marginalised in our society? What has happened to their right to access empowerment through higher education, on-line learning, technology assisted courses? All too often they don't have the tools, the courses are unavailable in their homes and therefore education

becomes inaccessible to them in a way that we have not seen in schools since the middle of the 1800s (Hills, 2011 [14]).

Though iPads are thus far the most educationally suitable tablet, current models also have disadvantages compared to netbooks and laptops. iPads are more expensive to purchase than netbooks (making them costly even for a US context), and more difficult to write and edit on than netbooks or laptops, unless one gets an external keyboard at extra expense. The lack of a computer-style file structure in iOS can make the organizing and sharing of student work more complicated, at least without establishing new file maintenance systems. And iPads are unable to access websites that use the Adobe Flash multimedia platform, which is still common on many educational sites and on-line university offerings. Of these disadvantages, the most important long-term educational one is in the area of writing. Learning to write well is a critical part of education, and is hindered if students don't have a device optimized for composing and editing. However, this problem can be overcome through use of an external keyboard, and we will likely see a wide variety of mobile tablets in the future with detachable or folding keyboards or other alternative input systems.

Because of the small size of the devices, there are design implications for learning materials. For instance, the size of the screen requires more scrolling if there is too much text. To compensate for their small screen size the tools rely on rich media that combines texts, graphics, audio, and video. The differences are as a result of certain dynamics, which include the following: 1). Devices' hardware and software used affects what content can be delivered. Although mobile technologies are rapidly and increasingly powerful, there are still some data formats and that are best delivered via computers. For example: the file formats, size of the files, types of files, memory, navigational issues, and the association with the operating system libraries. 2). The main limitations of WAP today are related to the devices used and the mobile networks. The limiting factors of the device means that large amounts of data, especially graphics and animations are not recommended.

The user interface and the memory and processing power are the main limiting factors of mobile devices. However, Goundar, 2011 [13] argues that with mobile devices connected to cloud

computing providers [almost all mobile network providers are utilising the cloud computing service platform], a user can save money by not paying for processing power, intensive memory requirements and storage. Just pay for devices like \$29 mobile phones, \$20 Tablet PCs, and other portable devices and the required subscription to the mobile network provider. They are cheap because they don't have much processing power, internal memory and storage capacity. However, these devices provide connection to cloud service providers. And once connected, the cloud service provider will do all the processing using its own memory and store whatever is required. Time, effort and money are not spent on processing. Processing power and storage capacity of large companies like Google can be utilised for free or by paying an insignificant amount.

The main pedagogical issue to consider is the suitability of a course to the mobile learning environment. Not all courses are suited to the mobile learning environment. Purely technical and very practical courses are not suitable. However, short courses and mainly theory and information type courses are suited to the mobile learning environment. The learning environment can be enhanced by the use of quizzes to test knowledge, summary of main learning points, and interaction with other students and the tutor via telephony integration.

One of the major issues that were faced when using ICT in education was the platform [for example, Windows, Mac, or Linux] on which to create and deliver learning materials. With mobile devices the platform issues are more complex and many. As one might realise that there are hundreds of mobile network providers, each establishing its network infrastructure and service provision structure based on the country in which it operates. Then, there are thousands of mobile device manufacturers, each with its own internal architecture design, functionality and features. Then, there are smart phones and mobile devices again based on the Apple iPhone, Windows 7 Phone, and Android Phone platforms. Are we going to go through the same platform issues that we have not been able to resolve with PCs, or are we finally going to come to our senses and decide on a common platform?

In many educational institutions, especially at the primary and secondary school level, institutional culture and regulations may actually prohibit mobile phones and devices on the

premises. Debate on the issue is ongoing. In my University, students are not permitted to have mobile phones and devices during tests and final exams. Some of my colleagues complain that a student with a mobile phone in class receiving a text message or a call interrupts the entire class. Others argue that most of the work that students do on their mobile phones and devices are unproductive and not conducive to the learning environment as most of the time they are either playing games or sending text messages to their friends or families. To stop the unproductive use, as alleged, my University has even blocked students and staff access to sites like facebook, and other social web sites to PCs on their network. How are we going to convince such institutions?

Much needs to be done in order to address issues of standards, infrastructure and performance, of access and equity, of content and training but the main hurdle is teachers' and officials' perceptions about loss of control and agency in the class-room. As heard during a recent teachers' conference, if a teacher is just a facilitator, and if any device or technology can do the same, then there is justification to replace the teacher with that device or technology. That is probably the fear that most teachers have and that creates one of major hurdles of using mobile devices in education. Most institutions are at the moment using mobile devices as a supplementary tool to deliver face-to-face education and suddenly there is a drop in student attendance because without physically attending classes, the students are able to get access to the material that was taught.

The Txt Me Project implemented at Australian Vocational and Educational Training demonstrated that, for disengaged learners, it is necessary for practitioners to engage in and understand their world. It is only in this way that content and strategies can be made real and relevant. In spite of their high familiarity with technology, relationships were of greater importance to the young people involved in the Txt Me Project trial (Ison et. al., 2004 [18]). At present, educational systems own the hardware and software required for learning. Students' personal mobile phones are a completely different issue, in which the centralized models cannot effectively work. Taking into account the new meaning of students working with their own personal mobile devices is a challenge.

