Leveraging mobile computing and communication technologies in education

Incorporation of mobile learning into Tertiary Education

Annan, Nana Kofi

Publication date:
2014

Document Version
Early version, also known as pre-print

AALBORG UNIVERSITY
DENMARK

LEVERAGING MOBILE COMPUTING AND COMMUNICATION TECHNOLOGIES IN EDUCATION:

"Incorporation of Mobile Learning into Tertiary Education"

Nana Kofi Annan

Supervised by Morten Falch, Associate Professor

Department of Electronic Systems, Aalborg University
Centre for Communications, Media & Information Technologies (CMI)
Aalborg University, Denmark

This Dissertation is submitted to the Aalborg University
As a requirement for the award of the Degree of Doctor of Philosophy (Ph.D.)
In Mobile Information & Communication Technology (mobile-ICT)

Submitted in May, 2013.

Abstract

The emergence of mobile computing and communication technologies has come with it, an unprecedented transformation in digitalising every aspect of human activities. This transformation has brought about high degree of mobility in the way knowledge is constructed, processed, stored and disseminated through the use of portable information and communication technologies (ICTs) such as smart phones, tablet, personal computers and laptop computers. These mobile devices use mobile communication infrastructure to promote the mobility affordances for human activities anywhere and anytime.

Although education and technology have evolved in tandem over the past years, this dissertation recognises the lapse that there is, in not being able to effectively leverage technology to improve education delivery by most educators. The study appreciates the enormousness of mobile computing and communication technologies in contributing to the development of tertiary education delivery, and has taken keen interest to investigate how the capacities of these technologies can be leveraged and incorporated effectively into the pedagogic framework of tertiary education. The purpose is to research into how these ubiquitous ICTs can be used to facilitate teaching and learning, based on a conceptual framework, which uses mobile learning platform to supplement traditional face-to-face method of education. The study uses both qualitative and quantitative data with action research as the strategy of inquiry.

The study was situated within a developing country context using Ghana as the case study. In view of this, the m-learning project of Central University College with student population of about 10,000 and teaching staff of 143 was purposefully and conveniently selected as the case study for this thesis.

The analysis of the results conducted after rigorous theoretical and empirical research unveiled the following: mobile technologies can be incorporated into tertiary education if it has a strong theoretical underpinning which links technology and pedagogy; the technology would not work if the user's concerns in relation to the use of the technology is not holistically resolved; mobile technologies offer tremendous opportunities for the generation, processing, Storing and disseminating knowledge.

These findings led to the conceptualisation of the STUMP framework as a theoretical contribution for ensuring effective leveraging and incorporation of mobile computing and communication technologies into tertiary education.

Resume

Med fremkomsten af mobile it- og kommunikationsteknologier (IKT) er ethvert aspekt af menneskelige aktiviteter blevet digitaliseret i et hidtil uset omfang. Anvendelsen af smart phones, tablets og bærbare computere har muliggjort en høj grad af mobilitet i skabelse, lagring og formidling af viden, således at disse processer i stigende grad kan ske uafhængigt af tid og sted.

Denne afhandling tager som udgangspunkt, at selvom IKT anvendes mere og mere i uddannelsessystemet og nye uddannelsesmetoder er blevet udviklet parallelt med den teknologiske udvikling, er der stadig et stort uudnyttet potentiale for udvikling og anvendelse af it-baseret undervisning inden for de videregående uddannelser. Formålet med denne afhandling er at analysere, hvordan de muligheder, tilstedeværelsen af en mobil informationsinfrastruktur giver, kan integreres i en ny pædagogisk ramme i de videregående uddannelser. Ideen er at udvikle en platform for mobil læring, der kan supplere den traditionelle face-to-face undervisning. Studiet anvender aktionsforskning som metode og er baseret på både kvalitative og kvantitative data.

Studiets kontekstuelle ramme er implementeringen af en m-learning platform på et universitet i et udviklingsland. Central University College beliggende i Ghana er blevet udvalgt som en konkret case. Universitetet har omkring 10.000 studerende og 143 lærere, og universitetet besluttede at indføre m-learning på forsøgsbasis sideløbende med udarbejdelse af denne afhandling.

Den teoretiske og empiriske analyse indikerer, at mobile teknologier bedst kan indarbejdes i videregående uddannelse, hvis teknologi og pædagogik sammentænkes teoretisk og i praksis. Anvendelsen af mobile teknologier giver enorme muligheder for produktion, forarbejdning, opbevaring og udbredelse af viden, men teknologien vil ikke fungere, hvis brugerens betænkeligheder i relation til dens anvendelse ikke imødegås ud fra en holistisk synsvinkel.

De analytiske resultater er anvendt til udviklingen af en konceptuel ramme kaldet STUMP-modellen, der kan anvendes i forbindelse med indførelse af mobil IKT inden for videregående uddannelser. Denne model er testet i praksis på Central University College.

Dedication

This dissertation is dedicated to my parents, my wonderful wife and my lovely daughter for their love and support.

Acknowledgement

From a heart overflowing with gratitude, I wish to say; *to God be the glory, great things he has done (M.H.B 313).* Indeed, I can't help but to agree with *Ronald E. Osborn* that unless you try to do something beyond what you have already mastered, you will never grow. To start and finish a doctoral research is not child's play. It demands great commitment and diverse forms of sacrifice, and without the grace of God and the kind support and help of many individuals and organizations, I would not have been able to come this far in my academic life. It has been an elongated insufferable years of hard work motivated by my quest to feed my mind with knowledge for academic excellence. Telling the story today sounds simple, but it was not an easy journey. Nevertheless I pressed on towards the goal; and now with joy I harvest its fruit with a thankful heart and I also agree with the psalmist in Psalm 118:23 that the Lord's has done this and is marvellous.

I would like to gratefully acknowledge the enthusiastic supervision of Associate Professor Morten Falch who accepted to supervise my PhD research. I thank you Prof. for your patience and pieces of advice which shaped up the research and kept me on focus. I am also very much aware and appreciative the uncountable number of meetings you had with me and the sleepless nights you endured for my sake in reading through my dissertation and giving relevant suggestions. Special thanks also go to Professor Knud Erik Skouby Director of Centre for Communication, Media and Information Technologies (CMI) Aalborg University, Anette Bysøe secretary – CMI, Professor Anders Henten – PhD coordinator (CMI) and all the staff at CMI for making my stay and study in Denmark memorable.

Words are inadequate in offering my thanks to Central University College (CUC) and AD-CONNECT Consulting & Software Gh. Ltd (all in Ghana) for the mobile learning project which served as the case study for my research. I will like to use this opportunity to say thank you to the President of CUC, Professor Oduro-Afriyie – former Vice president academics (CUC), Reverend Godson – mobile learning project coordinator (CUC), Dr. Benjamin Aflapkui – Head of department (HOD) physician assistantship, all faculty officers and the entire staff and students of CUC whose mobile learning activities I studied. I thank the CUC Board of regents and academic board for mobile learning pilot project. I thank Mr Adiel Ntuk – CEO of AD-CONNECT for his innovative ideas and earnest support. I also thank Prince Oti Ankrah, Rtd. Captain Joseph Larbie, Chris Umunnabuike, Victor Adigbli and all the wonderful staff of AD-CONNECT for their hard work and sleepless nights in configuring and keeping the mobile learning system working 24/7.

I am also highly indebted to Dr Akosua Hagan – Registrar (WIUC-GH) for the special role she played in making it possible for me to do this PhD. Dr. I thank you so much for all that you had to endure because of me. May God bless you and grant you good health and long life. Another important personality in my life is Dr. George Orleans Ofori-Dwumfuo. This man is my academic mentor and he has really contributed enormously to my academic achievement. Dr. I thank you very much for your encouragement and advice which has made me what I am today. Thank you for being a good man to me.

Another special person who deserves a standing ovation from me is Wendy Wordie – editor of EPP Books Ghana. Wendy, I thank you very much for editing the grammatical construction of my thesis for me. I am very appreciative of what you have done for me.

I will also like to acknowledge and thank Dr. Gamel Wiredu, Dr. Jamel, Reverend Dadebo and Dr Osei Darkwa for being part of my main speakers for the workshops I organised as part of this study, not forgetting Ms Abena Ofei – Head of Research, Ghana Technology University College (GTUC) for the role she played in putting my workshops together.

Also, I thank Srinivas Raju the divisional head of United Telecoms Limited (UTL) training centre, Rashaka, Raja, Ashok, Kundan, Singh and everybody at UTL for making my stay and study in India enjoyable.

I cannot conclude without mentioning Reverend Joshua Kyeremeh and the entire congregation of the United Methodist Church in Denmark for their spiritual and physical support. Special thanks to Mrs Kyeremeh aka "Sofo Mame" for your motherly care.

I would also like to thank all others who have been of some help whatsoever to me, whose names I have not mentioned.

In all I thank God for bringing me this far.

"If it has not been the Lord who was on my side where would I have been"…Psalm 124:1-2

Table of Contents

Figures

List of Tables

CHAPTER ONE

RESEARCH PARADIGM

1.1 Introduction

Effective combination of various educational ICTs is a useful way for expanding educational opportunities (Afshari, Bakar, Luan, Samah, & Fooi, 2009), but most educators find it difficult to identify a combination of ICTs which match pedagogy to enhance instructional delivery. Undoubtedly, the integration of technology into teaching and learning with a definite purpose of influencing education delivery has been going through evolution over the past 20 years (Dias & Atkinson, 2001), (Dockstader, 1999). This is basically motivated by unprecedented advanced developments of ICTs in tandem with educational psychology and philosophical basis for teaching and learning. Several research works and reports on ICTs in education opine that successful ways to incorporate information technology into education for improving educational process is anchored on the understanding of pedagogical and psychological underpinning of education and technology (Benzie, 1995).

Although educational technology is still at its infancy stage of fully permeating the school setting, research has shown that education and technology are growing in a rather faster pace in recent times, shaping each other for excellence (Selwyn, 1999). This to some extent is seen in the use of several forms of technologies in education at various levels, with feedbacks which lead to the improvement of these technologies each day. This inherently has produced the term - Educational Technology (ET) which refers to innovative technologies which are found to be useful for the purpose of teaching and learning. Technology is substantially used in education and it continues to be an influential factor in education delivery, especially in the 21st century. Technology strengthens the dynamics in education by way of broadening delivery options by offering powerful teaching and learning tools to meet various teaching and learning styles.

Notable among educational technologies or technologies used in education are Information and Communication Technologies (ICTs) which are "diverse set of tools and resources used to communicate, create, disseminate, store and manage information." These technologies include the combined use of devices, infrastructure, services and applications software. Notable among these are Desk Top Computers, Laptops, Notebooks, Palm Books, Personal Digital Assistants

(PDAs), Tablets, Smart-phones and mobile phones. Internet, WIFI, 3G/4G Mobile Telecommunication, Blue tooth, and WIMAX as well as Electronic Learning (e-learning) and Mobile Learning (m-learning), Knowledge Management Systems, Learning Management Systems, Student Management Systems and Content Management Systems etc. Application software like Power Point and Interactive Whiteboard and other multimedia applications have also been used tremendously in education.

The proliferation of mobile computers with increased computing capacities over the past few years cannot be over emphasized. The use of these portable mobile computing devices for ubiquitous communication and information processing has brought fluidity into the mobility of people providing seamless interaction and information dissemination anywhere anytime. Most Information System (IS) and Educational research on mobile computers show that students have access to these mobile devices – Smart phones, tablets, note-books and laptops more than desktop computers (Thornton & Houser, 2004), (G. E. Kennedy, Judd, Churchward, Gray, & Krause, 2008), (Hlodan, 2010). The question is how tertiary education institutions can take advantage of the power of mobile technologies through the use of mobile computing devices which is highly adopted and diffused among students to introduce variation and improve teaching and learning.

This introductory chapter unveils the entire research project by discussing the premises of the study in section 1.2, motivation in section 1.3, context of the study in section 1.4, research questions and scope in section 1.5, overview of empirical study in section 1.5.1, research objective in section 1.5.2 and a preview of the organization of the thesis in section 1.6.

1.2 Background

The effective incorporation of educational technologies into the educational system is a complex, multifaceted process which does not involve technology alone, but also include pedagogy, institutional objective and readiness, as well as implementation framework, teacher competencies, and long-term financing, among others (Crescente & Lee, 2011), (Tearle, 2003). This study is intended to help educators in higher education institutions define a framework for the appropriate and effective use of ICTs in their educational systems, so before concluding on my research questions, I conducted an explorative study to gain good understanding to be able to describe and explain what is happening in tertiary education institutions in terms of

implementing and using educational technologies (Annan, Ofori-Dwumfuo, & Falch, 2012). This provided the main ground for this research project which is the overarching issue of effective incorporation of educational technologies or ICTs in tertiary educational institutions (TEI) and its rippling effect on teaching and learning. Over the few decades, demand for higher education has risen beyond the capacity of higher education institutions in terms of infrastructure, staffing, funding, logistics etc. This has resulted in the creation of lots of challenges, including large class sizes with high student teacher ratio (STR). This tends to affect the quality of delivery, monitoring and assessment of students which translates into fallen academic standards in most tertiary institutions. To this end, it is relevant to employ the use of a combination of educational technologies to help remedy the situation. Ways ought to be found to pedagogically implement ICTs in Schools especially since most of these education institutions struggle to successful integrate some of these technologies which have been identified to be useful for teaching and learning (Afshari et al., 2009; Yuen, Law, & Wong, 2003), (Selwyn, 1999).

For example large class sizes can pose a number of distinct challenges which can hinder students' learning and exhaust faculty members teaching the class (Kajander & Lovric, 2005). From a developing country perspective, high ratios of students to teacher in tertiary institutions in most circumstances have almost reduced teaching to resemble giving public speech. For instance, in Ghana some universities have large numbers of students to the extent that some students listen to lectures by peeping through windows. It undisputedly affects teacher & student interaction, learning outcome and overall management of students. This put so much pressure on faculty to actually have time to interact with students to understand individual student and attend to their personal academic problems. Some of these challenges can be mitigated by integrating ICTs in tertiary education to support teaching and learning. However, the problem is the use of technology such as ICTs in schools to promote teaching and learning. In most cases, this has not been as expected, especially with m-learning and e-learning, but effectively incorporating these technologies into higher education will reduce the workload of teachers and make teaching interesting and enjoyable which can help students to learn better (Lennon & Maurer, 2003).

The demand for higher education has over the past years increased tremendously in many parts of the world. This in most countries is due to changes in education policies, unemployment and low salaries of most workers who are non-degree holders. For example, in Ghana, the change

in educational policy in 1987 which brought about the Junior Secondary School (JSS) and the Senior Secondary School (SSS) and also the introduction of the FCUBE program have increased enrolment across board from primary, junior high school (JHS), senior high school (SHS) and tertiary education(George, 2003; Tawiah, 2006). This has mounted great pressure on tertiary educational institutions because of limited facilities and lack of the necessary capacity to handle large numbers of students effectively (Akpotu & Akpochafo, 2009; Sawyerr, 2004). Meanwhile, the desire of most workers and some adults to acquire tertiary education has also increased beyond measure (Blaug, 1985).

This phenomenon is not going to get any better especially since university degree is becoming the basic requirement for employment in most countries; it is therefore necessary for education institutions to explore educational technologies to facilitate teaching and learning in tertiary institutions. Thus, there is the need for the introduction and integration of state of the art educational technologies such as mobile computing and communication technologies to facilitate teaching and learning. This study seeks to identify how mobile technology can be incorporate into tertiary education framework in the form of mobile learning (m-learning) to facilitate student learning, flexibility in teaching delivery and administration, while reducing the cost of instruction and maintaining good quality education.

Numerous research have been carried out in the area of m-learning in an attempt to investigate the role and need for using mobile devices such as smart phone, tablet, notebook etc. for teaching and learning. The uniqueness and relevance of this study is established in the incorporation of mobile technologies that meet the learning objectives and pedagogical strategies of tertiary education, by way of using mobile devices on a m-learning platform for teaching and learning as a tool, intended to address daily challenges of teaching and managing students without compromising on quality, efficiency, reliability and affordability in providing high academic excellence for the 21st century learner and teacher.

1.3 Motivation

It is important to know that the 21st century student do not only think about different things. They actually think differently (Prensky, 2001), and they inhabit a social, cultural, and technological environment, and their learning is a constructive process of acting within an environment full of ubiquitous computing device aided with mobile communication network

which makes content accessible to them anytime anywhere (Cobcroft, Towers, Smith, & Bruns, 2006), (Sharples, 2000), where knowledge is constructed and shared as part of a social process (Johnson, Johnson, & Smith, 1998). A social constructivist view of learning considers that students learn best when given the opportunity to learn skills and theories in the context in which they are used (J. S. Brown, Collins, & Duguid, 1989), (Resnick, 1987), (Soloway et al., 1999). Students then construct their interpretations of a subject and communicate those understandings to others (Gay, Stefanone, Grace-Martin, & Hembrooke, 2001). Mobile technologies, if employed effectively, can support social constructivist approaches to learning. Todd Bryant (Bryant, 2006) sees these technologies as tools to 'expand discussion beyond the classroom and provide new ways for students to collaborate and communicate within their class or around the world'. Equally, the trend towards 'Web 2.0'(O'Reilly, 2007, p. 0), 3G, 4G, mobile applications etc. are characterized by open communication and communities and this is considered as a new wave of innovation for teaching and learning (Alexander, 2006).

