MobiLED – Mobile-Led and Leading via Mobile

Merryl FORD[1], Adele BOTHA[2]
[1]*Meraka Institute, Building 43, CSIR, Meiring Naude St, Brummeria, Pretoria, 0001, South Africa*
Tel: +27 12 841 4601, Fax: +27 12 841 4720, Email: mford@csir.co.za
[2]*University of Pretoria, Groenkloof Campus, Pretoria, 0001, South Africa*
Tel: +27 84 432 3276, Fax: + 27 12 667 1367, Email: adele.botha@gmail.com

Abstract: Historically Africa and it's people have faced many practical problems in their race towards digital inclusion and economic progress, such as a severe lack of infrastructure and resources. However, the advent of the cell phone, is set to become a catalyst for narrowing the digital divide in South Africa and the rest of Africa. In the absence of desktop computers and ubiquitous internet access, the cell phone has the potential to provide an alternative access and participation mechanism for those who have previously been "digitally excluded". Given their massive adoption and widespread use, as well as the recent technological advances in their computational power, cell phones are ideal substitutes for the personal computer throughout the continent. In 2006 a research collaboration, termed "MobiLED", was initiated between the Meraka Institute (African Advanced Institute for Information and Communication Technology of the CSIR) and the Helsinki University of Art and Design (Finland). The aim was to develop, expand and integrate cell phone tools, technologies and services into formal and informal learning environments in order to prepare learners for full participation in the knowledge society, towards the acquisition of 21st century skills. Over the past three years it has become evident that many of the initiative's innovations have a wider application than originally envisaged. This paper will discuss the results of the education-related MobiLED pilots and expands on the possibilities of using these as a basis for creating a "MobiLED Toolset" for other sectors.

Keywords: mobile, cell phone, mlearning, digital divide, services

1. Introduction

On 12 May 2008 the International Telecommunications Union (ITU) launched their latest regional report "African Telecommunication/ICT Indicators 2008: At a Crossroads". An extract of the report states the following:

"Growth in Africa's mobile sector has defied all predictions. Africa remains the region with the highest annual growth rate in mobile subscribers and added no less than 65 million new subscribers during 2007. At the beginning of 2008, there were over a quarter of a billion mobile subscribers on the continent. Mobile penetration has risen from just one in 50 people at the beginning of this century to almost one third of the population today. Mobile subscribers are also now more evenly distributed. In 2000, South Africa accounted for over half of all Africa's mobile subscribers, but by 2007, almost 85 per cent were in other countries. Mobile success, driven largely by competition, is also spawning new services such as micro-payment prepaid recharging, single rate inter-regional roaming and the uptake of m-commerce applications." [1]

Africa is also leading the way through the innovative and entrepreneurial ways in which the technology has been extended beyond the model of individual ownership. Thousands of jobs have been created and some very successful indigenous companies have emerged. From a developing country perspective, features such as limited or no dependence on permanent electricity supply, easy maintenance, easy to use audio and text interfaces, affordability and accessibility are the most important considerations for using cellphones as potential ICT tools [2]. These mobile devices are also becoming increasingly powerful computers, with built-in advanced multimedia facilities. It is interesting to note that today's high-end cell phones have the computing power of a mid-1990s computer— while consuming only one one-hundredth of the energy [3]. Today's cell phones are programmable, powerful, and capable of accessing the internet. Lacking a traditional PC, many Africans are turning to their mobile phones to connect with people, information and services [4]. The cell phone is poised to become the "PC of Africa" and is being used in ways that the developed world cannot yet envisage.

Unfortunately it seems that this "PC of Africa" is not being used to it's full potential in the school environment. Many schools in South Africa are either banning cell phones from school premises, or locking them away during school hours, due to the perceived "nuisance factor" of these devices. MobilED (Mobile EDucation) started as a 3-year initiative in 2006 which aimed to take advantage of the cell phone as the only effective technology device in the hands of African children and youth. Although cell phones currently do not play an active role in formal education in South Africa, in an informal learning context, they are used widely. We call our colleagues and friends to seek information and reciprocally help them in their knowledge acquisition and problem-solving situations [5]. Simultaneously, we build up our social networks and strengthen the links that are considered very important in modern theories of learning [6].

There is a need for new approaches to integrate technology into the classroom, particularly in an African environment. Using cell phones as learning devices requires a good deal of rethinking and flexibility on the part of educators. Our research findings suggest that, given the opportunity, students quickly embrace, use, and make the tool their own in various unexpected ways—just as they have been doing with all useful digital technology [2]. The model to be developed needs to merge lessons learnt from the developed world with the realities of Africa. Over the last three years MobilED investigated various cell phone technologies and protocols in collaboration with educators in order to develop useful applications for the classroom.

This paper describes the first three years of the MobilED initiative as an educationally-focussed research project, discusses the outcomes and outlines a strategy for the initiative over the next three years.

2. Objectives

MobilED's approach was to integrate research-based ideas for using mobile technologies in teaching/learning with active scenarios of real learning programs. The project included the design, development and piloting of prototype applications where multimedia and language technologies (voice, text, images) could be used via the mobile phone as tools in the learning process.

