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The m-technologies in m-learning

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THE M-TECHNOLOGIES IN M-LEARNING

Introduction

The emergence of mobile communication is empowering people, businesses and society; changing the way we live and work. It is a phenomenon that is creating a new culture all over the world. The evolution of telecommunications (see figure 1) from fixed-lines to analog mobile communication and subsequently digital mobile telecommunication systems coupled with the invention of computers and the Internet has contributed enormously to the creation, processing and dissemination of information anywhere at any time[1]. Unfortunately most of the times, the use of mobile computers and other handheld devices for teaching and learning is discussed around the mobile device without much emphasis on the antecedents which have facilitated and brought about the concept of mobile learning, some of which are the evolution of mobile telecommunications, evolution of mobile computing devices, software development and wireless Internet connectivity. The discussion of mobile learning will not be complete if its technological constituents which include mobile telecommunications, mobile devices, mobile applications and mobile internet connectivity infrastructure are not considered. These are basically the main technology enablers of mobile learning.

[1] M. Ally: *Mobile Learning: Transforming the Delivery of Education and* Training, Athabasca University Press, 2009.

Today, the role of mobile communication technology in facilitating education delivery is worth mentioning[2]; for example, students can use the vast interactivity of mobile communication infrastructure to develop their skills, knowledge and perception of the world. Mobile communication is undoubtedly minimizing distance through the use of broadband Internet, mobile computing devices and software development. It apparently makes it possible for people to become "virtual omnipresent" which enable them to seamlessly switch between context and space locally and internationally such that with the use of mobile technology, one can be at a fixed location and still be able to connect remotely or wirelessly to other people simultaneously in different places to converse, see what they are doing or synchronously participate in anything they are doing in any part of the world by text, audio or video. The use of mobile technology in education has precipitated the evolution of a new concept of electronic learning (e-learning) called mobile learning (m-learning) which is motivated by the perpetual advancement in mobile computing and communication technologies (Wi-Fi, Blue Tooth, GPS, GSM, GPRS, EDGE, UMTS, and LTE)[3].

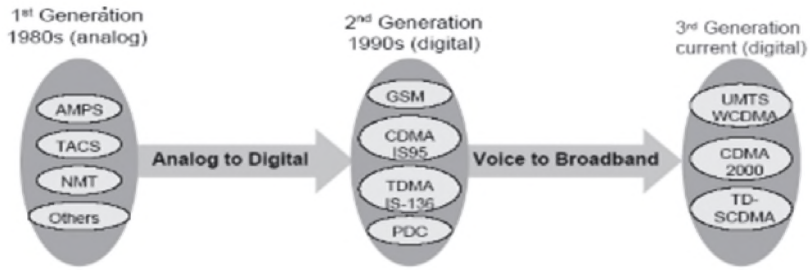


Fig. 1. Brief overview of the generations of mobile telecommunication from analog to digital

Source: http://www.nqlogic.com/2010/04/broadband-goes-mobile.html

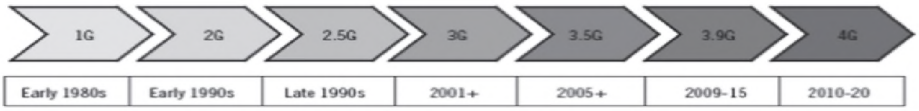
1. Evolution of Mobile Telecommunications

One of the significant breakthroughs in ICT is the invention of mobile communication systems. The two main systems of mobile communication are the European system which is GSM (Global System for Mobile Communication) and the

[2] K. Kumar, T.R. Reddy: *Role of Mobile Communication and Technology Services in Educational Libraries*, International Journal of Librarianship and Administration, 2012, Vol. 3, No. 1, p. 57-68.

[3] P.B. Muyinda, E. Mugisa, K. Lynch: *M-Learning: The Educational Use of Mobile Communication Devices*, Strengthening the Role of ICT in Development, 2007, p. 72.