The past few years have seen a rapid growth in research, development and deployment of mobile technologies to support learning. Although research in this area began with the seminal work of Kay and colleagues in the early 1970s with the Dynabook project from the Learning Research Group at the Xerox Palo Alto Research Centre (Kay & Goldberg, 1977) it is only recently that both technology and educational needs have converged. The new technology includes multimedia-equipped mobile phones, personal digital assistants (PDAs) and tablet computers; the new emphasis in education is on supporting the learner, in collaboration with peers and teachers, through a lifetime of education, both within and outside the classroom. This new area of personal mobile learning is distinctively different from learning within schools and colleges, and from the traditional notion of continuing education, with its emphasis on equipping people with the skills and knowledge for a rapidly changing society. It also brings with it a need to re-conceptualize the interaction between learning and the design of mobile technology.

Many variants of learning have been espoused from various perspectives reflecting proponents' focus on slices of the multifaceted problem of human development. They also reflect fundamental differences in assumptions of the nature of knowledge resulting in several learning theories such as constructivism, behavioural, Cognitivism, social-constructivism etc. (Dewey, 1895, 2010), (Jerome S. Bruner & Bruner, 1986), (Thorndike, 1932).

What gives the impetus for this study is that most projects on educational technologies especially e-learning and m-learning tend to present these technologies as holistic provision for effective education delivery, but practically it is not totally correct. We must appreciate that educational technology alone does not necessarily advance teaching and learning but well-integrated educational technologies and practices often do. Technology can advance education when implemented with sound pedagogic practices. This study is interested in identifying pragmatic approaches in the use of technology in education by contextualization.

1.4 Context and scope of the study

Over the past decades, excessive theoretical and empirical work has been done and is still on-going concerning the harnessing and effective integration of ICTs into educational systems (Mioduser, Nachmias, Tubin, & Forkosh-Baruch, 2002). The overarching issues are that most education institutions are not able to incorporate and take advantage of the opportunities offered by ICTs to advance their education delivery. Other educational institutions which attempt to incorporate ICTs into their teaching and learning, most often than not fail due to several factors; including but not limited to poor implementation framework and the lack of solid theoretical underpinning for the use of technology for teaching and learning. Granting that, some educational institutions have been successful in effectively integrating various ICTs into their education framework (Mioduser, Nachmias, Oren, & Lahav, 1999), (Venezky & Davis, 2002). The issue of using ICTs that meet the pedagogical needs of both teachers and students still remain and it is a concern to educators, researchers and technology developers (Cuban, 1986), (Schank & Jona, 1991).

We do not need rocket scientist or a poet laureate to know that teaching in higher education institution comes with very different sets of challenges and that educators have no choice but to find ways of appropriating ICTs in schools to mitigate some of these challenges which include but not limited to (a) management of paperwork: handing out, collecting, recording tests and other assignments, make-up works etc. (b) management of distractions: talking, late arrivals, early departures etc. (c) Perceived anonymity of students: difficulty of learning names, of taking attendance, of getting students to come to class, of getting students to participate in class, of getting students to do assignments on time. (d) Lack of flexibility in class activities: difficulty in varying activities, in doing group work, in enhancing critical thinking and writing skills. The effects of all these are reflected in the overall student learning outcome.

For example, if you consider ICTs such as e-learning or m-learning in Ghana, none of the 9 public universities, 45 private universities, 10 polytechnics, and other tertiary education institutes is successful in effectively incorporating these educational technologies into teaching and learning except Accra Institute of Technology (AIT). This thesis aims at obtaining in depth understanding and first-hand information in a contextual natural setting through action research implementation of m-learning platform in one of the above listed universities. E-learning and m-learning platforms in most of the higher education institutions in Ghana, has become white elephants failing to fulfil the intended objectives for implementing them. Among the numerous ICTs used in education, this study's focus is on the use of mobile computing and communication technologies as artefacts for mediating teaching and learning in tertiary education institutions while giving attention to the link between technology and pedagogy (Dede, 1996), (R. Kozma, 2000).

For this reason, this thesis uses a project of incorporating mobile computing devices in tertiary education for teaching and learning in a university in Ghana in sub-Sahara Africa as a case study. It is a private university of a total student population of 10,000 and 143 teaching staff. The aim of the project is to effectively integrate mobile learning into the pedagogic framework of the university to facilitate teaching and learning anywhere anytime. The study is relevant in helping to unearth the problem of using e-learning or m-learning as an educational tool in Ghana to facilitate education delivery to all. For example, out the 54 public and private universities in Ghana, 44 of them are all located in the capital city Accra. This has precipitated the proliferation of distance learning among others to cater for people in other regions of the country. Ghana has a total population of about 25,000,000 spread across ten regions with about 5,000,000 people living in the capital city. See figure 1.1

Figure 1. 1 the map of Ghana with its regions

1.5 Research Question

This whole thesis is founded on the affordance of portable computers & mobile communication technology in education delivery, and the challenge faced by educators in effectively harnessing and incorporating these technologies into their educational framework, to facilitate teaching and learning (Gupta & Koo, 2010). Faculties are faced with numerous challenges, which include large class sizes and high student-teacher ratio (STR). This mounts excessive pressure on faculty, which affects their delivery and students are eventually the end losers. Large class sizes means faculty cannot conduct so much class exercises, home works, assignments, interim examination, cannot assess students properly. Faculty has more scripts to mark, but the appropriate use of educational technologies especially in tertiary education

institutions has the potential of making teaching and learning flexible, less stressful, interesting, adaptive, enjoyable, and above all time saving.

The purpose of this dissertation is to investigate how mobile computing and communication technologies can be incorporated into tertiary education (TE) to supplement or blend traditional face-to-face method with mobile learning (m-learning). To provide seamless ubiquitous teaching and learning using suitable pedagogical framework, which best fits the task of teaching and learning as envisaged by tertiary educational institutions (TEI) without comprising on quality of education delivery, efficiency and productivity. Mobile computers have been identified through research as a fast growing potential technology, which is useful for teaching and learning. The portability and pervasive nature of these devices accompanied with high computing capabilities and powerful communication functionalities makes it more necessary for tertiary education institutions to take advantage of it to find suitable ways of using it to enrich teaching and learning anywhere anytime.

The obligation for the commencement of this research is on the quest to investigate how m-learning can be effectively incorporated into teaching and learning to facilitate tertiary education. To accomplish this objective I address the issue with the question: *How can Tertiary educational Institutions leverage on mobile computing technology such as m-learning platform to effectively incorporate it into teaching and learning?*

The question translates into five sub-questions:

- What are the challenging issues, which obstruct the effective incorporation of m-learning in tertiary education?
- In which ways do these challenging issues affect the implementation and integration of m-learning in tertiary education?
- To what extent is the blend of mobile learning and face-to-face going to enhance teaching and learning?
- What are the challenges of using mobile computing in tertiary education for teaching and learning?
- How should mobile learning systems be designed and developed in other to meet the pedagogic framework of tertiary education?

1.5.1 Overview of Methodology

In an attempt to answer the questions, I used a case study of implementing mobile learning in a university in Ghana. I conducted an empirical field study on the use of mobile computing devices for teaching and learning in tertiary education. This was done in a natural real world setting of a university. The study is concerned with change endeavours to intervene in higher education to bring about partial or major changes in teaching and learning. The strategy of enquiry which was used for this study is action research. I have unequivocally been involved as a participatory action researcher in the incorporation of mobile learning platform in Central University College, playing the role of a facilitator. This afforded me the opportunity to first-hand information on the intrinsic processes and stakeholder's involvement in augmenting traditional face-to-face classroom education with m-learning. The discussion of the study is based on the thorough and exhaustive analysis of the empirical data gathered from the research. *Figure 1.2* is an overview of the research design which was followed to find answers to the questions posed by this thesis.

The study was conducted within a period of three years from March 2010 to March 2013. As shown in figure 1.3, I started with a review of literature which paved way for the identification of a problem definition. I took relevant courses which equipped me in addition to literature. The pilot implementation of the mobile learning platform began in September 2010. The implementation took placed in a linear form with one cycle after the other. Other activities such as observation, interviews, survey, evaluation and conference participation were multi-task which were performed concurrently along with the implementation. There were three cycles involved in the implementation and this was done parallel with the conceptualisation of the STUMP framework.

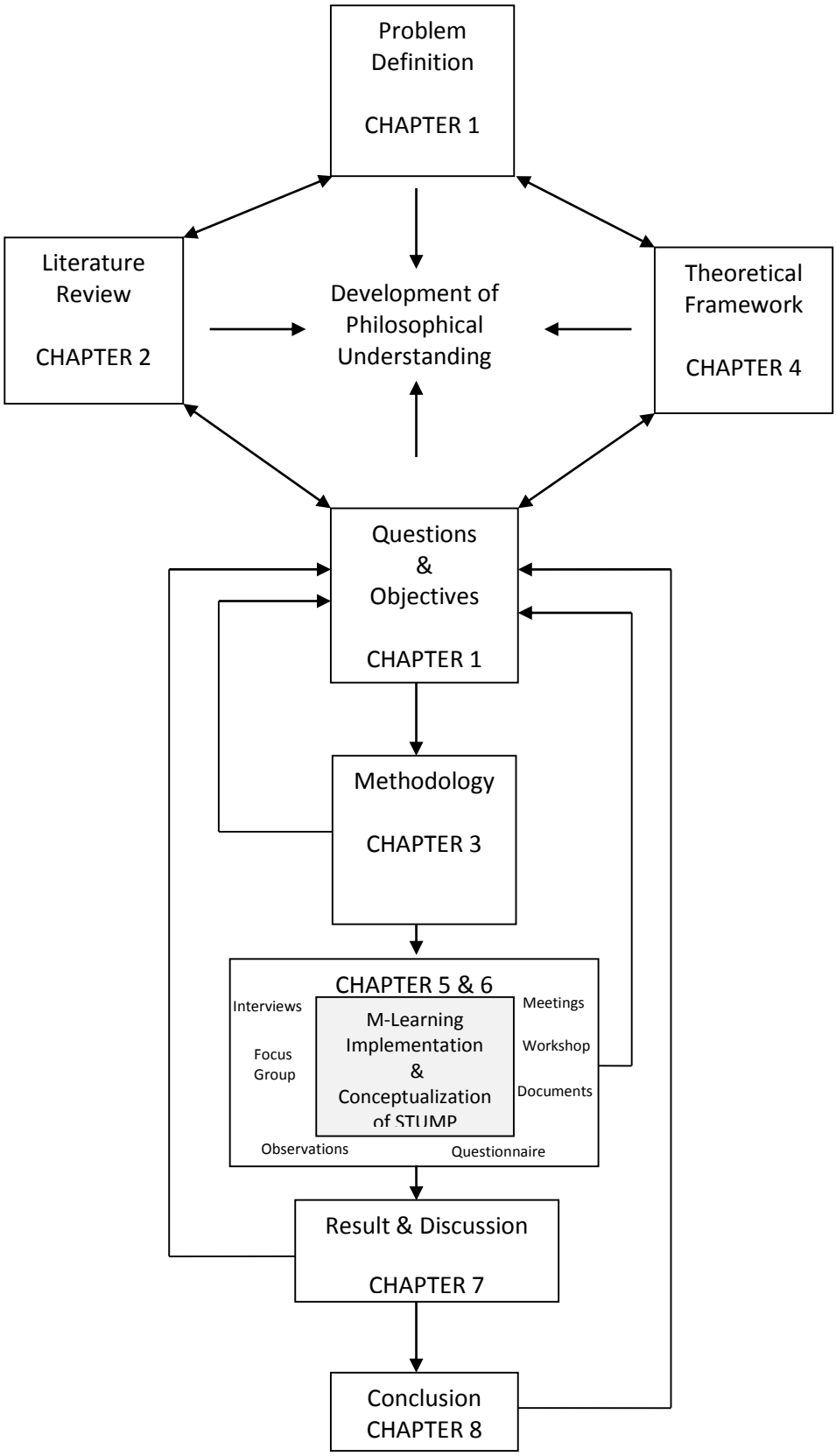


Figure 1. 2 Overview of research design

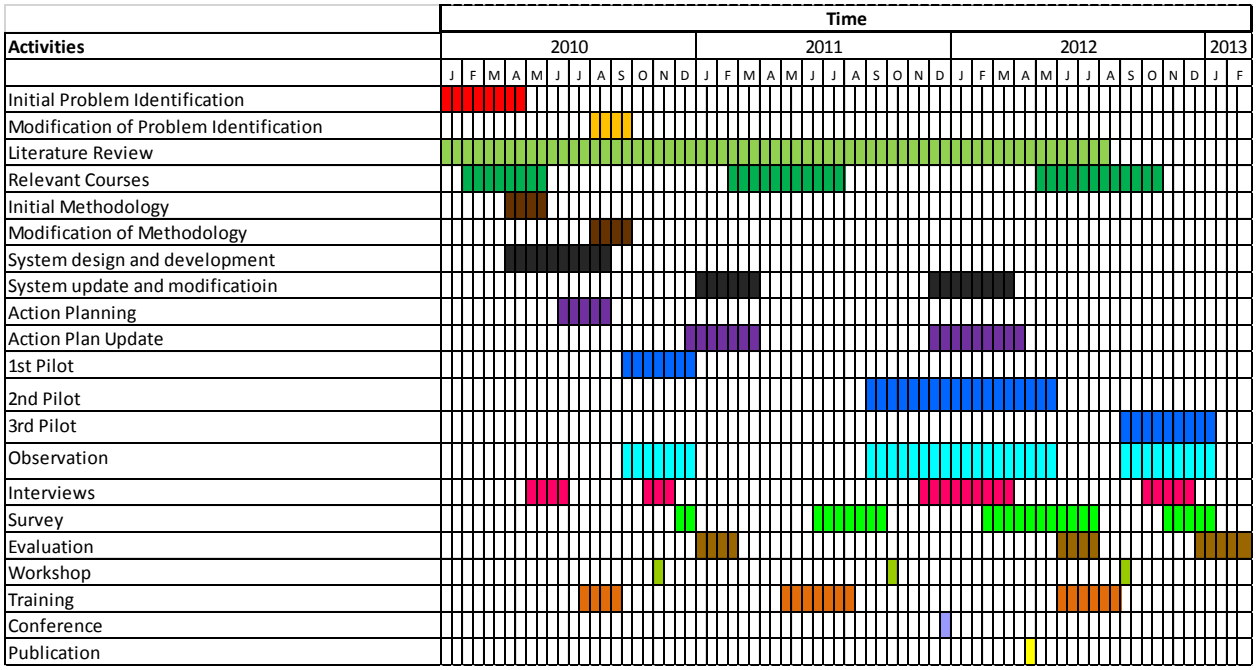


Figure 1. 3 activities and time schedule

1.5.2 Synopsis of empirical study

Mobile learning (M-Learning) is a new learning platform, which was introduced at Central University College (CUC) in Ghana to augment the traditional face-to-face classroom education to facilitate and extend teaching and learning anywhere anytime. The project, which was initiated in 2010 was the first of its kind to be piloted in a university in Ghana. The primary idea was to utilize mobile ICTs in ways, which will be meaningful and helpful within the university's educational framework. Some of the antecedents, which necessitated the project were mobility of academic activities, increased large class sizes, and technology affordances in education delivery in the 21st century among others.

After preliminary investigation, the use of mobile technology in the form of m-learning was adopted by the university to be used as a platform to supplement the traditional classroom teaching and learning especially in this era of increased numbers of students enrolment into tertiary education, which results in large class sizes which in turn affect faculty performance and student learning outcome. The university which was founded in 1997 currently has a population of over 10,000 students and 143 faculty members.

The implementation of the m-learning system was a pilot project which spanned over two and half years from 2010 to 2012. The purpose of the project was to help faculty in managing

paperwork, distractions, perceived anonymity of students while adding flexibility in teaching and learning and more especially to meet diverse teaching and learning styles. The outcome of the project was to help improve performance of faculty, students and administration.

My involvement as a researcher brought a second interest to the project which was to find out how the technology could be leveraged and effectively be incorporated in the school to advance teaching and learning. The project was implemented using action research, which allowed the implementation process to be iterated. By using action research in this study, the researcher and the practitioners had the affordance to learn, relearn and unlearn through the iterative nature of the action process until the desired result was obtained. The diagram below in *figure 1.4* explains the dual purpose of the project with the research interest of gathering empirical data and the practical problem solving interest.