The MobilED project initially had 4 key scientific, technical and developmental objectives [5]:

1. Explore and comprehend the cultural, social and organizational context of young people in and out of school in developing countries (South Africa, Brazil) and in a developed country (Finland) in their utilisation of mobile phones.

2. Develop research-based models and scenarios of how mobile technologies could be used for teaching, learning and empowerment of learners.
3. Develop concepts, prototypes and platforms that will facilitate and support the models and scenarios developed.
4. Test, evaluate and disseminate the scenarios, models, concepts, prototypes and platforms.

The initial partnership consisted of a collaboration between the Meraka Institute of the CSIR, Tshwane University of Technology, University of Pretoria (all South Africa), the Media Lab of the University of Art and Design Helsinki (Finland), Escola do Futuro Universidade de São Paulo (Brazil) and the WikiMedia Foundation (United States). For the pilots in 2006, handsets were donated by Nokia.

Unfortunately not all partners in the project were able to secure funding, so most of the research after Year 1 was undertaken by the Meraka Institute and the University of Pretoria, which meant that the comparative study in objective 1 was never completed.

3. Methodology

A research framework for the integration of cell phones into the school system was developed for the project in order to guide the multi-disciplinary team members and is shown in *Figure 1* below.

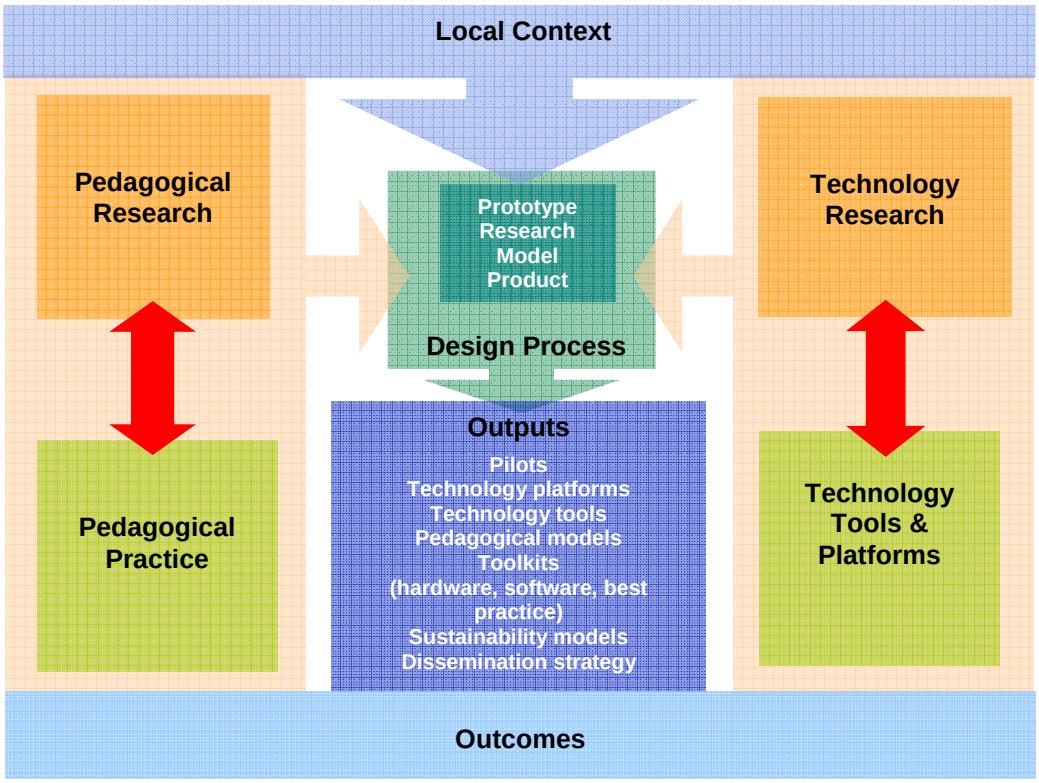

Figure 1: MobiLED research framework v2.0

Each intervention needs to grounded in the local context. Central to the intervention is the design process, which is fed by both the appropriate pedagogical models (educational research) and pedagogical practise (i.e. teaching) and the potential of the technology itself. The potential of the technology consists of new technological research combined with the development of new technological platforms and tools. The initiative takes into account that

on it's own, the cell phone would not necessarily be a useful pedagogical tool, but with the addition of other technologies it could be made much more viable. Where appropriate, the standard technology should be expanded to support educationally-appropriate interventions.

The project originally employed the *Outcome Mapping methodology* (as designed by IDRC in consultation with Dr Barry Kibel of the Pacific Institute for Research and Evaluation as an adaptation of the Outcome Engineering approach) to measure the outcomes of each pilot and intervention. This methodology looks at the results of an intervention as a behavioural change of project participants. Outcomes are seen as desired changes which indicate progress towards large scale development goals. At the heart of Outcome Mapping is documenting contribution rather than attribution; seeking to understand ways in which communities contribute to change rather than trying to attribute change to a single intervention [7].

Although Outcome Mapping is a useful tool, we found that it is very resource-intensive and we decided to use many of the concepts of the tool to create a "lighter" evaluation methodology for the pilots.