American system which is CDMA (Code Divisible Multiple Access). Unlike the fix landline telecommunications system, these mobile communication systems have better technologies and are able to support huge varieties of tasks and services which include but not limited to making calls, Short Message Services (SMS), Voicemail, broadband Internet connectivity[4], and other services such as mobile banking (m-banking), mobile money (m-money), mobile commerce (m-commerce), mobile learning (m-learning), mobile health (m-learning), mobile government (m-government), and mobile Internet television (m-IPTV). The emergence of mobile telecommunications has become an essential mediating tool in almost every aspect of our lives in how we communicate, do business, process data and information and learn[5]. It frees people from the constraint of boundaries, thus creating an ubiquitous environment to work or learn from anywhere at anytime. Interestingly, GSM and CDMA have different standards and evolution paths which support different services in their various capacities as shown in figure 2.



Generation	European Std	US Std
1G	ETACS	AMPS
2G	GSM	CDMA (IS-95)
2.5G	GPRS	CDMA 2000 1X
3G	UMTS	CDMA 2000 1x EVDO, EVDV etc..

Fig. 2. European and US Standards of mobile communication

Source: http://www.taiwan4g.com/evolution_history_celluar_technology.php

Technology advancement has contributed to the evolution of education delivery to some large extent taking recognisance of the revolution and evolution of the following technologies: paper and print technology[6], radio and television, fixed line telephony and communication, type writer, mainframe computer, desktop computer,

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

[5] R. Beaubrun, S. Pierre: *Technological developments and socio-economic issues of wireless mobile communications*, "Telematics and Informatics", 2001, Vol. 18, No. 2, p. 143-158.

[6] M. Lazzouni, M. Yousaf, R.A. Qureshi, N.A. Nazir: *Pen and paper infor-mation recording system using an imaging pen*, U.S. Patent 566150626-Aug-1997.

laptop, TCP-IP address and the Internet technology[7], with the most recent being the technology of mobile telecommunications and mobile computing devices. Mobile technology is a technology which perfectly fits into education delivery because it facilitates communication and conversation elements of teaching and learning and the mobility of both the teacher and the student. This makes teaching and learning possible at anywhere and anytime. For educators, educational technologists, instructional technologists and designers and policy makers to be able to conceptualize an appropriate educational framework and pedagogy for m-learning to answer the educational needs of the 21st century learner, they must appreciate and understand the evolution of mobile communication and mobile computing devices and how it can be used effectively to enhance education delivery[8].

2. GSM – Global System for Mobile Communication

The adoption of mobile computing devices and the opportunity to use it as mediating tool which has the ability to facilitate ubiquitous teaching and learning is a phenomenon which is motivated by the development of mobile communication. The shift from analog mobile communication by both the Europeans' ETACS and Americans' AMPS to GSM and CDMA respectively opened a new door of opportunities for information and communication technologies. ETAC and AMPS were analog mobile communication systems with low transmitting rate which could support only voice during the first generation of mobile communication (1G). The introduction of GSM with TDMA technology in 1992 was termed the second generation (2G) and marked the beginning of digital mobile communication with the following characteristics; high speech quality, efficient use of frequencies, ISDN service features, compatible with other ways of data transmission services and ensure high security as far as the user and information transmission are concerned. Many of these have been turned into advantages for users; the available frequencies are used efficiently, the average speech quality is higher than the analog mobile networks, speech encryption guarantees security standards, a wider range of service like voice, fax, data and Internet are provided as compared to analog networks, international roaming between all GSM countries is possible, further more, international competition reduces the prices.

Today, GSM is an open standard for services, infrastructure and communication independent of individual countries, network operators and producers and flex-

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[7] S. Guo: *From printing to Internet, are we advancing in technological application to language learning*?, "British Journal of Educational Technology", 2010, vol. 41, no. 2, p. E10-E16, 2010; L. White: *Technology and Invention in the Middle Ages*, Speculum, Apr. 1940, Vol. 15, No. 2, p. 141-159.

[8] M.L. Bargellini, L. Bordoni: *The role of the library in a new learning scenario*, Electronic Library, The, 2001, Vol. 19, No. 3, p. 153-157.

