MOBILE LEARNING: AN APPLICATION OF MOBILE AND WIRELESS TECHNOLOGIES IN NIGERIAN LEARNING SYSTEM.

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Abstract

Mobile learning (M-Learning) is the point where mobile computing and e-learning intersect to produce an anytime, anywhere learning experiences. Advances in mobile technologies have enhanced M-learning tools at just the right moment to meet the need for more cost-effective just in time training options-learning on the go. Electronic Learning offer methods, which decrease the limitations of traditional education but M-learning offers more. This paper discusses the existing devices and technologies appropriate to realize Mobile learning, its advantages over e-learning, and challenges to its adoption of in Nigeria.

Keywords: e-Learning, m-learning, mobile computing, SMS, MMS

1. Introduction

The traditional education is made in classrooms where teacher presents the learning material to a group of students. The educational technology depends mainly on teacher and the students that must be physically present to **participate in the learning process. Regardless of the** obvious advantages of a direct contact between a teacher and students; immediate feedback in the traditional classroom education has many disadvantages. For example if a student has no ability to take part in some lesson he or she will miss the training material. These shown in figure 1. M-learning is also the combination of mobile technologies and appropriate pedagogy to allow learners to interact with learning environments, and other learners, at any time from any location.

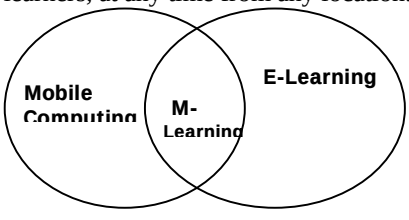

Fig. 1 M-Learing a subset of E-Learning

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disadvantages lead to search for new and more effective educational methods. E-learning offers new methods for education based on computer internet technology. M-learning is the intersection of mobile computing and e-learning **[**5]; M-learning has the ability to learn everywhere at every time without permanent physical connection to cable networks.

Mobile and Wireless technologies are being used in diverse areas such as travel, education, stock trading, military, package delivery, disaster recovery, and medical emergency care; but emphasis in this paper will be on mobile learning. Mobile and wireless systems cover two areas mobility and computing. Mobile computing means continuous accessibility to the user while wireless implies communicating without wires. As indicated in [6], mobile and wireless technology has improved substantially, making mobile devices remarkably convenient and affordable and M-Learning a reality.

2. What is M-learning?

Mobile learning is effectively a sub-category of the larger concept of e-Learning. According to Clark Quinn mobile learning is "the intersection of mobile computing and e-learning: accessible resources wherever you are, strong search capabilities, rich interaction, powerful support for effective learning, and performance based assessment – e-learning independent of location in time and space"[5]. So we can define M-learning as the intersection of Mobile Computing and e-learning as

To highlight the advantages of M-Learning over E-Learning a comparison is given in the table below:

Table 1: Comparison of M-learning with E-learning.

M-learning	E- Learning
It can be used everywhere at every time.	It cannot be used everywhere at every time
Most mobile devices have lower prices than Desktop (PCS).	Desktop (PCS) are more expensive than mobile devices.
Mobile devices are smaller in size and lighter in weight than Desktops. Hence they are portable.	Desktops are not portable. They are not easily carried around due to their heavy weight.
M-learning can provide	E- Learning cannot provide

location dependent education using GPRS technology	location dependent education.
It is flexible to engage by learners on the move.	It is not flexible.
One learner to more than one mobile device.	One learner to one computer.

3. Why M-Learning?

According to [1] M-learning is a natural extension of e-learning. It has the potential to further expand where, how, and when we learn and perform in all aspects of our life. A key benefit of M-learning is its potential for increasing productivity by making learning available anywhere and anytime, allowing learners to participate in educational activities without restriction of time and place. Mobile technologies have the power to make learning even more available and accessible than we are used to in existing e-learning environments. M-learning can be just- in- time learning where learners can actually access education and training at the place and time that they need it. M-learning can be information seeking, content delivery, adhoc questions and answers, notes, comments between learning community, or tasks related to learning administration [3]. The development and adoption rate of mobile technologies are increasing rapidly on a global scale; 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 instructors and peers "on-the-go" [4]

4. Mobile Devices

Mobile learning is impossible without the use of the mobile devices. They vary significantly in their abilities, sizes and prices [2]. The common ability which united them is their mobility and possibility to make wireless connections. The main types of mobile devices used in the education process are:

- **Notebook computers:** From one hand they have such abilities as desktop personal computer; from the other hand they have small sizes and support wireless communications. Their prices are still high.
- ***Tablet PC:*** These are one of the newest mobile devices. They also have full range of abilities as personal computers. Some of them haven't keyboard but have software to recognize handwritten text. It is relatively expensive.
- ***Personal Digital Assistant (PDA***): They have small sizes and significant processor power. New models support more than 65000 colors, recognize handwritten text and can play different types of multimedia files. The main operating systems used are Palm and Microsoft Pocket PC.
- ***Cellular phones:*** The low class devices mainly can be used for voice communication and sending and receiving of text messages (SMS). Some of their disadvantages are low memory capacity and low data transfer rate. The cellular phones from the higher class can be used to Internet access via WAP or GPRS technologies. They also can be used to send and receive the multimedia messages (MMS). Their prices continuously decrease.
- ***Smart phones:*** They are hybrid devices which combine the abilities of cellular phones and PDA. They have smaller sizes than PDA and bigger than cellular phones. Typically they haven't full sized keyboard and can recognize handwritten text. They use Symbian, Windows Mobile or other operating system. As they have Internet browsers they have potentiality to be successfully used in the mobile multimedia education. Today there are several communication technologies which are used in mobile devices. Their abilities vary vastly as well as data transmission range and range [2]

4.1 Mobile and Wireless Technologies

- ***Global system for Mobile Communications (GSM):*** is one of the leading digital cellular systems. It uses narrow band TDMA (Time Division Multiple Access). Originally a European standard for digital mobile telephony, GSM has become the world's most widely used mobile system in use in over 100 countries. GSM networks operate on the 900 MHz and 1800 MHz waveband in Europe, Asia and Australia, and on the MHz 1900 waveband in North America and in parts of Latin American and Africa. It provides integrated voice mail, high – speed data, fax, paging and short message services capabilities, as well as secure communications. It offers the best voice quality of any current digital wireless standard.
- ***Wireless Application Protocol (WAP):*** This is a free, unlicensed protocol for wireless communications. It makes possible creation of advanced communications services and access to Internet pages from a cellular phone. WAP devices understand the WML language (an XML application) that is optimized for small screens and navigation without a keyboard. WAP also supports WML script scripting language.
- ***General Packet Radio Service (GPRS):*** A packet linked technology that enables high speed wireless internet and other data

communications. GPRS provides about four times greater speed than conventional GSM systems. Currently 288 operators around the world have commercial GPRS services.

- ***Bluetooth:*** Wireless technology is a short range radio technology. Bluetooth makes it possible to transmit signals over short distances between telephones, computers and other devices and thereby simplify communication and synchronization between devices.
- ***IEE 802.***11 is a type of radio technology used for wireless local area networks (WLANs). It is a standard that has been developed by IEEE (Institute of Electrical and Electronic Engineers). Wi-Fi (802.11) is composed of several standards operating in different radio frequencies: 802.11b is a standard for wireless LANs operating in the 2.4 GHz spectrum with a bandwidth of 11 Mbps; 802.11a is a different standard for wireless LANs, and pertains to systems operating in the 5 GHz frequency range with a bandwidth of 54 Mbps. Another standard, 802.11.g, is for WLANS operating in the 2.4 GHz frequency but with a bandwidth of 54 Mbps.
- ***Infrared Data Association (IrDA):*** This association defined a suite of protocols for infrared (IR) exchange of data between two devices, up to 1 or 2 meters apart (20 to 30cm for low – power devices). IrDA devices typically have throughput of up to 115.2Kbps or 4Mbps. Smart phones, many PDAs, printers and laptop computers use IrDA protocols.

The comparisons between parameters of existing wireless technologies are given in the Table 2 [2]

Technology	***Data Rate (Mb/s)***	***Range (meters)***	***Frequency Band***
Bluetooth	1-2	100	2.4GHz
IrDA	4	1-2	Infrared
IEEE 802.11a	54	20	5GHz
IEEE 802. 11b	11	100	2.4GHz
IEEE 802.11g	54	50	2.4GHz

From Table 2 we can make conclusions that these technologies can be used to provide different data transmission rates with ranges less than 100 meters in the area of the universities or so called “hot spots”. To achieve higher ranges the cellular phones supporting WAP and/or GPRS technologies must be used.