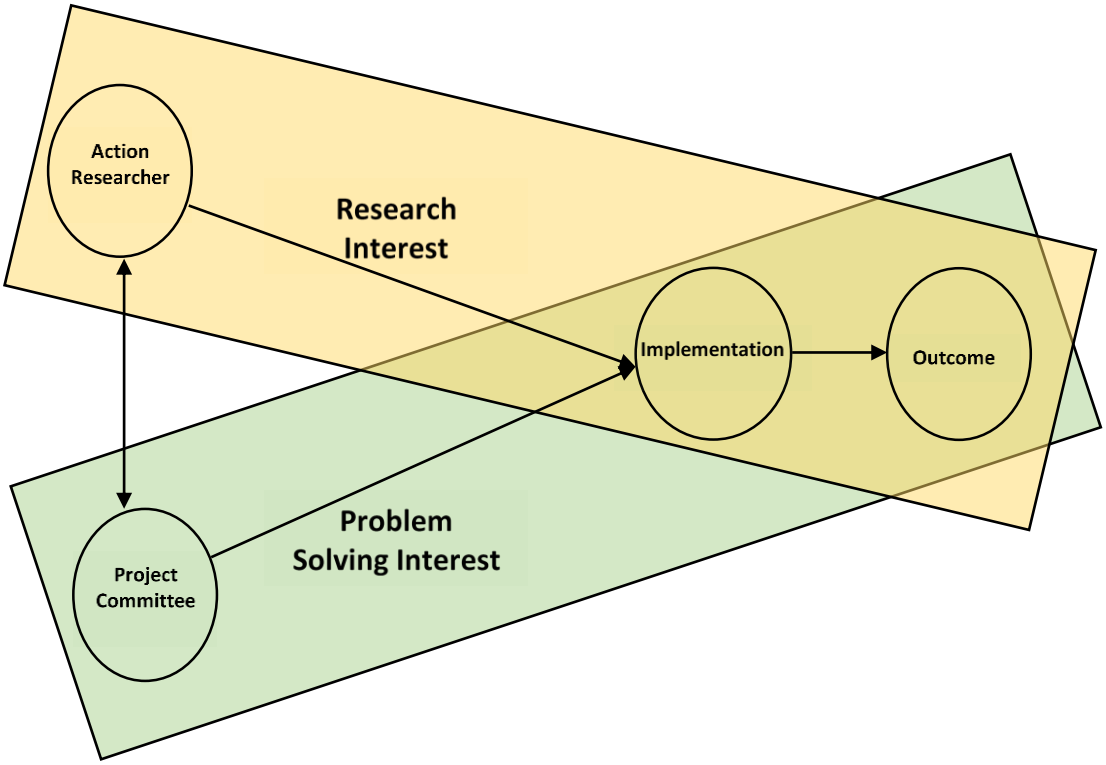


Figure 1. 4 my dual interest framework (An Action Research Perspective)

1.5.3 Research Objectives

Although Information System (IS) and educational technology research in the area of mobile learning, mobile computers and mobile technologies have progressed steadily in the last few years. The use of mobile computing devices in education is still in its incubation stage and as such, there is a knowledge gap in how to effectively harness these pervasive technologies and integrate it into teaching and learning to facilitate tertiary education delivery. This ignites the principal research agenda of this study, which is to investigate how tertiary education institutions can leverage and incorporate mobile technologies using portable mobile computing devices to enhance teaching and learning - linking technology and pedagogy for the advancement of higher education. Thus, the focus of this study is on tertiary education.

The point of departure of this project is to investigate how the use of portable computers such as smart-phones, tablets and notebooks integrated with mobile communication technologies can be used as a tool to enhance teaching and learning anywhere anytime. Various technologies including ICTs such as e-learning and m-learning are being used in education with varied reasons but this study seeks to introduce m-learning platform in a tertiary educational institution to supplement the traditional face-to-face in teaching, learning, conducting examinations, class works, assignments, academic notifications, chats, blogs, monitoring and assessment. Currently, there are several researches on m-learning relating to pedagogy approach, technology, user centeredness, standards etc. A good number of models (Frohberg, Göth, & Schwabe, 2009), (J. Taylor, Sharples, O'Malley, & Vavoula, 2006) have been experimented and tried with numerous m-learning platforms but it is quite difficult to say which of them is the most suitable. However, it is clear that different learners have various perceptions on m-learning; nevertheless a blend of m-learning and traditional classroom has been quite successful.

Looking at the various theories of learning and education (Dewey, 1998), (Piaget, 1952). The theoretical unpinning of the study is rooted in educational psychology of learning theories and educational technologies with a philosophical discussion derived from mobility, blended learning, technology mediated learning, technology enhanced learning, and activity theory. These theoretical frameworks have been used in similar Information System (IS) in education in different ways, which are in line with this study. The study explores these theories and models to understand through investigation, the facilitative role of mobile technologies and

portable mobile computers and how to effectively incorporate them into academic activities to facilitate tertiary education.

1.6 Organization of the thesis

The rest of the thesis is organized as follows:

Chapter two presents literature review of the state of the art of relevant issues which relates to the research domain of this thesis. The chapter begins in section 2.1 – 2.2.6 with an introduction into mobile computing and communication technologies by looking at aspects like hardware, software, service platforms, infrastructure and mobile communication, which fuse them together. This is followed with section 2.3 – 2.9.6, the section discusses education and educational technologies by discussing learning technologies, e-learning and m-learning. Mobility of people in contemporary world, the 'what' and 'why' of m-learning are also discussed. Section 2.3.1 presents the role of technology in education with section 2.3.2 touching on the overview of higher or tertiary education in Ghana. Section 2.4 discusses the e-learning and m-learning by looking at their differences and similarities and also the transition from e-learning to m-learning. The concept of m-learning is discussed in section 2.5 followed with the discussion on 'why m-learning'. Section 2.7 discusses the drawbacks of m-learning. The phenomenon of "anywhere" "anytime" is presented in section 2.8.

The research methodology, which throws light on the scientific approach to the empirical authenticity of the study, is presented in chapter 3. Section 3.2.2 presents a juxtaposition of positivism and Interpretivism epistemology and ontology of the philosophical underpinning of the research approach with an elaboration on the justification of choice of research philosophy. The research design is thoroughly discussed in section 3.5 emphasizing on strategy of inquiry, type of evidence, unit of analysis and data sources. Section 3.6 explains the data interpretation techniques, which we employed in the study. Issues on validity and reliability are discussed in section 3.7 with section 3.8 touching on the ethical considerations of the study. The chapter conclusion is presented in section 3.9.

Chapter 4 presents a discussion on the theoretical framework of the study. Overview of objectivism, Cognitivism and constructivism are presented under learning theories and

frameworks in section 4.2 while section 4.6 pedagogic models and the use of m-learning. Section 4.10 presents the chapter conclusion.

The conceptualisation of the STUMP model is discussed in chapter 5. Chapter 6 carries the heading 'the implementation of mobile learning at CUC' which presents a discussion on the action which was taken to answer the research questions. It begins with an introduction in section 6.1 followed by background in section 6.2 and an outline of investigation process in section 6.3 which explains in details how the study was conducted. Section 6.12 ends the chapter with the conclusion.

Mobile Learning Experience is the heading for chapter 7 which presents the major findings and discussion of the study. The data is subjected to detailed analysis and synthesis. The chapter scientifically presents the outcome of the observations, interviews, workshops, documents and meetings through the investigation process. It gives a comprehensive discussion on the mixed revelations on the use of mobile technologies in education, specifically mobile learning platform for teaching and learning in tertiary education institutions. Section 7.16 gives a conclusion on the chapter.

Finally, chapter 8 is the overall concluding chapter of the entire thesis. It gives a summary of the thesis, presents scientific contributions, limitation and future research and final concluding remarks.

CHAPTER TWO

STATE OF THE ART

2.1 Introduction

This chapter presents a comprehensive discussion on the theme of this dissertation from related literature. The search for literature or state of the art of the entire study is drove by the problem that this thesis seeks to address and the questions leading to the ultimate objective of identifying the cause of the problem and how it can be averted. The discussion encompasses germane discourse in existing literature, which is worth discussing within the context of this study. The chapter is subdivided into four parts. Part one concentrates on the mobile computing and communication technologies and their relevance in supporting education delivery. Part two talks about education technology – with emphasis on m-learning and its use for teaching and learning. Part three discusses the mobility of teachers and students in pursuit of their academic activities with part four presenting an overview of m-learning in Africa and Ghana. Part one begins the chapter by expounding the advent of mobile computing and communication technologies and its implications on education delivery. An overview is presented in *section 2.2.1* followed by *section 2.2.2* with a discussion on the evolution of mobile telecommunication. *Section 2.2.3* presents evolution of mobile devices with *section 2.9.4* touching on software evolution. *Section 2.2.5* discusses connectivity.

Part two starts from *section 2.3* with exposition into educational technology to gain an appreciable level of understanding of the relationship between education and technology. The discussion of technology in this context is limited to ICTs, specifically mobile-ICTs and their use in education. The section advances with the role of technology in education and an overview of higher education institution (HEI) or tertiary education institution (TEI). *Section 2.4* follows with the evolution of e-learning to m-learning. The concept of m-learning and *"why"* m-learning are discussed in *section 2.5* and *2.6* respectively. Part three of the chapter is on mobility. The purpose of this part of the chapter is to elucidate the dichotomy between teaching and learning activities and the use of mobile ICTs by teachers and students as they wander in pursuit of seeking and sharing knowledge. It discusses the role of mobile ICTs in facilitating academic mobility. The following sections constitute the content of this part: *section 2.9.1* – ICT and mobility of humans, *section 2.9.2* – Spatial mobility, *section 2.9.3* –

Temporal mobility, *section 2.9.4* – Contextual mobility, *section 2.9.5* – Fluid mobility and *section 2.9.6* on academic mobility.

The final part of this chapter presents a state of the art of a cross section of m-learning case studies and projects. It provides an overview of m-learning projects from a global perspective and zero in to Africa and Ghana and a chapter conclusion in *section 2.11.*

PART – 1

2. 2 Mobile Computing and Communication Technologies

2.2.1 Overview

The emergence of mobile communication is empowering people, businesses and society; changing the way we live and work (Traxler, 2007). A phenomenon is creating a new culture all over the world. The evolution of telecommunication (see figure 2.1) 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 (Ally, 2009). Unfortunately, most of the time, 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 telecommunication, evolution of mobile computing devices, software development and wireless internet connectivity. It is necessary while discussing mobile learning to consider its technological constituents, which include mobile telecommunication, mobile devices, mobile applications and mobile internet connectivity infrastructure, which are basically the main technology enablers of mobile learning.

Today, the role of mobile communication technology in facilitating education delivery is worth mentioning (Kumar. K & Reddy, 2012); 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 "virtually ubiquitous". This enables 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 (WiFi, Blue Tooth, GPS, GSM, GPRS, EDGE, UMTS, and LTE) (Muyinda, Mugisa, & Lynch, 2007).

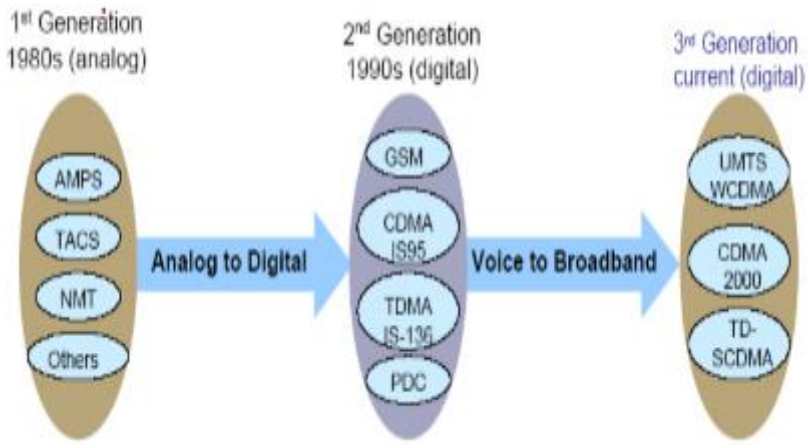
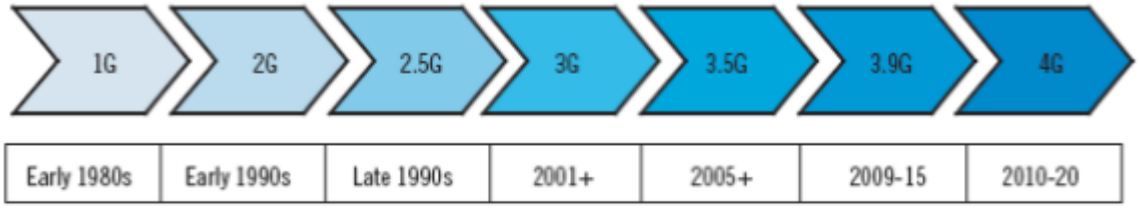


Figure 2. 1 brief overview of the generations of mobile telecommunication from analog to digital
Source: http://www.nqlogic.com/2010/04/broadband-goes-mobile.html

2.2.2 Evolution of Mobile Telecommunication

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 American system which is CDMA (Code Divisible Multiple Access). Unlike the fixed telephony systems. Mobile communication systems have better technologies and are able to support huge varieties of tasks and services. This include but not limited to making calls, Short Message Services (SMS), Voicemail, broadband internet connectivity (Looi et al., 2010), 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 telecommunication 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 (Beaubrun & Pierre, 2001) (John Traxler, 2009a). It frees people from the constraint of boundaries, thus creating a ubiquitous environment to work or learn from anywhere and anytime. Interestingly, GSM and CDMA have different standards and evolution paths, which support different services in their various capacities (as shown in figure 2.2), (Fuentelsaz, L., Maicas, J. P., and Polo, Y, 2008).



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..

Figure 2. 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 (Lazzouni, Yousaf, Qureshi, & Nazir, 1997), radio and television, fixed line telephony and communication, type writer, mainframe computer, desktop computer, laptop, TCP-IP address and the internet technology (Guo, 2010), (White, 1940), with the most recent being the technology of mobile telecommunication and mobile computing devices. Mobile technology is a technology, which perfectly fit 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 anywhere and anytime. For educators, educational technologists, instructional technologists, designers and policy makers to be able to conceptualize and appropriate educational framework, and

pedagogy for m-learning to answers 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 (Bargellini & Bordoni, 2001).

2.2.2.1 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, 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 services like voice, fax, data and internet are provided. As compared to analogue 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 flexible to the requirement of the individual user. All these have 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. 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 date transmission. These evolutions constituted the 2.5G to 2.75. HSCSD is a circuit switch, which increases the 9.6kbps to 14.4kbps. This allows, for example, faster email transfer, file transfer, faster and cheaper web

browsing and data download from the internet. This was further enhanced by the development of GPRS and EDGE (Halonen, Romero, & Melero, 2003). In contrast to HSCSD, GPRS is a packet switch instead of circuit switch 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 on only 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 than that of HSCSD and GPRS. The development of HSCSD, GPRS and EDGE were further steps to mobile multimedia (see figure 2.3).

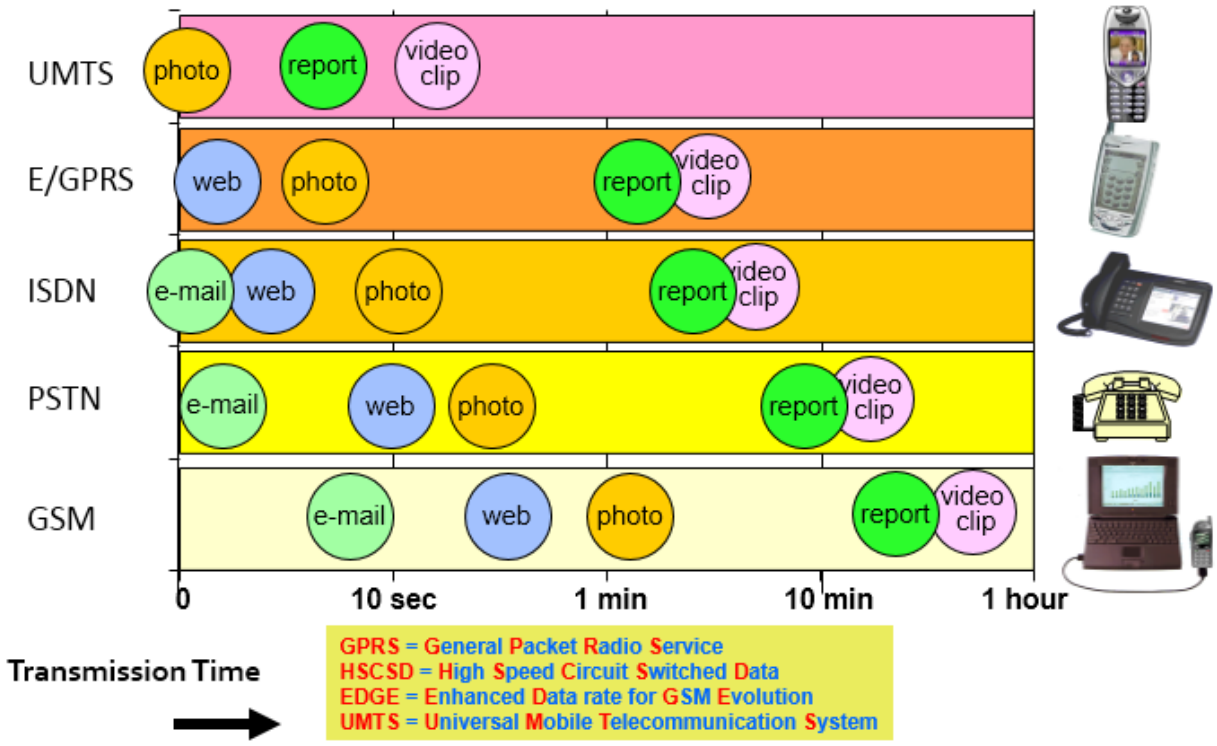


Figure 2. 3 improvement in transmission time and data services as mobile communication evolves
Source: http://dc304.4shared.com/doc/hPn1eLm-/preview009.png

The Universal Mobile Telecommunication Systems (UMTS) represent the 3rd generation of mobile communication, popularly known as 3G, which supports large volumes of data transmission at high speeds. With considerable modification to the existing network, UMTS or 3G can achieve 2Mbps of data transmission (see figure 2.4 & figure 2.5). 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 telecommunication, 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) or affectionately called 4G (Dahlman, 2008)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 toward 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.