ible to the requirement of the individual. Use of all this has boosted the adoption and diffusion rate of GSM all over the world with hundreds of network operators and billions of users, however, 2G was limited by a data transmitting rate of 9.6kbps and was applicable to voice communication only. To meet the growing demands of increasingly complex data applications, for example multimedia and Internet services; HSCSD, GPRS and EDGE were developed as an improvement on 2G to allow for higher data transmission. These evolutions constituted the 2.5G to 2.75. HSCSD is circuit switched system which increases the 9.6kbps to 14.4kbps. This allows, for example, faster email transfer, file transfer and speeder and cheaper web browsing and data download from the Internet. This was further enhanced by the development of GPRS and EDGE[9]. In contrast to HSCSD, GPRS is a packet switched instead of circuit switched with data rate of 21.4kbps. The radio network resources are only used if data is actually being transmitted and billing is no longer based on the duration of a call, but only on the amount of transmitted data, however GPRS requires some modification to the existing GSM infrastructure. EDGE is a technology which concentrates on air interface between the MS (mobile station) and the BTS (base transceiver station) based on a new modulation process, called "8-PSK". With this, EDGE is able to achieve a data rate of 474kbps for 8-time slots, three times greater than that of HSCSD and GPRS. The development of HSCSD, GPRS and EDGE were further steps to mobile multimedia (see figure 3).

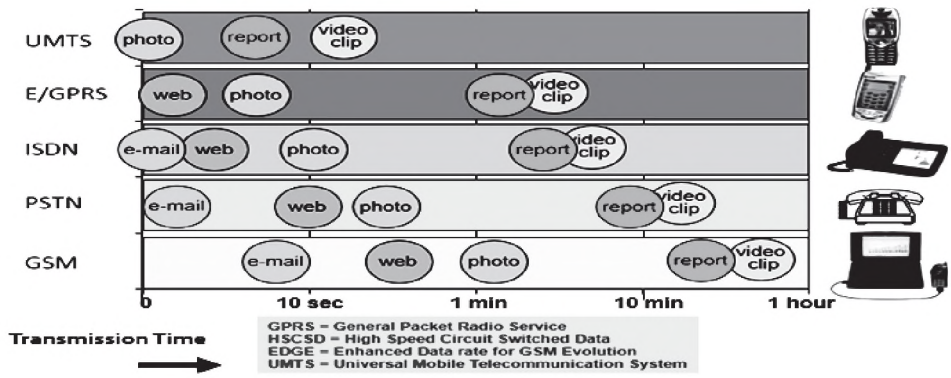

Fig. 3. Improvement in transmission time and data services as mobile communication evolves

Source: http://dc304.4shared.com/doc/hPn1eLm-/preview009.png

The universal mobile telecommunications systems (UMTS) represent the 3rd generation of mobile communication, popularly known as 3G which supports large

[9] T. Halonen, J. Romero, J. Melero: *GSM, GPRS and EDGE performance: evo-lution towards 3G/UMTS*, Wiley, 2003.

volumes of data transmission at high speeds. With considerable modification to the existing network, UMT or 3G can achieve 2Mbps of data transmission (see figure 4). Its enhancements mainly affect the air interface where a broadband transmission method achieves high transmission speeds. The development of UMTS marks a major milestone in mobile telecommunications, which makes it possible for the UMTS infrastructure to support different data services including video streaming, mobile TV, mobile banking, mobile learning, mobile health, mobile commerce, global positioning system (GPS) and several mobile applications systems. To further enhance mobile communication, the 3rd Generation Partnership Project (3GPP) has released the long-term evolution (LTE) technology, affectionately called 4G[10] which has the capacity to support a data transmission rate of 300Mbps, with network delay of less than 5ms, a considerable improvement in spectrum efficiency compared to previous mobile communication systems (Astély et al., 2009). LTE is a step towards advanced international mobile telephony (IMT) with highly flexible radio interface which provides mobile ultra-broadband Internet access with great interoperability. It supports mobile WiMax, Wi-Fi, and IPV6 which makes it possible for wide variety of mobile devices to be connected.