Discussion and Conclusion

Mobile phones are becoming ubiquitous in the world today – almost everyone can get access to simple voice and SMS text messaging phones. With the introduction of \$100 Android Smart Phones <<http://www.ictworks.org/news/2010/09/07/100-huawei-android-mobile-phone-bringing-netbook-revolution-smartphones>>, real computing power is coming to mobile phones at a price point that can be affordable for educational systems. One powerful smart phone per teacher, or a combination of voice/SMS phones and smart phones for teachers and students have the potential to actually achieve the unfulfilled technology saturation promise of OLPC [One Laptop Per Child].

The cost of mobile devices and its applications will be reducing with volume – it already has decreased dramatically. The services of the mobile network operators combined with cloud computing platforms are expanding all over the world, now reaching the inaccessible. Mobile device manufacturers are loading unlimited applications, functionalities and features to stay competitive. Mobile network providers are offering service packages at negligible costs to its users to match its competitors. The mobile device users are the winners in the end. It is a real choice to PC watt consumed in the developing countries and the energy resources of the World.

With the number of mobile devices surpassing the number of computers, there is now a real opportunity for innovative teaching and interactive learning with mobile devices. Mobile devices are ICT devices but with greater flexibility and ubiquitous connectivity, combined with the power of desktop computing. The potential impact of using mobile devices in education will result in the production of ground-breaking teaching and learning technologies. Teachers can have instructional support at their fingertips in the learning environment. Students can be empowered with access to learning resources with supplementary multimedia for better understanding regardless of time and physical location.

Educational institutions have always faced constraints in acquiring IT resources like computers and internet for e-learning, but with m-learning; the resources are already available as most students already have mobile devices or the schools are able to buy in bulk at reduced government subsidised prices. Additionally, any device that's mobile is always going to have an

advantage over technology that's fixed - just because students themselves are highly mobile and so should learning be. So if the potential benefits of mobile device technology like access to information, connectivity and collaboration can be with a student 24/7 in an easy to use mobile device and if the facilitating teacher knows how to help students manage such a process, then there is the required justification and a strong motivation to use mobile devices in education.

The availability of easy to access – instant on, user friendly technology like mobile devices is important and the value of having well trained teachers that can use this technology to teach is equally fundamental to use mobile devices in education. However teacher training becomes far more valuable when it focuses not just on how to use the mobile device technology, but instead encourages teachers to research and visualize how technology can be used to create new educational horizons. A skilled teacher isn't one that just knows how to use a specific tool or technology. A skilled teacher knows how to utilize that tool to forge new educational paths for his/her students. What are appropriate models to procuring or developing suitable digital content? Involving practitioners that is the teachers in identifying and developing ICT based learning resources would be relevant and effective in the long run. A collaborative exercise with educationists, teachers and educational software companies will result in successful learning outcomes and once you get it right – the digital lessons can be scaled (Gliksman, 2011 [12]).

The major challenges which I have observed in my research studies are getting teachers to use digital content. Many teachers are not for digital content and technology based teaching and learning. Some teachers argue that they have been teaching for decades and producing excellent results – if it works, they why is there a need to change – “don't fix till it broken”. Only teachers with adequate technology competency make attempts to integrate technology while teaching. The time constraints that are often cited as a reason for minimal use of technology can be eliminated by both schools creating a conducive environment and teachers planning for technology well ahead. In many instances there is resistant by the non technology savvy school administrators who perceive mobile phones as a disruptive influence. However, I believe in the concept of using technology that is already in the hands of children - it makes sense on so many different levels!

With mobile devices, the real power is that it is scalable, so this lower cost technology will spread beyond phones to tablets and existing computer networks in education as well as e-Books and e-Learning. We are already able to support student self-assessment and teachers in social networking style and directing assessment for learning using digital evidence. That can be sampled for external quality assurance and so accrediting learning can be integrated with assessment for learning. An educational institution in collaboration with others can offer a whole programme with individual courses from others without even creating or developing a single course.

In the last decade, mobile learning has been expanding and continues to do so in many countries. Schools, workplaces, higher education are all embracing various aspects of mobile learning. For years, groups have been attempting a variety of grassroots solutions and approaches across the continent to provide better options for schools than simply waiting. Tools such as loband, for example, were designed to strip out the 'extra' stuff in web pages so that they download quicker over slow connections. Some groups have supported training activities related to bandwidth management and optimization, recognizing that many universities could do a much better job of managing the current bandwidth that they already have. Other have advocated for more attention to designing web pages for faster access in low-bandwidth contexts (Trucano, 2011 [34]).

Many pilot projects on using mobile devices in education in developing countries are currently donor funded and have created huge impact. As discussed earlier many of these projects are changing lives and have the potential to change the economic situation of the country in which they have been implemented. Many of these have been university research projects and trials by mobile network operators and the results speak for themselves. It is time for the respective government of developing countries to take them on and scale them up nationwide? It is time to move from pilot and trail phase to full implementation.

At the end of the day; what is the added benefit of 200 new e-Books over 20 old text books if reading comprehension and critical thinking are absent from students learning outcomes?

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