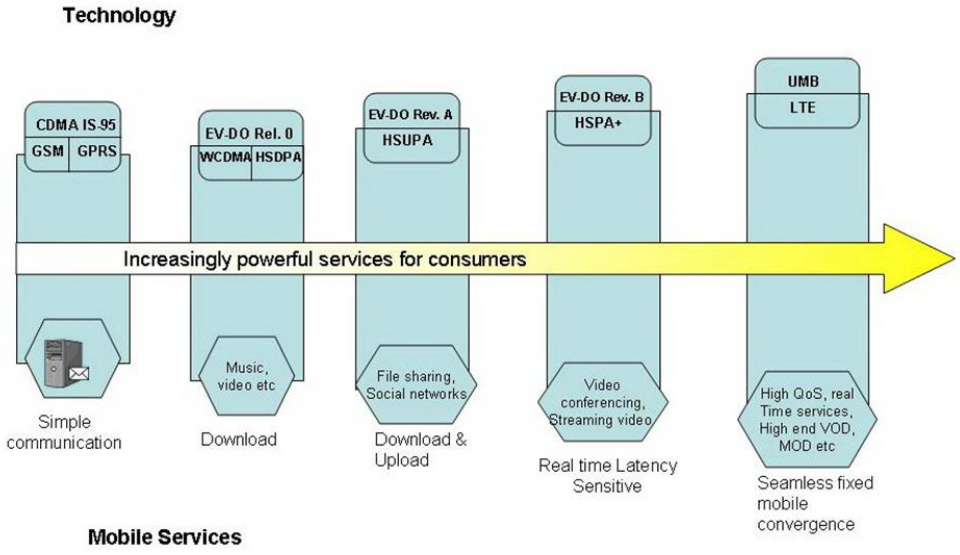


Figure 2. 4 Data rate capacities and how GSM has evolved over the years
Source: http://www.cse.wustl.edu/~jain/cse574-08/ftp/lte/

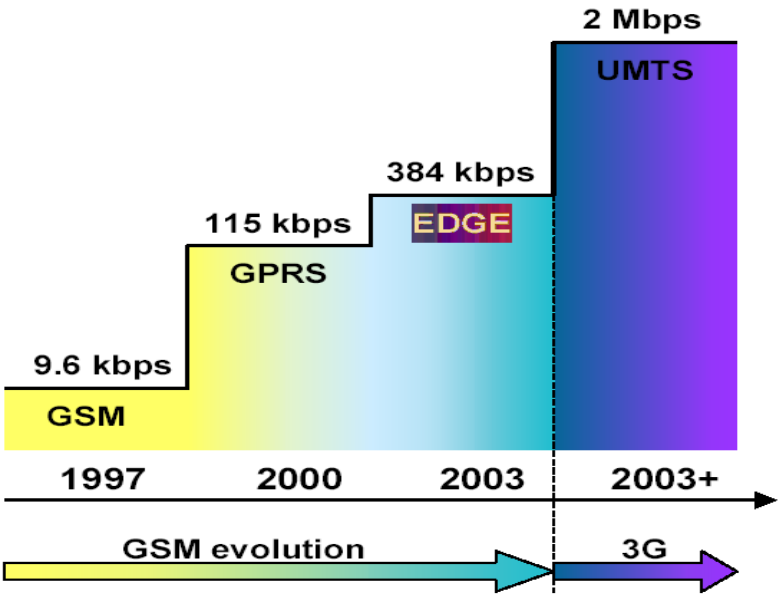


Figure 2. 5 Data rate capacities and how GSM has evolved over the years
Source: http://www.4gamericas.org/index.cfm?fuseaction=page&sectionid=242

2.2.3 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 (Woodbridge, 2011) 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 (Roschelle, 2003). This implies that without mobile devices there will 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 2.6 & 2.7) 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 telecommunication, mobile devices have also evolved over the years from analog to digital and simple to sophisticated (Sevari, 2012). 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 telecommunication 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 device, together with the latest mobile telecommunication 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.

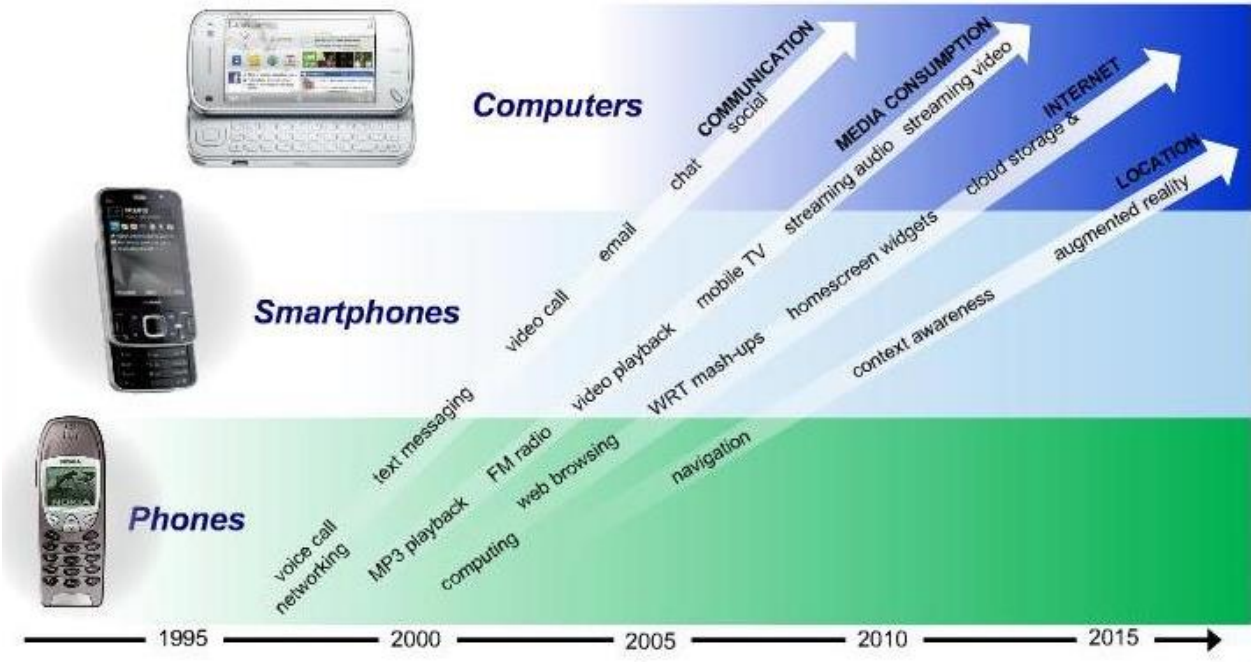


Figure 2. 6 evolution of mobile phone to mobile computer

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

Figure 2. 7 evolution of mobile devices since Martin Cooper made the first call on mobile phone in 1973 up to now
Source: http://propakistani.pk/2011/10/18/38-years-of-cell-phone-evolution/

2.2.4 Software Development

Software is what connects mobile devices and mobile telecommunication 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 telecommunication 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 is 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. Currently, there are many mobile learning applications, which include but not limited to kenexa mlearning, gomolearning, ko-su, mobile moodle and MobiLearn.

The cause of disagreement 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. On the other hand, for educators also to appreciate the pedagogical usefulness of these software to incorporate it into their educational framework. Nevertheless, there are several educational institutions around the world, who are piloting mobile learning, including CUC – Ghana.

2.2.5 Connectivity

The introduction of GPRS and subsequent advancement in mobile telecommunication paved the way for mobile phones and other handheld devices to access data from the internet, which hitherto was not possible. 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 any-time when and wherever internet connectivity is available (Cerf, 1993). 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 (Shim, Varshney, Dekleva, & Knoerzer, 2006) as shown in figure 2.8.

The internet, just like telecommunication and mobile devices has evolved over the years with the invention of TCP-IP by Vinton G. Cerf and Robert E. Kahn in the 1970s (Leiner et al., 1997) which has transformed communication among 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.

Figure 2. 8 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

2.2.6 Section Summary

The thrust of the discussion is that m-learning is facilitated by three main elements which I have named as the "Ms in Mobile Learning" - (i) mobile telecommunication (ii) mobile computing devices and (iii) mobile software applications as shown in figure 2.9. The combination of these three elements is what constitute m-learning platform which makes it possible for teachers and students to seamlessly teach and learn anywhere 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.

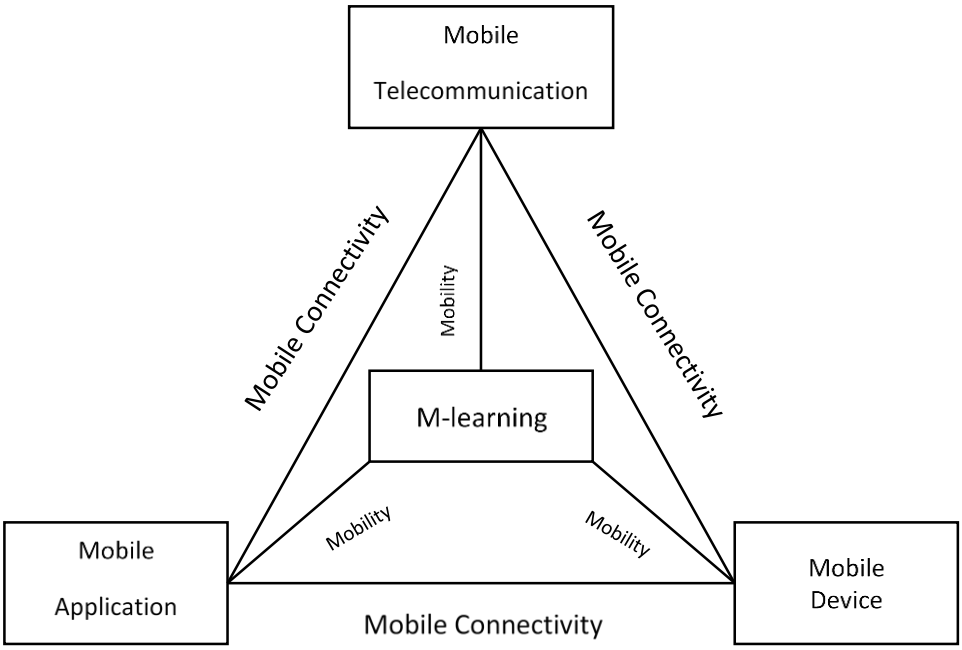


Figure 2. 9 the Ms in Mobile Learning

PART 2

2.3 Educational Technology

Growth in science and innovative technologies and their use in the organisation and management of the processes and products of education have yielded great benefits. This use of technology in education, popularly known as education technology, has great ability to offer better output in the process of teaching and learning (Mangal, 2009). Educational technology as the name implies is an amalgamation of two distinct components. That is education and technology and both of them have been in concurrent perpetual progressive evolution from

generation to generation and century to century with the aim of identifying the most suitable, appropriate and developed technology (both hardware and software) to serve the educational needs and purpose of students and the society at large at any-time anywhere possible.

Educational Technology (or Instructional Technology) could be traced back to the beginning of early learning and teaching tools such as cave walls, scrolls, codex, printing press, educational films and Sidney Pressey's mechanical teaching machines in the 1920s ("Educational technology," 2013). But it is popularly recognised as a post-Second World War phenomenon which sought means of improving teaching and learning (Ely, 2008). This started with audio-visuals, which included films, TV programs and other media. The whole idea was theoretically influenced by the basic paradigm of communication processes where a sender sends a message through a communication medium to a receiver while the receiver also sends feedbacks to the sender through the same communication medium (Schramm, 1997), (Shannon, Weaver, Blahut, & Hajek, 1949) and (Berlo, 1960). This phenomenon was likened to the process of teaching and learning where the teacher communicates to the student and vice versa. This in the broader contest was influenced by works of (Skinner, 1954, 1960), (Glaser, 1965), (Glaser, 1976), (Gagne, 1970), (J. S. Bruner, 1966), (Lumsdaine, 1964), (Mager, 1962) and (Papert, 1980) in behavioural psychology, cognitive psychology and constructivist philosophies of learning.

Educational technology can be explained as the study and ethical use of appropriate technologies to facilitate and improve learning and teaching performances (Richey, Silber, & Ely, 2008). The term educational technology and instructional technology are sometimes used interchangeably by researchers. Depending on what they want to emphasize. The Association for Educational Communications and Technology (AECT) provides one definition for educational and instructional technology as the theory and practice of design, development, utilisation, management, and evaluation of processes and resource for learning (D. R. Garrison, 2011). But in their separate meaning, most often educational technology is considered as a broader term, which is usually associated with and involves instructional and learning theories (Lowenthal & Wilson, 2010), whereas instructional technology is defined by Mangal and Mangal (2011) as a subsystem of educational technology, which helps the instructor or the learner himself as a part of his self-learning or auto instruction, by determining the media, methods and material for the realization of the stipulated instructional objectives in a given teaching-learning situation.

Educational Technology in the broader context consists of human and non-human resources including hardware, software, systems, methods of organisation, techniques and an array of tools, which might prove to be helpful in enhancing teaching and learning. These include but not limited to overhead projectors, smart boards, computers, smart phones, tablets, internet, e and m learning platforms, video conference facilities, and software application tools as well as electronic and online libraries. The combination of educational psychology and technology have brought forth several models and frameworks, which provide guidelines for the use of educational technology. Some of these models include but not limited to Computer Based Training (CBT), Computer-Assisted Instruction (CIA), Computer Supported Collaborative Learning (CSCL), Electronic Learning (e-learning), Mobile Learning (m-learning), Blended Learning (BL), Computer Mediated Communication (CMC), Technology Mediated Learning (TML), and Computer Based Learning (CBL) and Mobile Computer Supported Collaborative Learning (MCSCL).

2.3.1 The Role of Technology in Education

Technology is very broad, but this study is particularly concerned with Information and Communication Technologies specifically, *mobile-ICTs* which are identified from literature to be useful in advancing the cause of education delivery. Currently, the rapid development and improvement in the computing and communication power of information technology is gradually transforming the culture of teaching and learning. (Guy, 2009). This has given rise to new opportunities that are fast growing in the area of technology application in education. These technologies range from simple and easy to use stand-alone application tools, to sophisticated network based systems for teaching and learning. Information and Communication Technology is an innovative phenomenon which offers great opportunities to improve business operations including services, product development, delivery schedules, communication and management (Tearle, 2003). Although the education industry is yet to take full advantage of the tremendous opportunities offered by Information and Communication Technologies for teaching and learning. Many organizations including manufacturing industries, financial businesses, consultancies, civil engineering and construction, journalism, transportation, sports, music industry, broadcasting and security took immediate advantage and have been enjoying the goodies of the Information Technology in promoting effectiveness and efficiency in production, management and service delivery.

Information and Communication Technology is not only useful for economic reasons, instead it spreads educational opportunities to people (students) who otherwise would not have been reached (McDonald & Gibbons, 2009). Technology in education coupled with appropriate pedagogical strategies engage students in cognitive processes and creates flexibility in the educational system to include a broad range of learning outcomes (Lim, 2007), (Jonassen & Carr, 2000), (Kearney & Treagust, 2001), (Oliver & Hannafin, 2000).