4. Technology Description

The basic technology components that were used over the past three years included:

1. Various types of cell phone, from basic, voice-and-SMS-only models through to multimedia and smartphones;
2. GSM/GPRS/3G/Bluetooth communication channels;
3. Wikipedia: The Free Encyclopedia;
4. Social Software: MediaWiki, blogs; instant messaging;
5. Open Source Language technologies: Speech interfaces, audio usage, etc;
6. Cell phone development frameworks (such as J2ME); and
7. Open Source telephony and software frameworks and platforms.

From a technology perspective, all tools and platforms developed have been and will be made available as Open Source Software (OSS), in support of the collaborative, knowledge-sharing philosophy of the project.

The aim was to make provision for all models of cell phones via as many cell phone technologies and communication protocols (SMS, MMS, voice, bluetooth, Java and Symbian-based applications, telephony, WAP, GPRS/3G/EDGE) as possible. A conceptual model (see *Figure 2*) was produced to illustrate the cell phone capabilities that would be supported during the initiative.

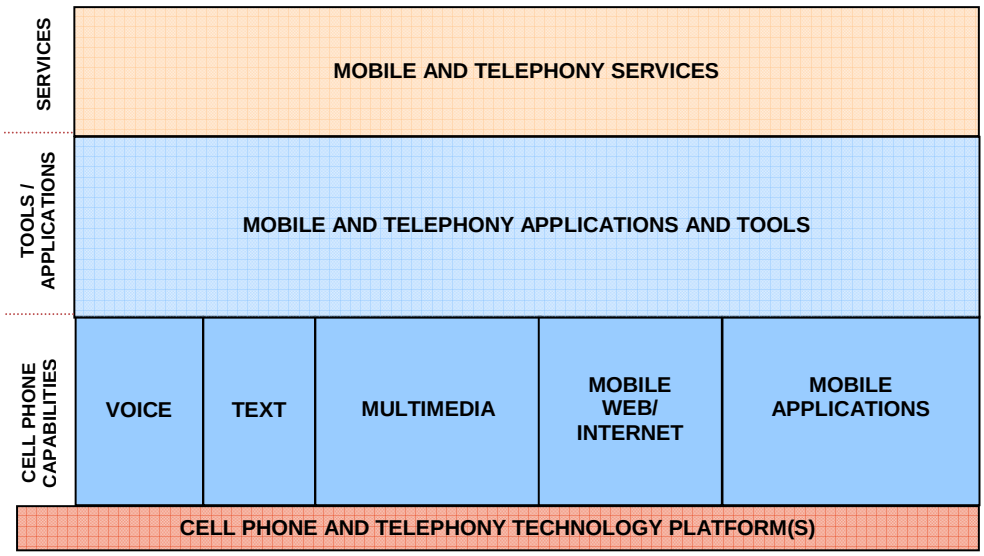

Figure 2. MobilED Conceptual model

5. Developments

5.1 MobiLED core and MobiLED audio-wiki

*Cell phone capabilities: **VOICE** and **TEXT** (SMS) services*

MobilED's first service focussed on providing access to learning and reference materials for both learners and teachers in environments where there is little or no access to the internet or even non-digital information sources, such as text books or libraries. The aim was to make a service available via very low-cost cellphones, which are readily available in Africa. Participants should not only access information, but have the ability to contribute information as well. Based on these prerequisites, we developed the concept of a **mobile audio-wikipedia**, using SMS and text-to-speech technologies [5]. The mobile audio-wikipedia works as follows:

1. A user can search for a term by sending an sms-message to the server.
2. The server then calls the user, and
3. A speech synthesizer will read the article found in the Wikipedia.
4. The user can navigate forwards and backwards or jump to sections by using the cellphone keypad.
5. A user can contribute any information to any section of the article by dictating it to the system.
6. If the term is not found in Wikipedia, then the user can contribute his/her story by dictating it to the system.

In order to realise the vision, software development was undertaken using various open source components and based on an Open Source Interactive Voice Response (IVR) system, OpenPhone, which was already under development at the Meraka Institute. A *MobiLED core* architecture was developed which consists of backend development using the Asterisk telephony platform to develop a mechanism to take input in the form of a phone call or an SMS message, use this to access an information source and then make the results available via a phone call using text-to-speech technologies or via a text (SMS) output. *Figure 3* shows the concept as plotted against the capabilities of the cell phone.

Two pilots were conducted at schools in South Africa. The first pilot was conducted at a private school, Cornwall Hill College, in Tshwane, South Africa in March 2006. The learners at the school are from a wealthy community and are fully computer-literate. The second pilot was at one of South Africa's poor farm schools, Irene Middle School, also in Tshwane. Both pilots were about HIV/AIDS. Learners were divided into groups and they could access information on HIV/AIDS from the MobilED Audio Wikipedia. The groups discussed the most relevant issues of HIV/AIDS for their own age groups and communicated the results to the school community as a pseudo podcast or “audiocast” that was recorded via their handsets onto the wiki. The HIV/AIDS themes/topics explored and investigated were chosen in an effort to explore and add to South Africa's rich “African Philosophical Thinking” so as to promote the preservation of indigenous knowledge and encourage sensitivity across a range of social contexts [8]. Learners were encouraged to delve into their own life experience and relate their own personal stories in their efforts to actively participate and contribute to the existing body of knowledge [9].