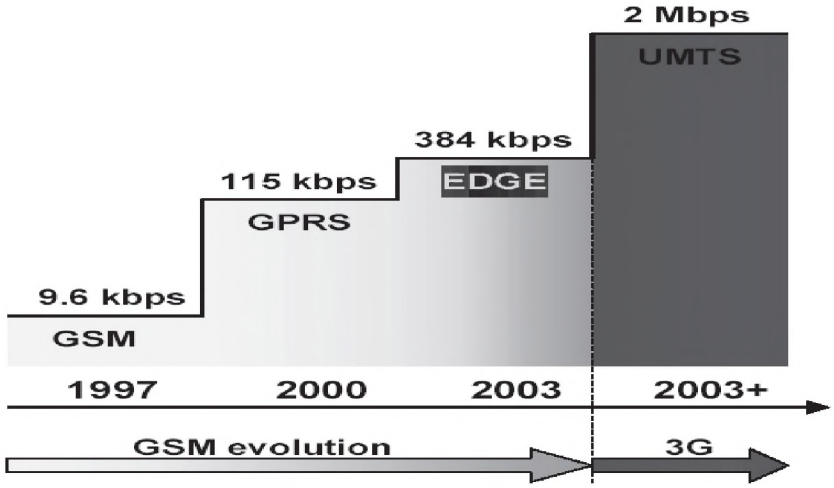

Fig. 4. Data rate capacities and how GSM has evolved over the years

Source: http://www.4gamericas.org/index.cfm?fuseaction=page&sectionid=242

[10] E. Dahlman: *3G evolution: HSPA and LTE for mobile broadband*, Academic Press, 2008.

3. Evolution of Mobile Devices

The technical term 'mobile learning' emerged out of the affordances of 'mobile devices' in facilitating teaching and learning anywhere anytime. Although the jargon "mobile learning" is surrounded with varied definitions and explanations, the mobile device[11] is an important element in the whole phenomenon of teaching and learning from anywhere at any time using handheld computers. The adjective 'mobile' in both 'mobile device' and 'mobile learning' to a large extent refers to the mobility of the device physically in spatial, temporal and contextual perspectives of human life. Mobile learning is basically nothing more than a technologically improved electronic learning (e-learning), which makes it possible for people to either teach or learn at anytime and anywhere with portable mobile computing devices facilitated by mobile communication and mobile software applications[12]. This implies that without mobile devices there will be no mobile learning.

Continuous upgrade of the functions and computing power of mobile phone and the gradual reduction of the size of personal computer from desktop to laptop to note book and recently tablet PC (see figure 5) is a mutual phenomenon which has given birth to the term 'mobile device'. Rapid advancement in the design and manufacturing of these devices is relevant in discussing mobile learning at any-time. Like the generations of mobile telecommunications, mobile devices have also evolved over the years from analog to digital and simply to sophisticated devices[13]. Mobile learning was not possible with the analog generation of mobile device for two reasons: (a) the devices did not have features and functionalities which could support mobile learning and (b) the corresponding analog mobile telecommunications infrastructure also did not have the capacity to facilitate mobile learning. The first generation of digital mobile devices had some basic features and functionalities which could be used for mobile learning in the form of SMS supported by the complementary first generation GSM infrastructure with minimum capacity. The current generation of mobile devices together with the latest mobile telecommunications infrastructure is able to support different forms, styles and types of mobile learning based on behaviourist, cognitivist and constructivist pedagogical concepts to meet different teaching and learning needs anticipated by educators. Figure 5 shows the evolution of mobile phone devices in use today for m-learning.

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[11] R. Woodbridge: *Mobile: The Key to Education Anywhere*, GigaOM, 17 Mar 2011, [online], http://gigaom.com/mobile/mobile-the-key-to-education-anywhere/ [access 27.12.2012].

[12] J. Roschelle: *Unlocking the learning value of wireless mobile devices*, "Journal of Computer Assisted Learning", 2003, Vol. 19, No. 3, p. 260-272.

[13] K. Sevari: *The role of mobile phones in education and instruction of classroom materials - Google Search*, "Advances in Education", 2012, Vol. 1, No. 1, p. 19-21.