Different technologies may offer different affordances and would have to be used differently within a particular educational context to yield the required result. One of the ways to appreciate and understand the role of information and communication technology in education delivery, is to see the computer applications tools and platforms as mediating artefacts, which helps in creating content, engaging students, modelling styles, and assessing learners' performance in ways similar to how an artisan would use a hammer, screwdriver, ruler and measuring tap to accomplish his or her goal. The relevant points in this analogy are (1) the tools make the job easier and (2) the result is of higher quality than possible without the tools. The effective uses of these tools are found in conceptual frameworks which describe the relationships among learning theories, pedagogic approaches, instructional designs and education technology (Dede, 2008).

The rapid advancement in information and communication technology and its use in education to receive, create and share knowledge is transforming the learning styles, interest and preferences for students of all ages (Dede, 2005). According to (Dede, Whitehouse, & Brown-L'Bahy, 2002), the use of educational technology such as ICT positively affects students' participation and their individual cognitive processes for analysing and understanding content. It improves their learning experience and complement other delivery modes, including face-to-face. For example, online forum and discussions deepens quality conversations among students than they experience in traditional classrooms. It allows students who are normally silent and passive in face-to-face classroom to express their views and participate. In bigger universities with large class sizes, as posited by Dede et al, it enable students to get to know colleagues whom they might not have had the opportunity to personally interact with in a classroom setting.

Technology in education is a versatile cognitive instrument, which can be better visualised as sets of tools which can support learning in different ways. According to (Kozma, 1991), there are some unique characteristics of information technology, which are necessary to teaching and learning which include (a) speed of processing information. (b) The way in which it categorizes and processes information. (c) Its transformation capabilities in converting text to voice or from equation to graph and (d) the way in which it can help novices to create and improve cognitive processes as experts would do. The use of technology in education offers learners the chance to take charge over their learning. Technology has the ability to lessen the dependence of students on the teacher, which may release the teacher of time and increase the student's repertoire of learning skills and allow greater student autonomy. This implies that, with technology, students can realize their role in learning and help to prevent teaching to be performed by teachers as an act of transmitting information to passive learners.

The use of technology changes the teacher's responsibility to secure the freedom, time and mental capacity to lead and affect more of the learning process and also perform increasingly as 'enablers of quality learning experiences'(Somekh & Davies, 1991), (Russell & Bradley, 1997). This allows greater opportunities for teachers and students to engage in communication, which generates mindful, deliberate deployment of cognitivism. As a result of this change in the nature of interaction, the roles of teachers and learners can become less distinct. The integration of any form of 'educationally' useful technologies into schools affects its functioning in different ways in facilitating new configurations of learning spaces and innovative teaching methods.

The development, adoption and diffusion of information and communication technologies in education over the past years has been reckoned as a major contributor to facilitating and making education delivery relatively effective, efficient and easily accessible anywhere anytime (Riddell & Song, 2012). Educational technologies progressively play an important role in teaching and learning both within the walls of the traditional classroom and outside, because it presents students with a new way of learning, coupled with modern, sophisticated and pervasive learning technologies. The adoption of any kind of ICT deemed to be useful in a given educational context by educators constitutes an essential part of the process of transforming teaching and learning from being a 'closed activity' in the 'black-box' of classroom into an open, flexible, enjoyable, interesting, situational, engaging, interactive,

constructive and collaborative as well as active activity connected to real life and mediated by appropriate technologies to achieve an overall educational objective.

Information and communication technologies have been considered as potentially useful enabling tools for educational change and reform (Tinio, 2003). The appropriate use of 'combination sets' of ICT are helpful in expanding access to education and foster the importance of education in todays' knowledge society. In recent years, ICT has been gaining momentum in permeating the education sector for the purpose of advancing teaching and learning (Cuban & Cuban, 2003). Technology is much concerned with 'designing aids and tools to perfect the mind'(A. L. Brown, 1994), mostly to extend the reach of education.

2.3.2 Overview of Higher or Tertiary Education in Ghana

The term tertiary or higher education means the same thing, they are synonymous and are used interchangeable from country to country. Tertiary institutions generally have relatively larger numbers of enrolment than primary and secondary schools. Tertiary education all over the world is referred to as the third level of education. It is the next level of education after a successful completion of primary and secondary education respectively (Bakvis & Cameron, 2000). Tertiary or higher education generally include universities, community colleges, and polytechnics among others. Unlike primary and secondary education which are compulsory in many parts of the world, tertiary or higher education is not (Brick, 2009), (Forest & Kinser, 2002). Normally young adults of 18 years and above and other adults voluntarily enrol in tertiary education institutions to acquire higher knowledge and skills that will make them competitive and employable. Although people with secondary education can gain some level of jobs, tertiary education certificate is basically the entry requirement for most good jobs with good salaries and better working conditions around the world. People with higher or tertiary education are more likely to be employed starting from middle management level upwards.

Educational frameworks for tertiary or higher educational institutions are entirely different from that of primary and secondary educational institutions. More often than not, tertiary education institutions are autonomous, thus different tertiary education institutions have diverse educational objectives and pedagogical strategies. Common to all tertiary education institutions is for them to nurture students to become people with good analytical skills, over the ability to memorize because they serve as an exit point from academia and an entry point

into the job world. The certification requirement by employers has propelled most students who finish secondary education to aim for tertiary education and also other adults who are already employed but do not have tertiary education are now compelled to go back to school to enable them firmly secure their jobs, so that fresh graduates from the university and other tertiary institutions would not render them redundant in the work place.

The role and importance of tertiary or higher education for sustainability and development of society can by no means be under estimated. In fact, the prevalent acknowledgement that tertiary or higher education is a key driver of economic competitiveness in a progressively knowledge driven global economy has made tertiary education more relevant than ever (Santiago, Tremblay, Basri, & Arnal, 2008). Tertiary education is the platform for training and developing manpower to build the needed human resource capacity to meet the workforce needs of government, private and non-governmental organisations for nation building. Acquiring higher education is therefore fundamental to individuals' development and society at large (Greene, 1988).

Tertiary education institutions have good systems and structures for teaching and learning and disseminating knowledge to the general public through traditional face-to-face lecturing, project, research, forum and public lectures, but it is also necessary to be abreast of time so as to be able to adopt modern ways of teaching and learning and disseminating knowledge in a more meaningful manner than before. There are several identified ICTs available, which are appropriate for teaching and learning in tertiary institutions to facilitate education delivery. Today's learner is exposed to a lot of technologies which need to be harnessed for a meaningful purpose such as teaching and learning. It is inevitably necessary for tertiary education institution to emancipate itself from some of the traditional ways of teaching and learning which are not helpful to today's student to allow for the use of appropriate educational technologies so that the students will be well equipped and conversant with technology when they actually enter the job field.

In Ghana, for example, National Accreditation Board (NAB) (NAB, 2013), National Council for Tertiary Education (NTCE) ((Ghana), 1999), Ministry for Education (MoE) are responsible for ensuring that tertiary education institutions adhere to standards of best practice and deliver good quality education to produce graduates. Ghana is a developing country with a middle income status with education as one of its main challenge to economic development. The

government recognizing the relevance of ICT in education has made policies such ICT4D, ICT and has established NITA as an agency to ensure the use of ICT for the purpose of promoting education delivery in Ghana. Recently the government of Ghana embarked on an ICT project which contracted rLG company ("rLG Distributes 'Better Ghana' Laptops," 2012) to distribute laptops to every tertiary education student to facilitate their use of ICT in supporting teaching and learning.

2.4 E-Learning (electronic learning) to M-Learning (mobile learning)

2.4.1 from e-learning

The revolution of learning through innovative technologies gave birth to e-learning as an attempt to improve education delivery (Clarke, 2002). E-learning basically consists of all forms of electronically supported teaching and learning, which are procedural in character and aim to effect the construction of knowledge with respect to individual experience, practice and knowledge of the leaner (Tavangarian, Leypold, Nölting, Röser, & Voigt, 2004). This refers to the utilisation of electronic technology for teaching and learning either inside or outside the traditional classroom. E-learning as a concept has fragmented definitions but the meanings of all the definitions are not so much different. The focus of our discussion in this study is not to try to define e-learning, but to explain it in relation to its relevance to teaching and learning, and how it is evolving and transforming knowledge acquisition in todays' world. The 'e' in the term 'e-learning' stands for electronic which implies a computer or a network-enabled computer platform used to acquire skills and knowledge asynchronously or synchronously, which previously were not possible (Trombley & Lee, 2002), (Gotschall, 2000; Wilson, 2001).

One of the purposes of e-learning is to create a system to support education delivery that is not constrained by time, space and location to make teaching and learning ubiquitously available anywhere anytime. Although it is an emerging educational technology, there are thousands of e-learning application systems and platforms with hundreds of thousands of courses and content available via the World Wide Web (www) protocol. Many schools either use e-learning to supplement traditional classroom learning (i.e. blended learning) or only the e-learning platform is used for teaching and learning; this is common for distance learning among universities. E-learning is an innovative means of empowering learners with the skills and knowledge they require in a convenient time and space (Omwenga & Rodrigues, 2009).

Traditionally, the design of e-learning is concentrated around the use of desk top computers and laptops connected to an online learning portal via internet. These limits e-learning in terms of mobility and technology, making it relatively difficult for learners who are highly mobile to carry along their desk top computers or laptops with them everywhere they go at any time (Chikh & Berkani, 2010). This and other limitations coupled with technology advancement in mobile computing and communication technologies paved way for a new technology called mobile learning (m-learning). In as much as traditional e-learning is all over the world with several projects, it has still not reached the level of success that is anticipated by its advocators (Kahiigi, Ekenberg, & Hansson, 2007). This problem is even heightened by the emergence of m-learning, which has brought about divided attention, making it difficult for researchers to decide on which way to go (Engelbrecht, 2003). Especially since the traditional e-learning as a 'baby' is yet to grow 'teeth'. But all indication from literature shows that the rapid advancement in information technology in the area of mobile computing and communication is revolutionizing the traditional e-learning into what is called 'mobile electronic learning' or 'mobile e-learning'(Traxler, 2009b), taking learning away from a fixed location restricted by wire or cable connectivity.

2.4.2 to m-learning

Mobile learning is the latest educational technology phenomenon that employs the use of mobile computing device such as tablet PC, smart phone and other handheld devices to make learning flexible, portable, spontaneous, personal and above all exciting. The high rate of adoption, diffusion and use of mobile technology across all age and group of people embedded with great interoperability and pervasive wireless connectivity makes mobile learning unique from other technological innovations of the past. The escalating rate of mobile learning research and projects are due to the educational and pedagogical needs of flexibility and the ubiquitous demand for learning. The applause of mobile learning can partly be accredited to the high penetration of mobile technology and its availability for application penetration (Ryu & Parsons, 2009). It is a new phenomenon, which has evolved through the rapid growth of mobile ICT, which provides a learning experience which exceeds what the classroom is able to offer, with the latest generation of technologies, such as tablet PC, smart phone, and smart chips with input and output features including freehand annotations, picture snapshots and video and audio give a learning experience which is boundless.

Perpetual spreading of portable computing devices is tremendously having an impact on people's daily lives in space and efficiency of everyday life and giving sufficient flexibility in all aspect of human activities. According to Ryu and Parsons, this phenomenon is giving rise to enormous opportunities to engage the use of mobile technologies in a broader context. Teaching and learning with mobile technologies, to some extent, is helping to broaden the scope of the educational sector in diverse ways, which were not possible a few decades ago. The simultaneous changing in society and ICT development are serendipitously giving birth to a new way of teaching and learning that are open and not limited to only traditional educators, but it is important to acknowledge that educational institutions work within a certain framework including pedagogic which are intended to ensure holistic education delivery. The advancement in mobile technologies is a duty call to educational institutions to do a review of their teaching and learning philosophy so as to be able to take good advantage of the educational opportunities in using mobile technologies.

The assumption of teaching and learning using portable or mobile computing and communication devices gives users new experiences in education either formal or informal, which is different from those offered by classical desktop computer-based learning system (a.k.a e-learning). According to Vavoula and Sharples, 'learning is mobile in terms of space, that is, it happens at the workplace, at home, and at places of leisure; it is mobile between different areas of life, that is, it may relate to work demands, self-improvement, or leisure; and it is mobile with respect to time, that is it happens at different times during the day, on working days or on weekends' (Vavoula & Sharples, 2002).

The most essential feature in the whole mobile learning concept is '*mobility'*. That is, allowing learners to be in contact while outside the reach of conventional communication spaces. Contrast to other e-learning or traditional classroom environments, mobility enables learners access to knowledge resources where and when they need them. This convenience contributes positively to students' autonomy. We can conceptualise '*mobility'* in different ways; mobility of the user, mobility of the device, and mobility of services. The issue of mobility is an essential ingredient in m-learning, because learners must at any point be able to participate in educational activities irrespective of the physical location they find themselves, bearing in mind that the interest to use the mobile device to learn outside a classroom or in any other place is partly motivated by portability, lightweight, small size and convenience to carry it around with

relative ease for both communication and educational purposes, utilising its spontaneous features to get access to unlimited information.

Mobile learning does not have one unified definition; rather, researchers have attempted to define it from different perspectives. One of the early definitions of m-learning by Clark Quinn focuses on the mobility of the technology, describing it as 'e-learning through mobile computational device including palmtops and cell phones' (Quinn, 2000). Focusing on the technology, John Traxler defines m-learning as 'any educational provision where the sole or dominant technologies are handheld or palmtop devices' (Traxler, 2005). O'Malley et al, defines it as 'any sort of learning that happens when the learner is not at a fixed, predetermined location, or learning that happens when the learner takes advantage of learning opportunities offered by mobile technologies' (O'Malley et al., 2005). All these definitions hold true for m-learning, but today if any attempt is made to re-define it, it will obviously include new devices like tablet PC among others, which combine several communication and storage facilities in a single portable device. M-learning is the next level of e-learning. It converts less ubiquitous e-learning into seamless ubiquitous e-learning. Figure 2.11 shows that m-learning is a part of e-learning (Peng, Su, Chou, & Tsai, 2009) and figure 2.10 shows that m-learning have an unlimited space for interaction which is seamless in society.

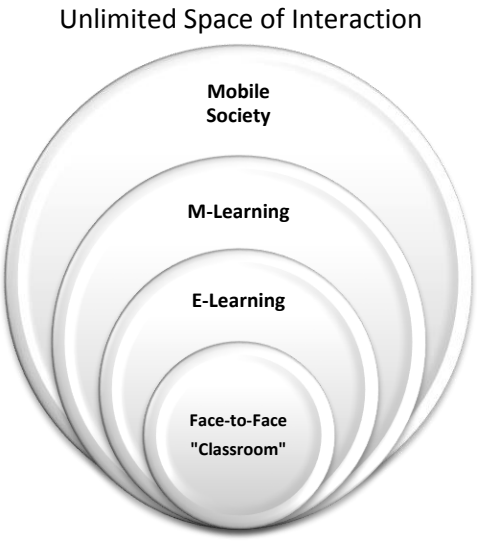


Figure 2. 10 space in terms of learning
Source: (Annan et al 2011)

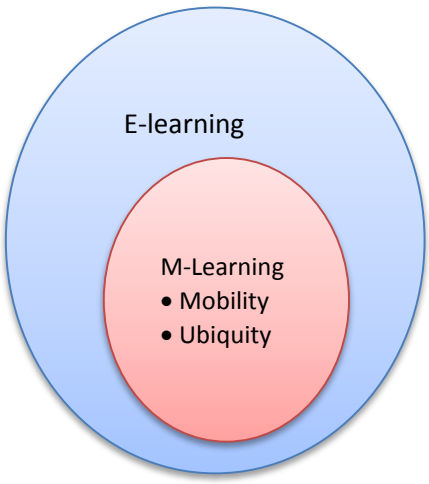


Figure 2. 11 m-learning as part of e-learning
Source: (Peng et al 2009)

For example, from literature review, some of the major premises of m-learning in Africa are that m-learning is a supportive mode of education, and not a primary mode of education. M-learning provides flexibilities for various learning and life styles (Keegan, 2004). The following are common use of m-learning in Africa (Keegan, 2005):

1. **Mobile learning for academic administration:**
   This provides universities and other institutions with structures to send SMSs to all their students, or all students in a particular grouping about timetable changes, examination deadlines, assignment results, and changes of procedure that all institutions need to immediately communicate to their students.

2. **Mobile learning for summaries:**
   Academic summaries of content, examination hints, assessment questions for course revision, guidelines for particularly difficult parts of a course or counselling provision for students in need.

3. **Complementary module mobile learning:**
   This mode provides m-learning platform for students and teachers as supportive platform to the traditional classroom, making teaching and learning accessible after normal school hours anywhere, anytime.

4. **Full module mobile learning:**
   This is the presentation of full courses, or full modules of courses, on mobile devices for distance learning, without students' necessarily going to the classroom.