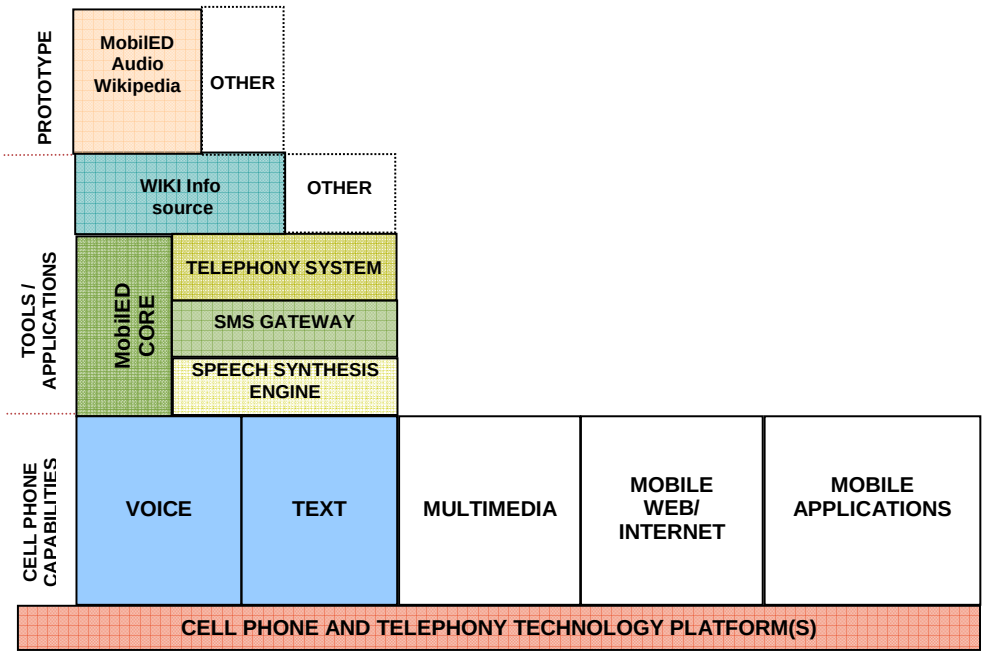

Figure 3: MobilED Audio wiki(pedia) mapped on conceptual model

5.2 Street Memory

*Cell phone capabilities: **Multimedia** Messaging Services (MMS)*

One of the scenarios developed for MobilED consisted of the "Street Memory" concept. The focus is on utilising cellphones that have some multimedia capabilities (such as a camera and the ability to make audio recordings onto the phone). Learners are divided into project groups and are instructed to investigate a recent historical event that took place in their environment or community. They then interview community members who were present during the event – either via an audio recording onto their phones or via short video clips. These are then transferred to a computer, edited and uploaded to a central server. Each story is given a unique number and the learners make a poster advertising the story and number and place it in the area where the original event took place. Any passerby is able to send an SMS containing the unique number and they receive an MMS which contains the video or audio clip created by the learners.

As can be seen in the scenario outlined above, this service currently depends on the use of a computer as an intermediate editing tool. However, many of the latest phones already have the capability to store, edit and upload video clips to a central server.

The Mbuni Free/Open Source Multimedia Messaging Service (MMS) gateway was added to the MobilED platform, giving the platform the capability to receive and send multimedia messages. Unfortunately due to the prolonged teacher strike in 2007, MobilED was unable to pilot this service. The concept is illustrated below in *Figure 4*.

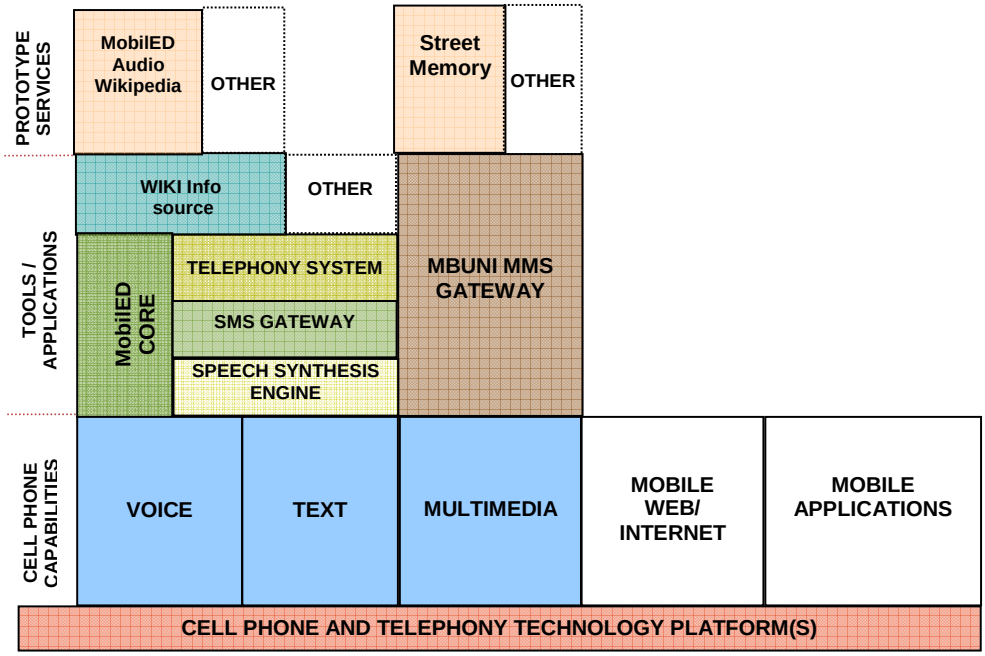

Figure 4: "Street Memory" mapped on conceptual model

5.3 Mobile drill-and-practise

Capabilities: ***Mobile Web/Internet***

Access to the web via browsers on cell phones is fast becoming the de facto way in which users in developing countries experience the internet. This year China overtook America as the country with the largest number of internet users — currently over 250 million. China also has some 600 million cell phone subscribers so the potential for the mobile internet is enormous. Last year Google's president in China, announced that Google was redesigning its products for a market where "most Chinese users who touch the mobile internet will have no PC at all." [10]