Table 3: Wireless technologies and associated characteristics

Technology	**Services/ Features**	**Coverage Area**	**Limitations**	**Example Systems**
Cellular	Voice and data through hand held phones	Continuous Coverage	Very low bandwidth	Cellular Phones, PDAs, Palm Pilots
Wireless LAN (WLAN)	Traditional LAN with wireless interface	Only in local environment	Limited range	NCR’s WaveLAN, Motorola’s ALTAIR
GPS	Determines three dimensional position and velocity	Any place on Earth	Expensive	GNSS NAVSTAR GLONASS
Satellite-based PCS	Mainly for paging	Almost any place on Earth	Expensive	Iridium, Teledesic
Ad hoc networks	Group of come together for shot time to share data	Similar to local area networks	Very limited range	Bluetooth
Sensor networks	Tiny sensors with wireless capabilities	Small terrain	Very limited range	Defense and civilian applications.

GPS-based Applications

Global Positioning Systems (GPS) [10] are space-based radio positioning systems that provide 24-hours, 3D position, velocity, and time information to suitably equipped users anywhere on the surface of the Earth. The NAVSTAR system, operated by the U.S. Department of Defense, is the first GPS system that allows intelligent vehicle location and navigation. It has many military applications such as intelligence and target location, command and control mine laying and detection, testing combat aircraft, missile guidance, and artillery pointing, to name a few, GPS can be used for surveying and can be done in almost all weather conditions. GPSs are useful in agriculture for precision farming as well as for search and rescue operations.

Automobile manufacturers have introduced GPS-based navigation in cars, with a four-inch monitor asking travelers their destination, displaying a color map of the area and scrolling down a list of preselected points of interest, such as hotels, convention centers, or a specific street address. Another example of GPS-based applications is the use of mobile notebooks in sporting competitions, including sailboat races, where progress is recorded and communicated wirelessly to servers.

Satellite-based PCS

The satellite-based PCS use a constellation of low-earth orbit (LEO) satellites [6], orbiting around the Earth at a few hundred miles. The Iridium project, conceived and created by Motorola, is a satellite-based technology consorsium for PCS. The satellites in the sky cover any point on Earth with continuous lines of sight. They provide small handheld phones with the conventional wireless options, and small pagers with text messaging. Teledesic is building a global, broadband Internet-in-the-sky network. The service is targeted to begin in 2004, and the idea is to provide affordable, worldwide access to telecommunications services such as computer networking, broadband Internet access, high-quality voice, and other digital data.

Ad-Hoc Networks

An ad-hoc network is a WLAN in which mobile or portable devices are parts of the network but only when they are in a relegated, close proximity. There is no fixed infrastructure, and information is forwarded in a peer-to-peer mode using multihop routing. Military applications for ad-hoc networks include a group of close-by soldiers who can share the information in their notebook computers using RF signals. However, numerous civilian applications are being explored. Home networking is replacing WLANs in home to connect multiple PCs and other computing devices by having wireless networks and one device connected to ISDN line. Another way of connecting many home devices is to employ a short-range frequency-hopping radio line of Bluetooth technology [7] and connect a cellular telephone to laptops, printers, PDAs, desktops, fax machines, keyboards, joysticks, and other peripherals.

Sensor Networks

Sensor networks [15, 16, and 17] are the newest of wireless networks in which a large number of tiny immobile sensors are planted on an ad-hoc basis to sense and transmit some physical characteristics of the environment. The information from sensors is aggregated on a "data centric basis." Battlefield surveillance with a large number of sensors dropped from an airplane in enemy territory is the most noted example territory is the most noted example. Other potential commercial fields include machinery prognosis, biosensing, and environmental monitoring.

5. Nigeria - Convergence, Broadband and Internet Market Report

According to Internet Usage and Marketing Report (2008), Nigeria's Internet sector has been hindered by the country's underdeveloped and unreliable fixed-line infrastructure, but this is changing as competition intensifies and new technologies are able to deliver wireless broadband access. More than 400 ISPs have been licensed as well as a number of data carriers, Internet exchange and gateway operators. Voice over Internet Protocol (VoIP) is already carrying the bulk of Nigeria's international voice traffic. The current deployment of the country's first Next Generation Networks (NGN) will drive further convergence of voice, data and video/TV, enabling the provision of triple-play services that will ultimately also involve the country's already competitive broadcasting sector [11].

[9], reported that African firms and telecommunications operators are forging ahead with new services and advanced technologies. Going by what we have in table 4, it remarkable the spread of mobile telephony throughout the continent. Presently, Africa's mobile usage has a growth rate of about 904% from 2000 to 2008; and that has made continent the fastest growing region in terms of mobile usage. Africa took over a hundred years to accumulate 28 million fixed lines: this is an average penetration rate of just 3 lines per 100 inhabitants, and is still below 1 line per 100 inhabitants in many countries. The stunning growth of mobile telephones, led mainly by private operators, means that mobile phones overtook fixed lines in 2001 and now outnumber fixed lines by nearly five to one, with 137.2 million mobile subscribers in 2005 [9].In table 4 as graphically represented in figure 2, the percentage of mobile market as at 2005 is 14.0% with the Internet usage growth of 3,900% from 2000-2007. According to figure 3, we discovered that 25% of all cellular mobile subscribers live in South Africa, 14% live in Nigeria, while the four Maghreb countries (Algeria, Egypt, Morocco, and Tunisia) account for a further 10%, 10%, 9% and 2% respectively of all African mobile subscribers. All the remaining African economies altogether account for just about 30% of subscribers.