2.5 The concept of m-learning

The conceptualisation of m-learning takes its root from Alan Kay's Dynabook concept in 1968 (Barnes, 2010), (Gookin, 2008). His idea was to develop a personal computer for children of all ages, by way of making a thin portable computer, which is highly versatile and with less weight. This conception led to the development of the Xerox Alto prototype (Ebert & Gershon, 2012). It was made up of several elements including graphical user interface and multimedia. From the Dynabook project we have steadily moved from desktop computer to laptop, notebook, palmtop, PDA, eReader, smart phone and more recently tablet PC (Hsieh, Chen,

Luo, Lu, & Huang, 2011) (as shown in figure 2.12) which makes it possible for the Dynabook concept to be extended to all – both children and adult. The Dynabook is the basis for contemporary e-learning or m-learning. Educationist and researchers also contributed enormously by grounding m-learning in educational psychology theories of learning to make it pedagogically relevant for teaching and learning, thus theorising m-learning as a phenomenon for education delivery. The notion of using mobile device for teaching and learning is complexly rooted in technology portability and mobility, human mobility, pedagogical needs, ubiquity of technology, wireless network and communication. Consequently, the concept of m-learning is based on the fact that Teaching or learning is activity which is communicative or conversational in nature mediated by artefacts as posited by Engestrom's activity theory. It is a seamless utilisation of mobile and communication technologies as mediating artefacts to meet the educational needs of people from anywhere at any time.

Figure 2. 12 Different portable computing devices in the hands of today's learner
Source: http://www.tidesinc.org/mobile-learning/

2.6 Why m-learning?

Technological advancement of hardware and software in mobile computing and communication has brought about a new culture which affects the way people think, act, relate to others and interact within their environment and the world at large (Fuentelsaz, Maícas, & Polo, 2008). Although the original manufacturing purpose of mobile devices were for wireless communication, it's continuous and explorative use has serendipitously given birth to new ways of using mobile devices for educational purposes. Users saw the potential of using their

mobile devices to do so many useful things apart from the core communication function (Huang, Chiu, Liu, & Chen, 2011). This caught the attention of designers and developers of mobile devices and has since worked tirelessly to improve the computer power, functions, battery strength, screen size and weight among others to meet user needs which includes mobile learning. The use of mobile device in education makes it possible for teaching and learning to take place anywhere anytime. It offers students with seamless 'just-in-time' learning.

Mobile technology is one of the technologies enjoying high adoption and diffusion rate among all age groups in all parts of the world. Almost every student has one kind of mobile device or the other, which keeps him or her connected to friends and other people and information resources via mobile broadband internet. The portability of mobile devices coupled with its availability, interoperability, functionalities and educational usefulness makes it necessary for educators to find ways and means of making teaching and learning available on these ubiquitous devices in the hands of students. A few years ago, effective and efficient use of mobile devices for teaching and learning was not easily possible because of some drawbacks, but today, majority of these drawbacks, which included screen size, battery life, keyboard etc. have been rectified.

The spread of advanced mobile computing device is gradually taking m-learning from a research-led pilot project to an everyday activity where mobile devices are becoming personal tools, aiding people to learn anywhere and anytime either formal or informal (Kukulska-Hulme, Traxler, & Pettit, 2007). Using mobile devices for teaching and learning creates opportunities for seamless learning experience which strengthens Technology Enhance Learning (TEL) by way of augmenting physical space, leveraging topological space, aggregating coherent across all students (Jeremy Roschelle & Pea, 2002). According to (Chan et al., 2006), the space of social-cultural development aided by ubiquitous devices is fast affecting and shifting the way students learn within and outside school environment, this brings the issue of m-learning to the fore. M-learning is necessitated by diverse technological and human factors, which include but not limited to (1) ubiquitous access to mobile, connected, and personal handhelds (2) the relentless pace of technological development in one-to-one computing, and (3) the evolution of new innovative uses of mobile computing devices. This supported by learning theories is influencing the nature, process and the outcome of learning and has opened a new door for teaching and learning, characterised by seamless learning space, which allow learners to learn anywhere anytime just-in-time by seamlessly switching between

different contexts such as formal and informal, individual and social learning with the opportunity of extending the social spaces in which learners interact with each other.

2.7 M-Learning Drawbacks

Mobile computing and communication technologies for the purpose of teaching and learning is faced with a lot of challenges, some of which have been resolved, some in the process of getting over them and others yet to be tackled. Initially, when the whole idea of m-learning started, it was criticised for many reasons from different perspectives of understanding relating to pedagogy, technology, usability, relevance in education, affordance, ethics, disruptiveness, misuse, availability, interoperability, appropriateness among others (Fetaji & Fetaji, 2011). Some of these perceived perceptions at the beginning stage of m-learning have contributed to its slow adoption and diffusion in education institutions, although most of the above mentioned problems are not currently the issue of contention due to the rapid innovative advancement of information and communication technologies.

For example, some of the big challenging issues with m-learning at the very beginning were the screen size of the mobile device, tiny keypad, unable to support rich graphics and multimedia, battery power not able to survive long hours of use, low computing power, slow internet connectivity, small storage capacity and processing power, and less sophisticated in terms of functionality among other things have been successfully eliminated through research and developments (Muntean & Tomai, 2010). Today, we have highly sophisticated mobile device with great computing power, which have wider screens with touch screen capacity and moderately larger QWERTY keyboard. They are able to support all forms of graphics and multimedia with fast internet connectivity, and more powerful battery, which is able to provide energy for several hours of usage. However, there are still reasonable numbers of challenging issues that need to be resolved for the betterment of m-learning within formal and informal circles. Some of these issues are related to application design, security, noise and disruptions, pedagogical suitability, implementation framework, digital divide, user adaptation, policy support, access to good internet connectivity, especially in developing countries among others.

2.8 The Phenomenon of "anywhere", "anytime"

Education delivery has come a long way and is advancing from specific geographic area to ubiquitous space, which is teaching and learning anywhere, anytime with any mobile computing device. This is a new paradigm in education, which has received the attention of researchers over the past few years with several pilot projects being conducted across the globe. "Anywhere" is a situation, which is not limited to a specific location or venue. "Anytime" can be explained as an undecided time or wherever seems convenient or appropriate. The device in this context refers to all types of mobile computing devices, which have the capabilities for teaching and learning without restrictions in terms of location. These devices include smart phones, mobile phones, PDAs, tablets, palmtop, notebooks, laptops and desktop computers. The integration of anywhere, anytime with mobile-ICT, creates Mobile Learning Platform (MLP), which offers numerous opportunities for education delivery in the 21st century. Today, human-beings with the advancement in mobile computing are gradually attaining a "Virtual Omnipresence Status" (VOS) which apparently makes people feel like they are at anywhere anytime (Hjorth, 2005), (Pellegrino, 2011). The innovative evolution of mobile technology is constantly reducing distance between people, making mobility more fluid as never before (Fay, Uteng, & Cresswell, 2008), (Benke, 2008).

PART - 3

2.9 Mobility of the "Learner" & the "Teacher"

The advent and advancement of Information and Communication Technologies (ICTs) are essentially renovating the use of technology, specifically regarding mobility. Mobile Technologies are currently playing significant role in easing the geographical obstructions to human activities. This refutes the argument of exclusively linking mobility to human corporeal movement (Kakihara & Sorensen, 2002). The incorporation of mobile technology in mobility relates more to the interaction of people anywhere anytime, which is the main concern of this study, in relation to academic activities of students and teachers in higher education.

The pursuit of education in higher education institutions are characterized by activities and locations. It is well noting that the entire processes of teaching and learning activities especially at Tertiary Education / higher education level are dispersing. Moreover, the advancement of information and communication technologies (ICTs) through the use of mobile computing

devices and the internet even make physical mobility seamless with virtual mobility. Mobile technologies create the platform for students and teachers to interact beyond physical boundaries, opening opportunities for fluidity in mobility for teaching and learning locally and globally.

Typical mobility of teachers and students can be categorized into three levels – micro (intra-campus mobility), meso (inter-institution mobility) and macro (inter-country mobility). The discourse on mobility is very broad. However, the purpose of this study is to discuss academic mobility, which refers to movement of students and teachers within the location of their institution or another institution inside or outside their own country to study or teach. Erasmus, Nordplus and Fulbright are among several mobility programs available for students at department, faculty, institution and national level. Discussing academic mobility will not be complete without mentioning social mobility. Because the mobility of teachers and students are deeply immerse in social mobility, which refers to the movement of individuals or groups in a social position over time. This could be vertical, horizontal or lateral but that is not the core of our discussion. The reality is that mobility presents a collection of complex issues, which every higher education institution must ultimately address.

(Sheller & Urry, 2006) explains the multiplicity of mobility to include the movement of images and information on local, national, and global media. They posit that it support one-to-one communications such as the telegraph, fax telephone, mobile phone, as well as many-to-many communications enabled by network and increasingly embedded computers. They further stated that the study of mobility also involves those static infrastructures that shape the intermittent flow of people, information, image, as well as borders and channels, and regulate movement or anticipated movement. The characteristics of the daily activities of students and teachers as prototypical mobile workers do not fall short of the assertion of Sheller and Urry.

Naturally, humans are mobile by the very nature of their existence as they interact in society in search of socio-economic satisfaction. Human activities are basically rooted in mobility and communication. People move from one place to the other as they communicate or perform some sort of activities in their micro, meso or macro mobility space. This implies that the activities of humans are intrinsically related to their mobility and communication, be it physical or virtual and it can be argued that the meaning of any human mobility is reflected in activity and communication.

2.9.1 Mobile-ICTs and Mobility of Humans

Various forms of technologies have been part and parcel of mobility of humans and non-humans from the industrial stage of society, through to the information & knowledge society of today (MacKenzie & Wajcman, 1999), (Silverstone, Haddon, In Silverstone, & Mansell, 1996), (Zubroff, 1988), (Bijker, Hughes, & Trevor, 1984). These technologies in diverse ways keep transforming society and mobility. New technologies come with improved functionalities to augment old technologies in shaping mobility. Information and communication technologies (ICTs) have especially contributed enormously towards this transformation of society and mobility. The way people live and interact with society and objects are unabatedly changing due to the massive use of mobile-ICTs. For example, the integration of mobile-ICTs with modern transportation technologies over the past decades have transformed automobile, train and airline into a more sophisticated and powerful technologies in terms of effectiveness and usefulness.

Kakihara & Sørensen argue that life styles have become more and more mobile to the extent that the speed of transportation and geographical access within a given time span is significantly strengthened by modern technological advancement and intricacies such as train and airplane systems. However, in spite of the increased discussion on mobility in our social lives, most literature limit the scope of mobility, narrowing it exclusively in terms of humans' independency from geographical constraints. However, mobile computing technologies and services such as mobile phone, tablet, and personal digital assistants (PDAs) allow mobility to transcend beyond geographical boundaries to virtual space.

Mobility or "being mobile" is not just an issue of people traveling. It has complex connection to the way people interact with each other in their social lives. The formation of social-technical relationships resulting from the diffusion of mobile-ICTs provides various dimensions of mobility to humans' interactivity with others in their social lives. These dimensions are spatial, temporal and contextual.

Table 2. 1 three dimensions of mobility and its extended perspective
Source: Kakihara and Sørensen 2002

Dimensions of mobility	**Aspects of interaction**	**Extended perspectives**
Spatial	-Where	Geographical movement of humans and objects, symbols, images, voice, etc.
Temporal	- When	Physical clock time verses Social time -Objective verses Subjective Monochronicity verses Polychronicity
Contextual	-In what way -In what circumstance -Towards which actor(s)	Multi-modality of interaction -Unobtrusive verses Obtrusive -Ephemeral verses Persistent Weakly & strongly tied social network

2.9.2 Spatial Mobility

Perhaps the most notable attribute of mobility in social lives is spatial mobility. Discussion on mobility cannot be explained in a better way without mentioning space because the meaning of mobility intrinsically encompasses movement of entities from a location to the other within a specific space. For example, people move to and fro domestically and globally. Objects, symbols, images, voice etc. are not left out because they are embodied in the daily activities of people as they change space moment by moment (Urry, 2000). The rapid advancement and innovation of contemporary ICTs have opened the avenue for interaction between entities beyond geographic boundaries. Thus people and the objects, symbols, images and voice that they carry with them to facilitate a number of activities to meet specific needs have become geographically independent empowered by the use of static ICTs and mobile communication technologies such as mobile phones, tablets and PDAs etc.

The discussion of spatial mobility is heavily concerned with the interrelated physical movement of humans, objects, symbols and services from one location to another and the mobility of space itself. Movement of objects, symbols and symbolic travel are intertwined with human dwelling and travelling norms (Kopomaa, 2000). For example, a person carries mobile phone, tablet, laptop, PDA, Walkman or iPad. This denotes the interplay between corporeal and object travel. These objects are virtually an extension of humans. Their pervasive nature makes them suitable companions for human mobility. However, it is worth noting that it is not the mere object that is relevant to the carrier, rather, service that is derived from carrying them along. The value for travelling with an iPod is the music one enjoys whiles moving about. Other objects may be for the purpose of transmitting and sharing information

across geographic boundaries. This means that inherently symbols, images, voice, information etc. travel with people and mediate their activities. Other instance are that these symbols, images, voice and information can also travel to humans with the aid of technology, an example is broadcasting of television and radio to billions of people in the world via satellite. In such scenario, it is the symbols, images, voice and information, which move to people in a fixed geographic location.

Space itself can be mobile and be represented symbolically. For example, symbolic travel on the internet creates another form of spatial reality. That is, network of computers have created "virtual community" or "cyber community" where millions of people at different location are connected and can communicate and share information through a virtual space where boundaries between "here" and "there" dissolves (Jones, 1998).

2.9.3 Temporal Mobility

Spatial mobility, which fundamentally deals with the aspect of "where" in space are entities moving to and fro, is also connected with the issue of "when" mobility takes place. Temporal mobility is concerned with the allocation of time resources to mobile activities. Time plays a vital role in all aspect of life, thus people try to seek efficient methods of doing things while saving time. As people and objects engage in complex movement from one-to-one, one-to-many, many-to-one and many-to-many, it becomes necessary for time to be managed effectively to maximize mobility whiles achieving the purposes which causes people to initiate movement from one place to another.

We cannot ignore the relevance of technology in social and business activities as it shapes mobility of humans and artifacts. Various forms of technologies including: automobile, train, airplane, ICT, telecommunication and mobile technology have in diverse ways facilitated mobility. The integration of mobile-ICTs with automobile technology have created modern transportation systems which make movement of people across geographical boundaries faster, thus speeding-up and saving time. The emergence of mobile-ICTs liberates mobility from geographic constraints to a boundless space. It reveals the importance of spatial mobility of artifacts. Thus, the immediacy of these artifacts as part of human mobility is appreciated by the content they provide.

Kakihara & Sørensen argue that speed and time saving are not necessarily the only temporal changes of social activities influenced by new technologies. Also, Barley in his study of "technology, time and social order in work place" identified that the temporal order of the workplace has dual function which are structural and interpretive aspect of temporality. Structural traits concern the organizational behaviour which to a large extent is assessed by specific order, duration, temporal location and frequency of repetition. His study also pointed out the relevance of interpretive traits of temporality saying that it is how people in the work place construct meaning of structural boundaries. The elements of his argument were that temporality involves complex relationships between people and artifacts. Another aspect of temporal mobility is Monochronicity and Polychronicity. This refers to how people work with time. Monochronicity relates to how people seek to manage their activities and routines by allotting specific amount of time for each activity. While Polychronicity refers to instances, where people have minimal importance and take divergence of structural and interpretive attributes of the temporal order. Barley in his study found that introduction of new technology enhances the Monochronicity of humans' activities by reshaping structural and interpretive views of temporality. Meanwhile, the rapid acceptance and use of mobile-ICTs in various aspects of social lives makes Polychronicity of human interaction more popular and relevant. (Lee, 1999), (Lee & Liebenau, 2000) used Barley's analytical framework to explain that new technological system can transform the temporal order of a company's business operation, leading to more Polychronicity at the work place. For example, the use of email or other asynchronous technologies provide people with the opportunity to perform multiple tasks concurrently. Sharing the same time for different activities and people become irrelevant. More importantly, telephones and fax machines can lessen the time a company spends on responding clients from weeks and days to a few seconds. It is even faster with the use of computers and internet, and not only that, mobile-ICTs create the platform for instant and concurrent delivery of information and many other types of content for different people to use virtually at the same time. The affordances of mobile-ICTs facilitate Polychronicity of the activities of people. One can conclude that ICTs and other technologies are constantly and rapidly mobilizing the temporal aspect of human interaction. That is, linear "clock-time" can no longer be a constraint to temporal interaction of humans'.

2.9.4 Contextual Mobility

Context in which mobility occurs is dependent on "what way", what circumstance" and "which actor(s)". According to the extended perspectives of mobility by Kakihara and Sørensen as

shown in table 2.1, they contend that mobility of humans' is contextual. They argue that the action of human is intrinsically situated in a particular context, which is constructed by his or her performance of the action recursively. This stresses the context in which an action or expression occurs, which according to the philosophy of contextualism, the meaning of human action or expression is immersed in a particular context which the action is performed.