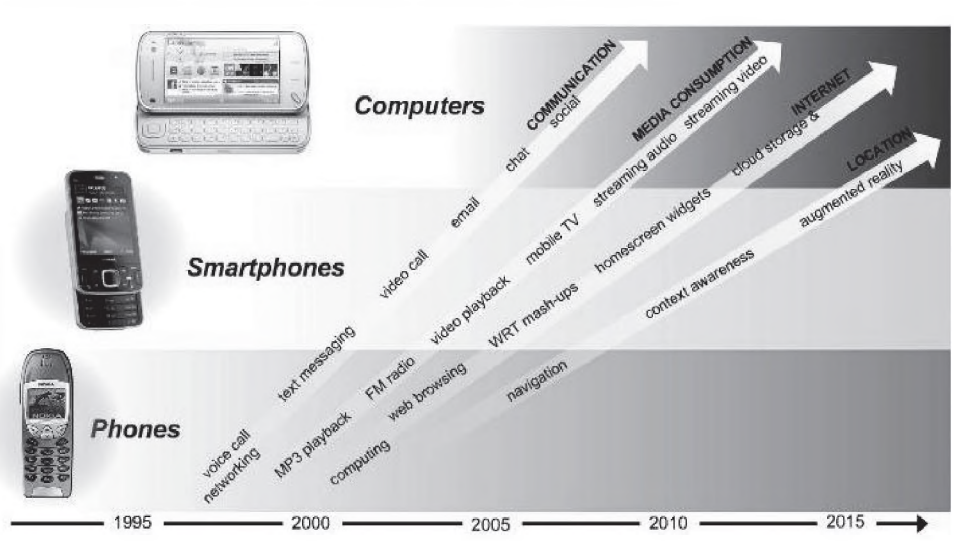

Fig. 5. Evolution of mobile phone to mobile computer

Source: http://www.migsmobile.net/2010/01/12/evolution-of-mobile-device-uses-and-battery-life/

4. Software development

Software is what connects mobile devices and mobile telecommunications infrastructure to make mobile learning possible. Software developers are like strikers on a football pitch, they wait for opportunities to score. In the same way, software developers study device innovations, communication infrastructure developments and user needs to develop software applications for user consumption. The innovative introduction of IP address and the Internet led to the development of network and web-based applications. Today the design and development of mobile-apps based on Android, Apple OS and others are possible because of mobile computing devices and mobile telecommunications systems. The fast growth of mobile computing devices for teaching and learning is partly motivated by the fact that there are numerous software applications for mobile learning which are available. This makes it relatively stress free for teachers and learners to choose any of them that meet their needs within a particular context. For example one can choose a forum application for collaborative learning or a social network application for social constructive learning among others.

The bone of contention between software developers and educators is the need for the developers to understand and appreciate the psychology and philosophy of learning from the perspective of behaviourism, cognitivism and constructivism in their design and development of mobile learning applications, and also for educa-

tors to appreciate the pedagogical usefulness of these software to incorporate it into their educational framework.

5. Connectivity

The introduction of GPRS and subsequent advancement in mobile telecommunications paved the way for mobile phones and other handheld devices to access data from the Internet which hitherto was not possible (as shown in figure 6). TCP-IP Addressing system is the transmission medium which allows computing devices to be connected to form a network for sharing data and information from anywhere at anytime when and wherever internet connectivity is available[14]. The World Wide Web (www) is a widespread information infrastructure and the largest computer network system which allows any computer in the world with IP Address to connect to the network. This 'www' is made up of several WANs, MANs, LANs, Ethernets and millions of standalone computing devices which create opportunity for people to get access to information all over the world from numerous information resource databases[15].

The internet, just like the telecommunications and mobile devices has evolved over the years until the invention of TCP-IP by Vinton G. Cerf and Robert E. Kahn in the 1970s[16] which has transformed communication to the use of computing devices as never before. It has become a worldwide broadcasting network system for information dissemination, and a platform for ubiquitous collaboration and interaction among people and their computer devices. E-learning and m-learning are major educational benefits of the Internet infrastructure. The recent upgrade of IPV4 of 32bits to IPV6 of 128bits to increase capacity for more devices to connect to the Internet is an advantage for m-learning among other educational purposes. Electronic Mobile Learning treads on mobile broadband Internet or wireless Internet access and other wireless systems like Bluetooth, Wi-Fi and WiMax with some service operators using fiber optics as the backbone infrastructure to provide high speed connectivity. Wireless access to information through the Internet or web-based educational resources is one of the core ingredients of using mobile computing devices for teaching and learning.

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[14] V. Cerf: *How the internet came to be*, 1993.

[15] J.P. Shim, U. Varshney, S. Dekleva, G. Knoerzer, *Mobile and wireless net-works: services, evolution and issues*, "International Journal of Mobile Communi-cations", 2006, Vol. 4, No. 4, p. 405-417.