5.1 Nigeria Mobile Market - Overview and Statistics

According to [12,13,14],the transformation of Nigeria's telecommunications landscape since the licensing of three GSM networks in 2001 and a fourth one in 2002 has been nothing short of astounding. With triple-digit growth rates for five years in a row, it passed Egypt and Morocco in 2004 to become the continent's second largest mobile market after South Africa and is set to take the top position during 2007, even though the growth curve has now started to flatten. And yet it has only reached about one third of its estimated ultimate market potential. The licensing of a fifth GSM network and four 3G networks in early 2007 will give additional

impetus to the market, as will the new unified licensing regime introduced in 2006, designed to increase competition between fixed and mobile network operators.

Table 4: Internet usage statistics in 2000-2007 and 10 largest Mobile Market in Africa in 2005

INTERNET USAGE STATISTICS AND 10 LARGEST MOBILE MARKET IN AFRICA						
AFRICA	**Population (2007 Est.)**	**Internet Users Dec/2000**	**Internet Users, Latest Data**	**% Mobile Market 2005**	**(%) Users in Africa**	**Use Growth (2000-2007)**
South Africa	43,997,828	2,400,000	**5,100,000**	25.0 %	11.5 %	112.5 %
Algeria	33,333,216	50,000	**2,460,000**	10.0%	5.6 %	4,820.0 %
Egypt	80,335,036	450,000	**6,000,000**	10.0%	13.6 %	1,233.3 %
Nigeria	135,031,164	200,000	**8,000,000**	14.0 %	18.1 %	3,900.0 %
Morocco	33,757,175	100,000	**6,100,000**	9.0%	13.8 %	6,000.0 %
Kenya	36,913,721	200,000	**2,770,300**	3.0%	6.3 %	1,285.2 %
Tunisia	10,276,158	100,000	**1,618,440**	2.0%	3.6 %	1,518.4 %
Ghana	22,931,299	30,000	**609,800**	2.0%	1.4 %	1,932.7 %
Tanzania	39,384,223	115,000	**384,300**	4.0%	0.9 %	234.2 %
Congo, Dem. Rep.	68,008,922	500	**180,000**	2.0%	0.4 %	35,900.0 %
Others	437,280,388	868,900	**11,139,100**	19.0%	24.8%	
TOTAL AFRICA	941,249,130	4,514,400	**44,361,940**	1000%	100.0 %	882.7 %

Source: ITU World Telecommunication Indicators Database

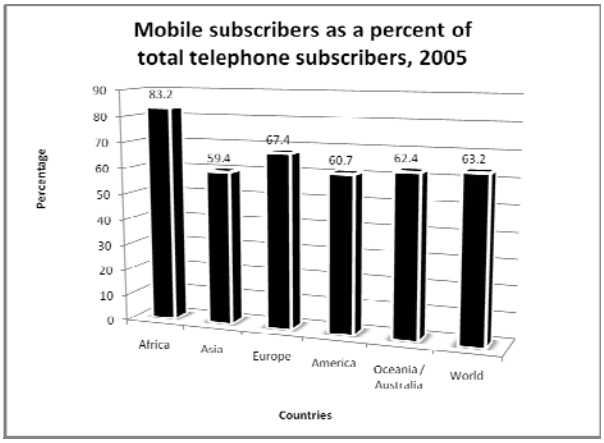

Figure 2: Comparative analysis of Mobile subscribers as a percent of total telephone subscribers, 2005

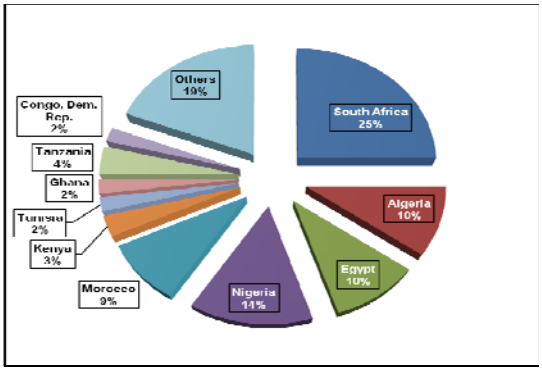

Figure 3: Comparative Analysis of the 10 largest Mobile Markets in Africa

Then one may want to ask, how well connected is Nigeria? According to figure 4 below, the data for 2007 show that 5% of Nigeria's 148,090,000 inhabitants (nearly 16 per cent of Africa's population) had access to the Internet, 3% have access to main telephone lines, while 20% are mobile subscribers.