Opera Software, a firm that makes web-browser software for mobile phones, reports rapid growth in mobile-web browsing in developing countries. The number of web pages viewed in June by the 14m users of its software was over 3 billion, a 300% increase on a year earlier. The fastest growth was in developing countries including Russia, Indonesia, India and South Africa. South Africa is currently the 6th largest user of the Opera mini browser [10].

Hadeda is a spelling "drill and practice" system that was developed as part of MobilED to investigate the use of the mobile web in education. Hadeda allows teachers and parents to create spelling lists using either a web browser or mobile web browser on a cell phone. These spelling lists can be in English, Afrikaans, French, or Swahili. The web application then generates a cell phone midlet which children can download onto their personal cell phones. They can then practice their spelling lists without incurring any more airtime charges.

Piloting for this innovation will be undertaken in early 2009. It is illustrated in the conceptual model in *Figure 5*.

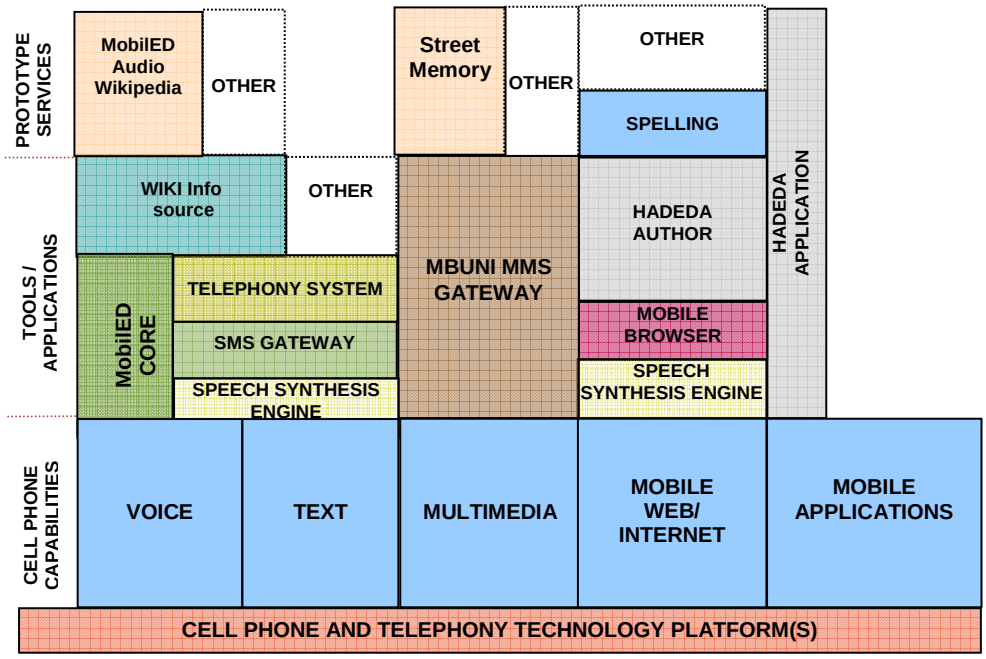

Figure 5: "Hadeda" mapped on conceptual model

5.4 Mobile tutoring and content toolsets

Capabilities: ***Mobile Applications***

As cell phones become more powerful and as these cell phones start permeating into all levels of society, it becomes possible to start utilising these phones in similar ways to the personal computer. It is now possible to download applications and content onto cellphones at fractions of the cost of traditional models. The following section expands on some MobilED services that have been developed or are still under development to support mobile learning applications.

5.4.1 Math on MXit

In South Africa, one of the phenomenal indigenous success stories of cell phones, has been the MXit service. MXit is proprietary mobile instant messaging (MIM) software of MXit Lifestyle (Pty) Ltd which is based in Stellenbosch, South Africa. The MXit software runs on cell phones and enables participants to instantly send text messages to each other. It is often compared to SMS; however, one of the major differences between sending an SMS and using MXit is the cost. Messages sent using MXit cost approximately 1 or 2 cents. An SMS, however, typically costs about 80 cents. This has resulted in a huge uptake of the service in the country, especially amongst teenagers. MXit currently has more than 5 million registered users, with 9 million logins and 200 million messages passing through their servers daily [11]. The service offers one-to-one chat options as well as many-to-many chatroom facilities.