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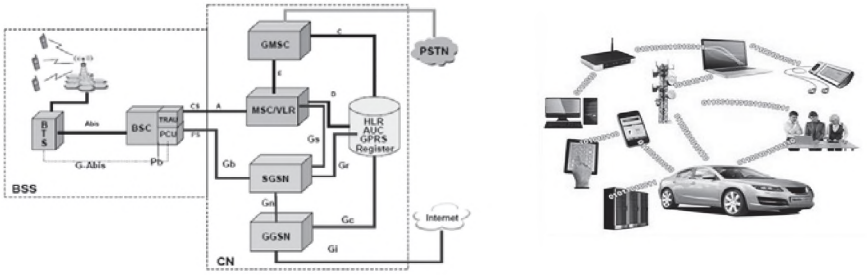

Fig. 6. The infrastructure development of GSM to E/GPRS marked the beginning of mobile Internet connectivity on any TCP-IP enabled device at anywhere and anytime

Source: http://futrs.com/images/news/telematics/the-next-boom-in-mobile-devices-is-the-connected-car.jpg

Conclusion

The main point of the discussion is that m-learning is facilitated by three main elements which we have named as the "Ms in Mobile Learning" - (i) mobile telecommunications (ii) mobile computing devices and (iii) mobile software applications as shown in figure 7. The combination of these three elements is what constitutes m-learning platform which makes it possible for teachers and students to seamlessly teach and learn anywhere and anytime without restriction of geographic location. The relationship between these Ms in facilitating m-learning is mobility. Some of the core ingredients which distinguishes m-learning from e-learning in this regard is wireless access to Internet and device portability and mobility. The phenomenon of mobile computing and communication technology has brought about a new global life of convergence, ubiquity and connectedness to one platform of information super highway and database.

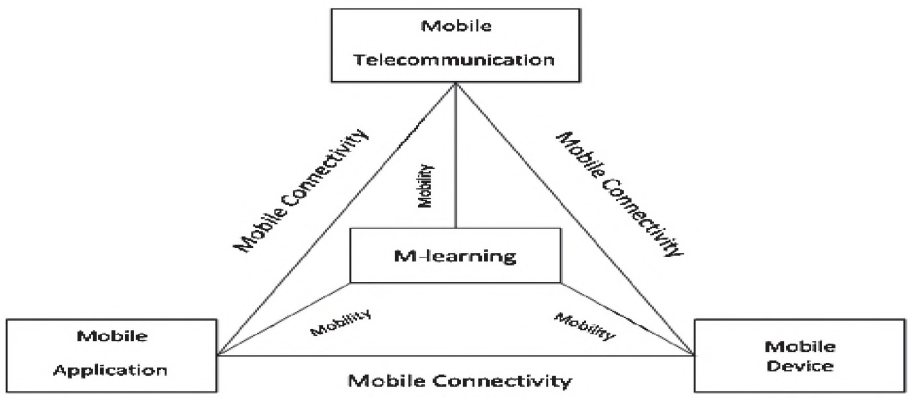

Fig. 7. The M-Technologies in M-Learning

Source: own elaboration.

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THE M-TECHNOLOGIES IN M-LEARNING

Summary

The term mobile technology is used in reference to the mobility of a technology, that is, the ability to virtually use a technology anywhere and at anytime without mobility constraints. Different types and forms of technologies have been part and parcel of human activities and the evolution of such technologies especially in the area of ICTs have brought about several technologies; among them are mobile-ICTs. The 'mobile' prefix is an indication that there are ICTs which are not typically mobile in nature. Contemporary, these are refered to as 'static-ICTs'. Desk top computing and the use of cable network are vivid examples of static-ICTs while smartphones, tablets and mini laptop with wireless network connectivity, represent mobile-ICTs. The purpose of this paper is to elucidate the relationship between mobile computing and communication technologies, and their implication for education delivery. The phenomenon of using mobile-ICTs for teaching and learning as popularly refered to as m-learning and is an off-shoot of e-learning which implies the use of static-ICTs for learning. The problem however, is that m-learning has a highly fragmented meaning because most fail to understand all the constituents of m-learning which this paper perceives to be the interconnectivity between mobile device, mobile telecommunications and mobile applications in their entirety as inseparable elements of m-learning. The questions that this paper seeks to address are; what are the key technological components of m-learning and what role do they play in making m-learning possible? As a method, a desktop research is done by reviewing relevant literature and documents on the theme of this paper, coupled with interviews and survey to arrive at an empirical outcome.

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