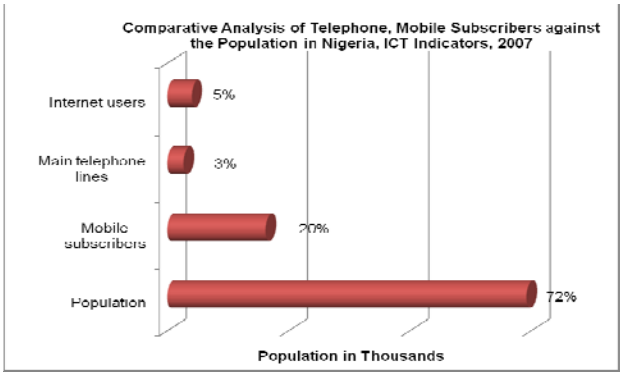

Figure 4: Comparative Analysis of Telephone, Mobile Subscribers against the Population in Nigeria, ICT Indicators, 2007

6. Why M-Learning in Nigeria

The strength of M-Learning lies in a communication approach rather than a content approach. This statement by no means implies that M-learning cannot have a content approach. Mobile technologies and mobile devices will in the future, be used with the content approach, but the real advantages of M-learning lies in the communication domain. Why then all the fuss about M-learning if it is merely a subset of e-learning?

M-learning provides more mobility, flexibility and convenience than online learning. Life-long learning demands learning while you earn which is possible

through e-learning. M-Learning takes it further and makes it possible to learn while you earn on-the-go.
Mobile technologies such as mobile phones allow for synchronous audio communication with much greater ease and at a relative lower cost than online technologies, especially in areas where bandwidth is still a limitation as in Nigeria.
Why M-learning in Nigeria?
Well the answer is quite interesting. Because of lack of infrastructure for ICT (Cabling for internet and telecom) in Nigeria, the growth of wireless infrastructure is enormous. [18] Reported that the adoption rate of mobile technologies in Africa's developing countries is among the highest rate globally and forecasts estimate almost 200 million mobile users in Africa by 2007.

6.1 A Model for m-learning in Nigeria by way of Mobile Phone- 2007:

- Learners have periodic access to the internet using PCs at learning or community centers. During these periods of access, the focus is on
  -downloading of content
  -access to articles/study materials/resources
- Learners use mobile phones on a daily basis
- Academic support for learners through SMS, MMS, and Wireless Application Protocol (WAP):
  -communication and interaction from and with educational institutions
  -browsing e-learning course material
  -complete multiple choice assessments with immediate feedback
  -motivational messages
- Administrative support through SMS MMS WAP, integrated with the internet.
  -Access to financial statement and registration data by way of mobile service number
  -daily tips
  -receive course schedule and calendar
  -access to institution M-portal on the web

7. Conclusion

M-learning will not replace traditional learning. It just provides another way of learning using new mobile technology. Of variety of mobile devices available today, smart phones, PDAs and tablet PCs are the most applicable mobile devices for delivering learning. PDAs offer greater functionality than mobile phones and similar advantages to tablet PCs, though tablet PCs are more robust than PDAs and offer additional features. PDAs, Tablet PCs, and mobile phones can be used in many educational settings and accomplish many different educational tasks. These mobile devices are useful in education both as administration, organization and teaching aids for practitioners, and also as learning support tools for students. M-learning fulfills the growing demands for life-long learning opportunities that enable learners to "learn while you are on the go"
M-learning has already started to play a very important role in e-learning in Nigeria. It should be noted that M-learning has brought e-learning to the rural communities of Nigeria- to learners that we never imagined as e-learning learners just a few years ago. M-learning is the gateway to e-learning for most learners in Nigeria as the rapidly growing wireless infrastructure increasingly fulfils their access needs. Nigeria is actually leaping forward from an unwired, nonexistent e-learning infrastructure to a wireless e-learning infrastructure. The statistics in this regard are already significant proof of this process.
The role of m-learning in the future of e-learning in Nigeria should not be underestimated. M-learning in Nigeria is a reality that will continue to grow in form, stature and importance. It will become the learning environment of choice.

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