MobilED has developed a mobile tutoring (mtutor) service to support learners with their mathematics homework, using the MXit platform. The service is known as *Dr Math.* Learners can use MXit on their cell phones to ask questions. These questions are routed to the first available tutor who is online during specified hours to help provide guidance in working out the mathematics problems. The tutors do not do the learners' homework. Instead, the tutors are there to guide the learners into working out the problems for themselves [12]. Tutors are volunteer engineering students from the University of Pretoria

who use a traditional computer connected to the internet in order to interact with learners. The service is available Sunday to Thursday, 2pm to 8pm. Here is an example of a typical interaction between a tutor and a learner:

(13:43:50) dr.math: any math questions
(13:46:21) Cutie: can u pls explain trinomials 2 me
(13:47:10) dr.math: give me an example
(13:48:28) Cutie: xsquare+7x+6
(13:49:25) dr.math: I will use ^ for power x^2 +7x +6 so you need to find two numbers that if you multiply them you get 6 and if you add them u get 7. what are those two numbers
(13:50:09) Cutie:
(13:50:41) Cutie: 6 1
(13:51:32) dr.math: right so the factors are (x+6)(x+1)
(13:52:58) Cutie: nw wat bout x^2-5x-6
(13:53:36) Cutie: i dnt get da '-' part
(13:54:20) dr.math: so you need to find two numbers that multiplied give you -6 and added give you -5. that means one of the numbers must be negative and the other positive
(13:55:16) Cutie: +6 -1 ?
(13:56:27) dr.math: does +6 -1 give you -5?
(13:57:44) Cutie: o i c! -6 +1
(13:58:26) dr.math: very good
(13:59:06) Cutie: thanx! u helpd me stax!
(13:59:57) dr.math: good i'm glad to hear that. come back if you have another problem
(14:00:26) Cutie: i wil!

[12]

This system is being expanded to include simple maths exercises and competitions as well as the introduction of a text-based adventure game. Learners have to solve simple mathematical problems in order to advance in the game. Learners are also able to interact with the system by requesting simple formulas and definitions using keywords.

5.4.2 IGLOO

IGLOO is a content creation and transmission tool which enables multimedia information dissemination and response using a combination of computer and cellphone technology. The information is put together using a standalone computer application, then packaged to be transmitted to cellphones. Responses are then returned to a computer or cellphone. Currently the transmission is via bluetooth. The aim is to supply educators with a mobile application that can be used to facilitate and support assessment practices in formal and informal learning scenarios as well as provide researchers with a tool they would be able to use for data gathering using mobile technology. As mobile technology extends the formal borders of the brick classroom to learning beyond the physical constraints, it is desirable to also extend the practice of assessment to those areas where learning occurs [13].

The application consists of an “Author” on a traditional PC platform which enables an educator or researcher to set-up a multimedia questionnaire/test/quiz which can include photos and/or sound files. This application supports open-ended questions as well as unrestricted optioned multiple choice questions. Once a questionnaire has been created, it is “packaged” and can then be distributed via bluetooth to any Java-enabled cell phone. The “package” installs on the phone and presents the user with the questionnaire or set of information slides. The questions can be redone and the user can scroll forward as well as backwards through the questions allowing the user access to voice and pictures files multiple times. When the questionnaire is completed the user can send the results back to either the educators' cell phone or a PC.

IGLOO will be piloted and expanded throughout 2009.

Figure 6 illustrates the Dr Math and IGLOO tools and applications as per the conceptual map.