The discussions of spatial, temporal and contextual dimensions of mobility in human interaction have diverse paradigms in different disciplines. For example, education institutions appreciate the urgency of all these three aspects of mobility in faculty and student interaction. That is, teaching and learning can only take place at a particular place and time in a specific context. Traditional education (face-to-face) where teaching and learning were tied to place and time is now giving way to a new paradigm where the use of both static and mobile ICT systems are shaping the spatial and temporal dimension of academic mobility with context which transcend geographical constraints. Example of some of these educational framework which consider mobility with respect to technological innovations of ICTs which enable faculty and student to organize and manage their academic activities with minimal constraints include Computer Supported Cooperative Work (CSCW), Computer Supported Collaborative Learning (CSCL), Mobile Computer Supported Collaborative Learning (MCSCL), E-Learning, M-Learning, etc. The use of these ICTs makes their work schedule flexible and independent from spatial and temporal constraints. However, we must understand how these ICTs influence the contextual interaction of humans in different ways, with the affordance of various modalities of interaction through ICTs. Ljungberg and Sørensen classify interaction modalities into two perspectives: unobtrusive verses obtrusive and ephemeral verses persistent following Schmidt and Simone's work. Human interaction can be obtrusive based on the responsibility it imposes on the actor to react. In like manner, interaction can also be ephemeral which only linger for a while or it could be persistent which seeks further attention. Unobtrusive interaction does not necessarily distract mobility but obtrusive may distract. With this analogy, one will have no doubt that communication technologies influence modality of interaction. ICTs allow interactivity among humans to be void of contextual constraints. Computer mediated communication (CMC) changes the contextual constraints of people while allowing them to connect to each other irrespective of the geographical distance. For example, social network such as face-book, Skype, twitter, LinkedIn etc and other educational platforms including Moodle, Mobilearn, lectora, ispring are solutions, which enhance the interaction of users. Shyness and lack of confidence in most students, which hinder face-to-face interaction,

which results in weakly tied social relationships can be compensated with the use of unobtrusive and persistent ICTs to grease the interaction beyond their constraints.

It can therefore be argued from educational perspective that Contextuality of mobility, just as spatial and temporal mobility has influence on teachers and students interaction as any other humans. The mood, cultural background and other factors affect interaction on campus in diverse way. However, with the use of mobile-ICTs in most schools, interaction is now emancipated from contextual constraints.

2.9.5 Fluid Interaction

Every day, life and interaction in the 21st century is hugely influenced by ICT applications. This implies that the use of ICTs have enhanced human interaction in terms of spatiality, temporality and Contextuality. Thus for us to appreciate the total relevance of mobilization of our social lives, our discussion must go beyond spatial, temporal, contextual mobility and the use of static ICTs. ICTs involvement in human mobility today is inevitable, but we must be able to distinguish mobile ICTs from static ICTs. This will help in understanding their different roles in improving human mobility beyond spatial, temporal and contextual mobility.

Mobile Computing and Communication Technologies (MCCT) demystifies the overarching limitations of geographical movement, time, context and the use of static ICTs like desktop computer, fixed line telephone, fax etc. Today the advent of mobile phone, tablet, and PDA and note-book laptop makes mobility of people seamless across boundaries via the mobile broadband and cyber space. Mobile technologies as an integral part of human interaction can be likened to Mol and Law's ideas of social topology and a fluid metaphor (Mol & Law, 1994) as cited by Kakihara and Sørensen (2000). They explain a fluid world to be a world of mixtures and variation without boundaries and transformation without discontinuity. They identify three topologies of interaction, which are regions, networks and fluids based on the spatial-temporal-contextual coordinate systems. In their analysis, region is characterized by boundaries, network is characterized by relationship and fluid is whereby neither boundaries nor relations mark the difference between one place and another. Kakihara and Sørensen also used the Mol and Law's metaphor to advance the understanding of highly mobilized human interaction.

The pervasive or ubiquitous nature of mobile or portable computing devices allows human interaction "anywhere", "anytime" (Kleinrock, 1996). This makes people accessible to each

other on a mobile virtual platform. It can be said that human interactions become virtually omnipresence with the use of mobile technologies. This offers great opportunity to teachers and students where teaching and learning are not limited by spatiality, temporality, Contextuality dimensions of mobility and static ICTs. Rather mobile technologies compensate the boundary of physical presence with seamless virtual presence.

2.9.6 Academic Mobility

The academic activities of students and faculty have a complex mobility, which involves non-humans and artifacts. Students and faculty engage in multiple mobility – temporal, spatial and contextual which include but not limited to wandering and mobile communication. The mobility of students and faculty is influenced by first, the physical appearance or architectural designs of higher education institutions, which differ from institution to institution. This in a way influences the intra-campus mobility and its connections to the larger society, where the student and teacher find themselves. Some institutions have only one campus, ranging from just a single building to multiple buildings spread over a vast space of land which have administration blocks, classrooms etc and includes residential facilities for staff and students. Others have campuses at different locations, away from the main campus. In any university or tertiary education institution, faculty and students commute between offices, lecture halls, library, etc. Not only that, they also commute from one institution to another within their country and even beyond. With this, one will have no doubt that students, faculty and administrators are exemplary mobile workers. They wander as they carry out their daily activities of acquiring and sharing knowledge.

Secondly, the curriculum and educational philosophy of the institution contributes enormously to the mobility of students and faculty. Course content and pedagogic framework which is grounded in the curriculum and educational philosophy of the institution in a way determines how and where a given teaching and learning activities should be carried out. The mobility of students and faculty in a solely traditional face-to-face course will differ from an entirely e-learning / m-learning course or a blend of face-to-face and e-learning / m-learning. These blend and varieties in higher education delivery involves multiple or hybrid mobility. For example if an institution use problem based learning (PBL), then of course the activities of the student and faculty are not only concentrated within the walls of the institution but with industry as well. This means that students and faculty by nature of the educational framework must commute from campus to the field and vice versa.

Thirdly, the availability of learning materials and resources also has its fair share on the mobility of students and faculty. Learning materials and resources can be physically located in the library and books shops on campus or outside campus or it could be virtually available on the internet. With this mix of activities and mobility of students and faculty, it is prudent for higher education institutions to embrace multiple means which facilitate Student and faculty mobility, both physical and virtual as they go about doing their daily activities by incorporating an educational technology platform such as m-learning into their institutional framework, which will allow students and teachers to take advantage of the flexibility in mobility of using mobile computing and communication technology for teaching and learning.

PART – 4

2.10 M-Learning in Africa and Ghana

The eLearning Africa conference in collaboration with UNESCO, DANIDA, NEPAD and other educational developing partners including the Association of Africa Universities (AAU) are doing a lot to promote the use of various forms of ICT to improve education delivery in Africa as a means to contribute to its educational needs through research, conferences and policy formulation ("AAU/ICT Report," n.d.). There have been several pilot projects on different forms of m-learning across the length and breadth of the African continent, all in anticipation of seeking ways of making education accessible to all, either as a complementary or comprehensive learning platform for teaching and learning that engages the interest of the user (Traxler & Kukulska-Hulme, 2005), (Traxler & Leach, 2006). Some few universities and institution including university of Pretoria in South Africa (Ally, 2009; Keegan, 2005), Makerere University in Uganda (Kajumbula, 2006), and University of Ibadan in Nigeria among others. For example, the faculty of health science in university of Cape town saw a need to communicate with students in ways not accommodated by current online methods by introducing an m-learning pilot project in January 2005 (Masters, 2005), the BridgeIT initiative in Tanzania, also provides teachers with the access to digital video content for on-demand screening in class via mobile technologies, and Nokia's Mobile Mathematics (MoMath) project in South Africa (Isaacs, 2012a, 2012b). Educational institutions in Africa have been using m-learning on pilot basis and more universities are buying into the whole m-learning concept. This has been possible because most institutions and governments with the

help of donor agencies and telecommunications companies are putting in place, logistics and frameworks that could advance learning using mobile technologies (Frohberg, 2006).

2.10.1 Mobile learning in Ghana

The innovativeness of mobile phones has found a place in the educational sector. For example, the Ghana government has introduced the Computer School Selection Placement System (CSSPS), which enabled the admission of students into the second-cycle educational institutions through a computerized selection process in 2005 (Gyepi-Garbrah, 2012). Generally, things changed with the computerization of the process opening up for better scrutiny, coordination and access. Now, students can send SMS to find out about their school placements (Essegbey & Frempong, 2011). The West Africa examination council has introduced an online service which enables students to make enquiries and check for their exams results on their mobile phones ("WAECDIRECT ONLINE - RESULT CHECKER," n.d.). Students in universities and some other tertiary educational institutions use the mobile phone to access relevant information such as time table, transcript, registration, examination results etc.

In this study, AD-CONNECT is the company, which is tasked with the responsibility to pilot m-learning in Central University College in Ghana. Meanwhile, similar agreement has been reached with the same company in Nigeria by Ibadan state University. Apart from the CUC m-learning pilot project, there are some other m-learning activities in Ghana, which is worth mentioning in this study. The first among them is the CocoaLink; an m-learning project initiated by Hershey Company, World Cocoa Foundation, World Education, Ghana Cocoa Board (COCOBOD) and their technology partner DreamOval ltd ("News," n.d.). The project utilise the use of mobile phone technology to educate cocoa farmers on performance-enhancing and marketing information on cocoa farming. The project was piloted with cocoa farmers in the western region of Ghana. The farmers received information on best farm practices, child labour, health, crop disease prevention, post-harvest production and crop marketing. The other two are m-learning services provided by telecom operators – Vodafone Ghana ("Vodafone Ghana » About eLearning @ Vodafone," n.d.) and MTN Ghana ("Forum Solutions - Online Conferencing Solution, Teleconferencing Applications For Education, Religion, Governance, Politics, Business, Media, Others," n.d.).

2.11 Chapter Conclusion

This chapter delved into literature of empirical research on educational technologies, specifically on m-learning in tertiary educational institutions. State of the art literature was gathered from relevant areas of ICT and education including e-learning, m-learning, mobile computing and communication technologies, mobility of humans and their activities mediated by artefacts and the role of technology in enhancing education delivery. The connection or link between mobile technology and educational psychology were discussed to explain the pedagogical relevance of mobile computing technologies in facilitating teaching and learning in tertiary educational institutions. The chapter further touched on the evolution of mobile communication system and the numerous educational opportunities that it comes with, including the possibility of getting boundless access to information anywhere anytime.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter presents the methodological foundation of the whole research. I have termed this chapter as the "show how" chapter because this is where a detailed description of all the steps which were involved in conducting the empirical study are sequentially outlined to show how data was collected and analysed to arrive at the result. It explains and justifies the scientific approach adopted for the study.

What makes scientific research different from consultancy or report of inquiry is the methodology, which concisely explains the method and strategy of inquiry used in arriving at the findings of the study. Research methodology is embedded in the research design and is seen as the most critical aspect of any scientific research because that is what provides the basis for the empirical study. Methodology must be scientifically proven with appropriate tools and instruments to lead the researcher or team of researchers to answer research questions/hypothesis and objectives for any kind of study being conducted. Methodology is therefore relevant in assessing the empirical credentials of any scientific study such as PhD dissertation among others.

My understanding of methodology of any research project is to tell how the study was conducted in a scientific acceptable manner. Methodology is to meticulously explain how the research was conducted. In this chapter, the philosophical backing of the research is discussed touching on positivism and interpretivism/constructionism epistemology and ontology. Theoretical perspectives of quantitative and qualitative paradigms of research enquiry are highlighted, including the mixed approach to research design with an explanation of the justification of the research philosophy (Kumar, 2011). The entire discussion on the research design and methodology is summarised in figure 3.1 which throws more light on figure 1.2 in chapter one.

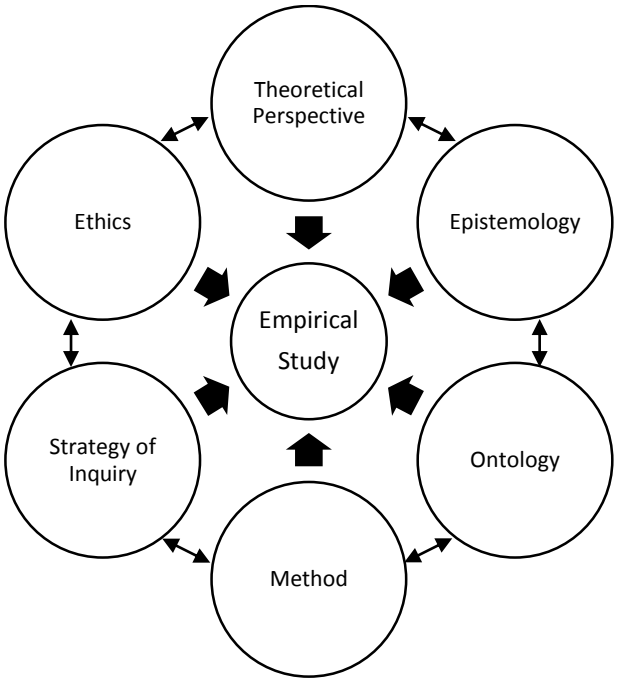


Figure 3. 1 Ingredient of the research design

3.2 Research Philosophy

A philosophy can be explained as a precept, or set of precepts, beliefs, principles, or aims underlying somebody's practice or conduct in a given context serving as a basic concept underpinning a particular sphere of knowledge. It portrays the basic set of beliefs that guide action. This is reflected in the inspiration of a researcher's perception of reality (ontology) and how it connects to knowledge (epistemology) to create meaning (Audi, 2010). The objective of research or science for that matter is to develop an understanding of the world to produce knowledge out of perception. That is, science is based on fact and knowledge to establish scientific truth (Fox & Fox, 1999). Research philosophy could be seen as the way a research is carried out, beginning with the initial ideas of the researcher and working through the ideas to create an understanding of the research findings to produce knowledge (Babbie, 2012). Research philosophy is therefore very important in any given research process, because it serves as the elements of foundation for the rationale, evidence, analysis, discussion and outcome of the research (Goddard & Melville, 2004).

3.2.1 Epistemological and Ontological Foundation

Epistemology and ontology assumptions create the basis for understanding different phenomena, their conditions of existence and how they are related (Hadzic, Wongthongtham, Chang, & Dillon, 2009). Ontological assumptions are concerned with the nature of social reality while epistemological assumptions are concerned with the sets of knowledge – how we can know these things – and the criteria for deciding when knowledge is both adequate and legitimate. Every scientific research strategy draws inspiration from a particular combination of ontological and epistemological assumptions and these serve as the philosophical background of any given scientific research, either natural or social science. This provides the basis for understanding the "what", "why" and "how" of the research within a particular contextual framework. Several philosophical stands (Babbie, 2010) have sprung out of the two main extremes of ontology and epistemology which are objectivism & constructivism and positivism & interpretivism respectively. Creswell analyse and discuss ontology and epistemology under what he terms as philosophical worldview (Creswell, 2008). He put them into four categories, thus post-positivism, constructivism, advocacy/participatory and pragmatism. For the purpose of this study, I will discuss my philosophical rationale by juxtaposition of the two basic traditions of ontology and epistemology, link it to my philosophical view and consequently the method of inquiry.

3.2.2 Ontology

The issues of social ontology are interested in the nature of social entities. The major point of orientation here is the issue relating to how social entities should be perceived. Either as objective reality which is external to a given phenomenon, or social constructions created from the actions of participants as they interact within their social setting (Klenke, 2008). These stands respectively are referred to mostly as objectivism or constructionism.

Objectivism is an ontological stance, which denotes that we encounter social phenomena as external facts that are beyond our grasp or control. The assumption is that the understanding of phenomena is separated from the participants. It means the action of actors, which brings about a phenomenon has no bearing on the outcome of the phenomenon. Researchers who are objectively oriented believe that reality is detached from the individual who observes it. They deem the subject (the researcher) and object (the phenomena) to be two distinct entities. They believe that the object of the research has qualities that exist independent of the researcher. However, they admit that the reality can only be known through the artefacts they have created

– theories, frameworks and construct by way of experiment and survey with the intention of looking for large volumes of empirical data which they can analyse statistically to determine a phenomena. To a large extent, they believe that a statement by a researcher is true if it has a one-to-one mapping to the reality which exists outside of the human mind.