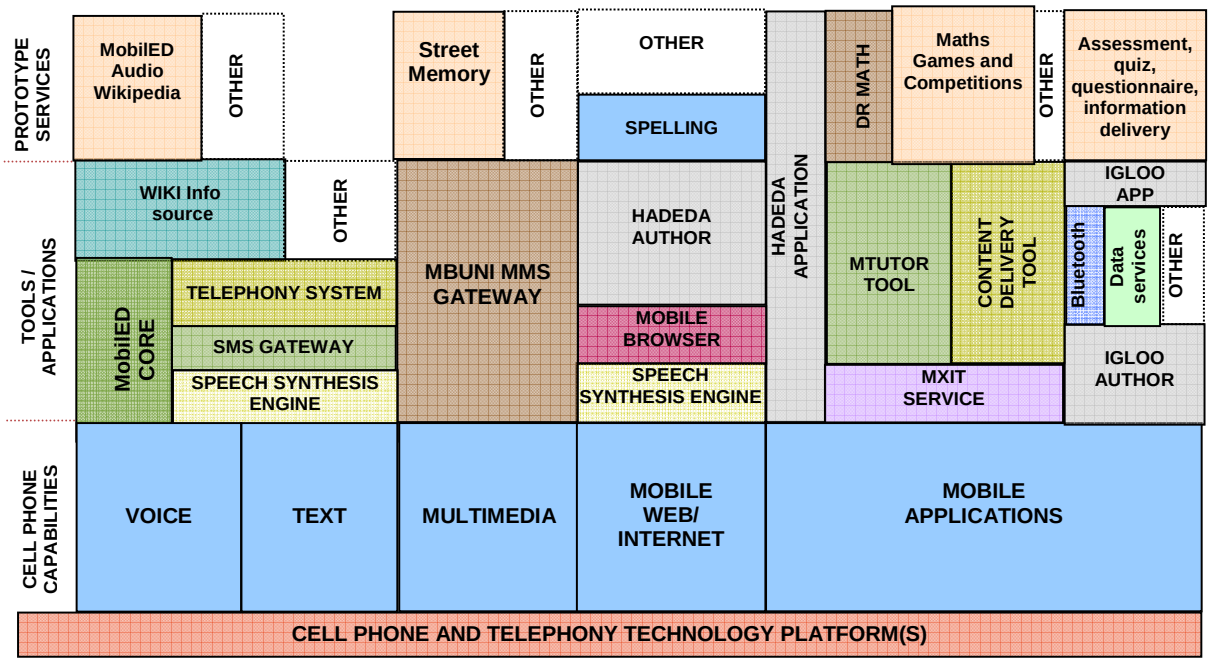

Figure 6: "IGLOO" and "DR MATH" mapped on conceptual model

6. Results

From an educational perspective, all the pilots undertaken during the course of the MobilED research initiative, showed that the cell phone could be used very productively as a tool in the learning process. In addition, from a technology development point of view, the aim to develop mobile technology tools and platforms that make provision for the various capabilities and models of cell phones was also successful (as illustrated in the conceptual mapping of all the technology solutions as in *Figure 6*). However, this paper will focus more on the non-educational outcomes and learning as a result of the work outlined above.

An important early lesson learned was the importance of including all the roleplayers in the educational environment in the process. In this particular environment, this included the headmaster, the teachers, the parents, the learners and the provincial and national departments of education. This is particularly important due to the sensitivity of schools regarding cell phones in the classroom. Parents were informed and presentations were given at parent-teacher meetings. We also applied for permission to pilot from the provincial departments of education and were sensitive to periods like exam-time (no research may happen in a school in the last school term, for example). We found that as soon as the concepts were explained and the technology demonstrated with open invitations to the teachers to participate with regard to additional ideas, the teachers became excited about the new possibilities. In fact, many of the ideas and expansions came from the teachers who were exposed to the pilots. A good example was a request from Cornwall Hill College (where the first pilot took place) to use the audio-wikipedia concept in a field trip. A wiki was seeded with "byte-sized" content for the field trip (a trip to a theme park as part of a science lesson about energy, gravity, acceleration, etc.) and the audio-wiki was expanded to include information retrieval via SMS as well. All interactions between the

teacher and the learners leading up to the field trip were done via SMS. The learners used their own cellphones and there was spontaneous sharing of mobile phone capabilities (such as photos, audio and video) [14]. Cornwall Hill College is now one of the leading schools in the country in using cell phones in the classroom. Many of the teachers involved in the pilots have decided to continue their studies as a direct result of the pilots.

The second important lesson was the importance of understanding the context of many of the learners and the possible consequences of introducing a technology like a cell phone into the teaching and learning process. Although these learners were able to intuitively use the technology, they should still be considered "naive users". Many of them have never used a computer and have never accessed the internet. Prensky [11] talks about the singularity that has taken place, where things have changed so fundamentally that there is no going back. He specifies this as the "arrival and rapid dissemination of digital technology in the last decades of the 20th century". These devices are here to stay, becoming more powerful in orders of magnitude and are already integrated into daily life. The answer is not to try to suppress the use of cell phones by banning them in schools, but to embrace the opportunities offered by this technology. This should not, however, be done naievely, but with the understanding that there is a great deal that needs to be done to prepare the way. It is imperative that learners are equipped with the necessary skills to deal with this new world. This was most evident in the Dr Math project. Learners seemed to have no problem sharing personal facts about themselves, despite the fact that Dr Math will only interact regarding maths problems. Many learners will inform Dr Math about their test results, for example. This has resulted in a "code of conduct" for the Dr Math tutors, which they have to sign. All interactions are also monitored via logfiles for any inappropriate behaviour. In addition, a set of "Digital Life Skills" lesson plans are being developed, in collaboration with learners themselves to develop a set of mobile etiquette rules, dubbed "Mobiquette" by the project team. In South Africa there is already a focus in the curriculum on developing life skills amongst the learners, but there is currently no integration of the skills needed in the digital world into this curriculum – the intention is to make the lesson plans available to teachers around the country.

The third lesson learned was the importance of having a multi-pronged dissemination strategy. It is important to share the lessons learned, not only with the academic community, but with all the stakeholders. Thus the popular media was used to share results of the pilots as well as targeting various academic conferences and publications. Various workshops were undertaken at non-academic teachers' conferences in South Africa. Interest is high amongst teachers and other stakeholders as indicated by the high attendance at mobile learning sessions at these conferences. Both the Departments of Science and Technology and Education are kept in the loop as well, via reports and presentations. The project team was also asked by the national Department of Education to manage a learning space on mobile learning using the cell phone on Thutong, the national educational portal. This learning space is being used to share ideas with teachers around the country, and to stimulate thinking and debate about the use of cell phones for teaching and learning. A MobiLED website has also been set up, which describes the various initiatives, makes available open content (using Creative Commons) lesson plans and makes open source mobile tools available for download.

The fourth lesson or "challenge" has been in designing solutions that are sustainable. One of the first commercial applications of the MobiLED audio wiki technology is a service in Ireland named "Callpedia" where a user can SMS a search term and then ring the service which then reads the information to the user. In this case all costs are carried by the user. Since many of South Africa's learners are from very poor backgrounds, the aim is to provide mobile tools that are "free" to the end user (i.e. teachers and learners). Many potential sustainability models are currently being investigated, such as:

- sponsorship models;
- advertising models;
- harnessing corporate social responsibility targets of organisations;
- free basic services with additional charges for more functionality;
- subsidisation models (already a model being used within the education system); and
- micro-franchise models.

In many instances we will look at innovative ways to make services cost-effective to provide and to use, by using the technology components themselves (examples include forcing audio information into voicemail which is free to the user and providing bluetooth dissemination options, which is also free). However, sustainable use of mobile technologies still remains a challenge in South Africa.

7. Conclusion

Although the tools developed were specifically for the educational domain, we have had numerous requests to apply the technology to the health, NGO and SMME domains. As an example, the MobiLED audio wiki has been earmarked as a tool by UNICEF, the United Nations Childrens Fund. MobilED audio wiki will be used in all their youth-related activities in the developing world, and will form an important part of the "Our Stories" project, an initiative by UNICEF, Google, StoryCorps and the OLPC consortium to get the audio stories from 5 million children worldwide [15]. UNICEF is also embedding other MobiLED tools into many of their solutions.

The concept of MobilED as "Mobile Education" has developed and expanded into a wider concept of "MobiLED", where we as Africans are being "led" by the mobile revolution and by innovating according to our unique circumstances have an opportunity to "lead via mobile". Over the next three years it is our intention to further develop, consolidate and "industrialise" the current MobiLED tools together with additional tools from project partners and to conceptualise new tools in collaboration with service providers and communities in the education, health, SMME and NGO domains. The result will then be packaged into various instances per domain of a "MobiLED Toolkit" that can be easily downloaded, installed, customised and potentially expanded by service providers. The main goal of the MobiLED Toolkit is to de-skill the process of providing cellphone-based or -supported services that will support socio-economic development in the education, health, SMME and NGO sectors. A secondary goal is to support skills development in Africa by giving young developers the opportunity to gain wide practical experience within the mobile technologies and mobile application development fields.

The MobiLED Toolkit will create an opportunity to catalyse the use of the cellphone as a tool for empowerment and development for service delivery in the education, health, the SMME and NGO sectors. It will create the building blocks for non-ICT experts to quickly and easily create services and applications so that they can more efficiently reach their markets, using the PC in everyone's pocket, the computer of Africa. Although this may seem to be a very African-specific approach, we are convinced that the use of the cellphone as the computing device will quickly be emulated in the rest of the world, as these devices become smaller, more powerful and even more ubiquitous and multifunctional. This sentiment is echoed by a story in the Economist [10], entitled "The meek shall inherit the web", where the author states:

"Shackled to our desktop and laptop computers, we in industrialized nations might just be missing the next computer revolution. Wouldn't it be deliciously ironic if developing countries leapfrogged ahead of us by using inventiveness born of the need to make-do with less? It might very well already be happening in the form of mobile-phone-based computing."

8. References

[1] http://appablog.wordpress.com/2008/05/12/itu-telecom-africa-2008-opens-in-cairo/. Accessed 21 November 2008.

[2] Mutula, S. M. (2002). The cellular phone economy in the SADC region: Implications for libraries. Online Information Review, 26(2), 79-91.

[3] Prensky, M. (2005). What can you learn from a cell phone? Innovate online magazine. (http://www.innovateonline.info/)

[4] http://www.kiwanja.net, Accessed 21 November 2008.

[5] Ford, M., Leinonen, T. (2006). MobilED – A mobile tools and services framework for formal and informal learning. Paper presented at mLearn 2006, the 5th World Conference on Mobile Learning, Banff, Canada.

[6] Senge, P.M (1990), The Fifth Discipline: The Art & Practice of The Learning Organization: Currency Doubleday, New York.

[7] Smutyo, T. (2001). Crouching Impact, Hidden Attribution: Overcoming Threats to Learning in Development Programs. IDRC, Toronto, Canada.

[8] Batchelor, J. (2006). Mobile information and communication technology use in secondary schools: A feasibility study. Unpublished Masters thesis in Computer-Integrated Education.

[9] Van den Bergh, M., Aucamp, F. (2007). A technical overview of a pilot in mobile learning. Paper presented at IST Africa, 9-11 May 2007, Maputo, Mozambique.

[10] http://www.economist.com/science/tq/displaystory.cfm?story_id=11999307: The meek shall inherit the web, Economist, accessed on 26 November 2008

[11] IOLTechnology, 25 January 2008, http://www.ioltechnology.co.za/article_page.php?iSectionId=2884&iArticleId=4223025 accessed 6 February, 2008.

[12] Butgereit, L (2007). Math on MXit: Using MXit as a Medium for Mathematics Education, INNOVATE Conference, Pretoria, March 2007.

[13] Botha, A, Aucamp, F. , Ford, M (2008). More than Mobile. Paper presented at IST Africa, 7 - 9 May 2008 in Windhoek, Namibia.

[14] Botha, A., Batchelor, J., Cronje, J., Aucamp, F. (2006). When wikis grow up and go for outings. Paper presented at mLearn 2006, the 5th World Conference on Mobile Learning, Banff, Canada.

[15] http://wiki.laptop.org/go/Our_Stories, accessed 26 November 2008