However, Constructionism also known as constructivism can be considered as an alternative ontological position, which claims that in a given social setting, the activities of the actors and its resulting effects are linked. It means that the action and the actor are inseparable. The term also ascribes to the notion that researchers who are constructionism bias tend to favour qualitative method of inquiring. This position challenges the suggestion that the reality as pertain to the object (phenomena) is separated from the interaction of the subject (researcher). Contrast to objectivism, constructionism believes that reality and the individual who observes it cannot be separated and that the life-world has both subjective and objective representation which reflects the perceptions about the meaning of the world (Pfister, 2007) which is an indication that we constantly negotiate meaning with others with whom we interact. Constructionist believes that the attributes they assign to the objects they research are socially constructed and an outcome of their life-worlds. Constructionist accepts truth when a researcher's initial assumption of a particular phenomenon relates to the meaning given to the phenomenon through the researcher's lived experience of the phenomenon. One focus of constructionism is to seek understanding of how people interact with objects to create a social reality. It consist of observing the ways social phenomena are created, institutionalized, known, and made into tradition by humans. The constructionist researcher sees construction of reality to be a dynamic process which is capable of producing varied outcomes in different context (Bryman, 2008).

3.2.3 Epistemology

Epistemology in this context is the underlying facts or principles of research and it is based on this that the theoretical perspective of the study is founded (Pintrich, 2002). This informs the kind of methodology relevant for the study with its associated methods. This can be seen as a linear sequence where each offers the premises for the other. Epistemology can simply be explained as the theory of knowledge underpinning the research philosophy. Starting with the positivist assumptions, this represent the traditional form of research and hold true more for quantitative research than qualitative research. This assumption is known as the scientific

method or doing science research. It is popularly called positivist research, empirical science and positivism. A positivist researcher holds a deterministic understanding in which causes determine effects or outcomes. That is to say, the positivist studying a problem reflects the need to identify and assess the causes, which influence outcomes, such as is found in experiments. Positivist research is reductionistic to the extent that the purpose is to reduce the ideas into small, discrete set of ideas to test. The positivist develops knowledge based on thorough observation and measurement of the objective reality, which exist "out there" in the world. Thus, creating numeric measures of observations and studying the behaviour of individuals becomes ultimate for a positivist. The accepted procedure to research by post-positivists is for an individual to begin with a theory and collect data, which either supports or refutes the theory. Positivist sees the world through laws or theories that govern the world, and the need to test or verify to understand the world.

Positivists through rigid methodology build knowledge of a reality, which exists beyond the human mind. They argue that human experience of the world reflects an objective, independent reality and that this reality provides the foundation for human knowledge. Positivism regards reality as consisting of discrete events that can be observed by the human senses (Smith, Booth, & Zalewski, 1996). To the positivist, the only knowledge of reality, which is acceptable is that which is deduced from experience. In contributing to positivism, August Comte a 19th century philosopher and founding sociologist argued that society operates according to its own laws, in like manner as the physical world functions on the law of gravity and nature. Positivist believes that exclusive source of authentic knowledge is of data derived from sensory experience, and the logical and mathematical treatments of such data. Positivist are with the notion that for knowledge to be perceived as "true" it must be scientific and measurable (Sjolander & Cox, 1994).

Interpretivism or anti-positivism assumptions have a rather contrast opinion on the way reality and knowledge are conceptualized and understood by positivists (Mölder, 2010). In discussing epistemology, the term interpretivism denotes an alternative to the positivist orthodoxy which seeks the interpretation of human actions (Blaikie, 2009). It posits that a paradigm of knowing is required to appreciate the relationship, which exists between actors and the outcome of their actions. Max Weber in his advocacy described sociology as a "science which endeavours to interpret the meaning of social phenomenon to arrive at a causal explanation of its course and effects". His point of departure clasp both explanation and understanding, but within this

context, the task of "causal explanation" is perceived from the "interpretivist view of understanding social phenomenon" rather than to external forces that have no meaning for those involved in that social action. Thus the interest of interpretivism in research is to focus on understanding the meaning that social actions have for the people being studied (Crotty, 1998).

For the interpretivist researcher, social reality is seen as the product of its inhabitants, thus the world must be interpreted by the meanings participants produce and reproduce as a relevant part of their everyday activities. Interpretivism was founded with the purpose of producing verifiable knowledge of the meanings that constitute the social world. With attention directed at the role of understanding patterns in social life, in relation to the nature of meaningful social action and how this meaning can be assessed, the interpretivist believes that reality and the individual who observes it cannot be separated.

Interpretivism strongly holds the assumption that individuals try to construct their own meaning of how they understand the world (Walliman, 2006). The individuals develop subjective meanings of their experiences with focus directed toward certain objects. These meanings are varied and multiple, leading the researcher to look at the convolution of views rather than narrowing meaning into limited ideas. The aim of the interpretivist researcher is to obtain meaning constructed by people as they engage with the world and to depend heavily on the participants' views of the situation being studied, contrast to the world of natural science (Mi & Chen, 2007).

In a nutshell, interpretivism is a contrasting epistemology to positivism (Kasi, 2009). It puts together the views of people with intellectual influence who are critical on the use of rigid scientific model for the investigation of the social world. One of the major intellectual traditions that have been responsible for the anti-positivist position has been phenomenology, a philosophy which studies how people interact and construct meaning within their immediate world. Thus interpretivism tends to focus on constructed reality instead of objective reality. It is flexible as compared to positivism which is mechanical in nature.

3.2.4 Pragmatism

The two major extremes stance of philosophy have since their inception received diverse criticisms, which have given birth to a number of post philosophical stances. This in my opinion adds variety or flavour to the basic traditional ontological and epistemological assumptions, which broaden our horizon of understanding the world. These criticisms tends to commend the strength of these philosophies and seek better ways of strengthening their weaknesses to provide deep insight into how both natural & social sciences perceive and understand phenomena as they unfold. Some of these constructive critics are Charles Sanders Peirce, Williams James, John Dewey and William Van Orman Quinn among others whose work led to the pragmatist philosophy which combines positivist and interpretivist ideologies (J. Garrison, 1994), (Peirce, 1905). Subsequently Creswell et al also came up with the mixed approach to research. The hybrid philosophy by Andrews Jamison also provides critical analysis of the rationale of the distinctive philosophy of positivism and interpretivism and the relevance of the hybrid lens of theorizing phenomena.

Doing due diligence in scientific research could be seen as blending positivism (as in quantitative strategy of inquiry) & interpretivism (as in qualitative strategy of inquiry) to present result, make analysis and draw conclusions. This gives a holistic understanding of a particular phenomenon. Pragmatism emanates from actions, situations, and consequences rather than antecedent conditions as in positivism (Bacon, 2012). It is concerned with the application of what works and solution to problems. Instead of focusing on methods, the pragmatist researcher place emphasis on using multi-methods in gaining deeper understanding of a prevailing problem being studied. This serves as a philosophical underpinning for mixed methods studies. With pragmatism, the relevance of social science research is focused on the research problem while using pluralistic approaches to deduce knowledge about the problem.

The pragmatist philosophical assumption is geared towards connection of practice and theory (Murray, 2004). It illustrates a course of action where theory is winkled out of practice, and re-applied to practice to create intelligent practice. This is characterized by instrumentalism, radical empiricism, verificationism, conceptual relativity, and fallibilism. Thus theory and practice are not detached departments. John Dewey does not mince words by saying there is no question of theory versus practice but rather of intelligent practice versus uniformed practice.

A pragmatic researcher is normally not extremely devoted to any one system of philosophy and reality. Rather, a combination of both positivist and interpretivist understanding of the world are used. This is applicable when using mixed methods. The inquirer in this case, draws liberally from both quantitative and qualitative assumptions as he or she engages in research. The researcher has the freedom to adopt and select the method, techniques, and procedures of research that best address the research hypothesis, questions and objectives. A researcher with a pragmatic view does not perceive the world to be in absolute unity. In like manner, mixed methods researcher tends to use multiple approaches for collecting and analysing data instead of adhering to a single method. Blending positivism and interpretivism assumptions lead to a truth, which is based on what works at the time. It is not founded on the duality between reality independent of the mind or within the mind. That is to say, mixed methods researchers use both quantitative and qualitative data because they work to provide a better understanding of a research problem. Pragmatist researcher seeks "what" and "how" to research, based on the intended consequences and the direction they want to go with the research. They have great conviction that research takes place in a social, historical, political and other context and also believe other factors independent of the mind as well as that which is in the mind. The epitome of hybrid or pragmatism assumption in research is that it creates the opportunity to combine different approaches of inquiry, worldviews, and assumptions as well as data collection and analysis.

3.3 Theoretical Perspective of Quantitative & Qualitative Research Design

Quantitative research is oriented toward positivism and post positivism which believes that a theory of knowledge about the world is attainable only by direct observation and experimentation not through metaphysics (Muijs, 2010). It is a philosophy, which believes that the only authentic knowledge is scientific knowledge and such knowledge can only come from positive affirmation of theories through strict scientific method refusing every form of metaphysics.

Positivism asserts that the logic of inquiry of a research is the same across all sciences and the purpose of inquiry is to explain and predict an outcome. Most positivists say that the ultimate objective of knowing is to lead to the construction of general laws of understanding, by discovering relevant and adequate conditions for a phenomenon. That is if the law is known, then a condition can be manipulated to produce a predicted result. With positivism, research can be proved only by empirical means, not argumentations and that research should be

deductive, and thus the logic of deduction is to develop statements, which are testable. This is normally done with a theory leading to a hypothesis, which in turn leads to discovery and study of evidence.

Quantitative research is characterized with positivism epistemology of enquiry and is concerned with quantifying relationships between variables, which can be tested, verified and generalized. Quantitative methods work towards objectivity using systematic empirical investigation of quantitative properties and phenomena and their relationships. Quantitative research is dominantly suitable in situations where cause and effect of variables are to be interpreted and determined. Data collected through surveys administered to a sample or subset of an entire population, allows the researcher to generalize or make inferences. Results are interpreted to determine the probability that the conclusions found among the sample can be replicated within the larger population. Conclusions are derived from data collected and measures of statistical analysis that is to say that quantitative research is largely deductive.

Anti-positivism also called non-positivism or interpretivism may be related to qualitative research methods (Somekh & Lewin, 2005). Anti-positivists use research methods, which rely more on unstructured interviews or participant observation. Anti-positivists share the view that there is no methodological of unity of science and that the three purposes of positivism: description, control and prediction are incomplete. Anti-positivism approach to research relies on naturalistic methods and these methods ensure adequate dialog between the researcher and those they interact with to collaboratively construct a meaningful reality. Generally, from this perspective, theory of knowledge emerges from the research process. Researchers who share this worldview typically adopt qualitative methods for their inquiries.

According to Creswell (1994) doing qualitative research is an inquiry process of construing a social , which is conducted in a natural context and framed on deep description of a phenomenon as it unfolds. It is characterised by presenting a holistic view of the participants. Qualitative method put premium on understanding through careful observation of people's words, actions and experiences. This is done by presenting the participants' own words and examining the trend of knowledge, which emanates from data. A qualitative researcher is concerned with identifying patterns from the original words and actions of people as they experience and construct meaning within the framework of a given phenomenon.

The ultimate purpose of doing qualitative research is to discover recursive trends, which emerge through thorough observation, documentation, and thoughtful analysis of the research problem. What can be discovered by qualitative research are mostly contextual finding, which is not typical for generalizations. This method of seeking empirical understanding is fundamental to the philosophical assumptions of the qualitative approach to research. According to Denzin and Lincoln (1994), qualitative research is multi-method in nature, which involves naturalistic interpretation of phenomenon. This connotes that qualitative researchers investigate phenomenon in their natural perspective and interpret the phenomenon in terms of the meanings the participants bring to bear. It involves the study and collection of a variety of empirical evidence through case studies, personal experience, introspective, life story interview, observations, documents, interactions, and the like to establish concrete conclusions. Having analysed both the quantitative and qualitative approaches to research, I realized that based on my research questions and objective, the mixed method of research will be an appropriate option to find answers to the research questions and the objective. The mixed approach to research involves the combination of both quantitative and qualitative style of inquiry in a single study (Blaxter, Hughes, & Tight, 2006; Tashakkori & Teddlie, 2008), (Creswell & Clark, 2010). Mixed methods can be described as the "third methodological movement" following quantitatively and qualitatively oriented approaches. Philosophically, it is a paradigm, which provides logical and practical alternative to empirical inquiry. Mixed research makes use of the pragmatic method and system of philosophy (Tashakkori & Teddlie, 2002). It is inclusive, pluralistic and complementary which employs the logic of both induction and deduction.

3.4 Justification of Research Philosophy and Method

This research blends or combines positivist and interpretivist philosophies (as in hybrid or pragmatism) which translate into the use of both quantitative and qualitative methods (mixed methods), (Creswell & Clark, 2010; Tashakkori & Teddlie, 2008). The ontology and epistemology of pragmatism were chosen for the study as the fundamental ground of making meaning, to provide a holistic understanding of the phenomena being studied. The nature of the research questions and objective suggest that both qualitative and quantitative data must be collected in order to obtain broader understanding of the phenomena to be able to give rounded explanation and description of the empirical data within the context of study.

Credibility of most scientific research especially with the social science has been argued on the way reality, truth and knowledge are understood and interpreted based on the approach adopted for data collection and result interpretation. That is, a positivist oriented researcher will use only quantitative data inquire such as survey and experiment in gathering data, and ignoring other social elements of the subjects being studied. But in some cases, qualitative strategy is needed to extract other data which may be inherent to the subject to augment the quantitative data. Although the assertion by positivism philosophy posits that the world exists objectively and externally, and that knowledge is only valid if it is established on observation of the external reality explaining the cause and effect of relationships to forecast a foreseeable outcome, the assumption is that what truly happens in the world stage, has nothing to do with the human beings' actions and that the reality can only be present by measurement and statistics guided by universal laws. This is good but it might not necessarily represent the entire truth of the reality.

The interpretivist philosophical assumption tends to suit qualitative strategy of inquiry. They believe in knowing the truth of reality through the construction of meaning from humans and the phenomena under study. Thus knowledge of the truth is subjective and varies for different cases or situations. This assumption espouse and demonstrate that the activities of the subject (humans) directly or indirectly influences the pattern of the object (phenomena) which implies that the subject and the object are inseparable and not separate as advocated by positivism. Interpretivist believes and share the view that meaning are constructed by humans beings as they engage with the world they are interpreting. Data is collected using individual interviews and focus group so that the participants are able to share their views. However, there is the argument that subjective analysis of data could be influenced by the researcher's personal interpretations, which raise validity and ethical issues. With the juxtaposition of positivism and interpretivism philosophy and research methods, it explains the position of these stances and their way of understanding and making meaning of the reality of the world through their accepted principles and ethics. It also implies that in social science research, the problem definition, question/ hypothesis and the objective will to a large extent determine the type of empirical data which must be collected either quantitative, qualitative or both.

In this study, statistical data were collected coupled with observation, interviews and workshops on the daily activities of students and teachers as they use portable mobile computing devices for learning and teaching respectively. With this approach, the study

refrains from being bias to one particular philosophy. Instead, a pragmatic philosophy of ontology and epistemology is used to generate both positivist and interpretivist meaning of the empirical data. This option became obvious because the nature of the research objective and questions suggested the use of both quantitative and qualitative data to interpret the meaning of the phenomena of mobile learning in tertiary education specifically in CUC.

3.5 Method

3.5.1 Strategy of inquiry

According to Blaikie, choosing research strategy which is appropriate is unequivocally based on acceptable research principle (Blaikie, 2009). For example, social research may be conducted to explore, describe, understand, explain, predict, change, evaluate or assess impacts. This reflects the type of knowledge researchers seek to produce. In this study, I was in a quandary to use case study, design based or action research because they are closely related (Avison, Lau, Myers, & Nielsen, 1999). What distinct them is the role of the researcher and the research approach but they share common features of flexibility which allow the use of mix methods – qualitative and quantitative. Although they are more qualitative oriented, their flexibility features offer researchers the opportunity to add quantitative data to consolidate the shortfalls of using only qualitative data types. Action research was chosen as the strategy of inquiry for the study instead of case study and design based research. Because case study is normally conducted to explore, explain or describe a phenomenon and the researcher is not directly involved as an insider, but rather conduct the study as an outsider who investigate mostly through the use of interviews and observation. Unlike the action research, which is conduct purposely to seek change through an intervention where the researcher is basically part of the phenomenon being studied. This study exhibited the same characteristics of case study as argued by Yin et al that it must be contextual, real-world setting, practice-based, current and constructive (Stake, 1995; Yin, 2008). However, the use of case study for this study was negated because typically of action research, the study had dual objectives – "problem solving interest" and "research interest" and the intention was to bring change in teaching and learning in higher education, which is uncharacteristic of doing case study. Interestingly design-based research resembles action research in that it pinpoints real world problems followed by subsequent actions to improve an unsatisfactory situation. Furthermore, practitioners such as teachers are mostly engaged in the research activity. The researchers are integral part of the entire phenomenon being studied with a dual purpose of solving real life practical problem as

well as gathering scientific knowledge to effect change. On the other hand, I see a thin distinction between design-based research and action research. In design-based research, usually the researcher takes the initiative in the research process as both researcher and designer but in action research; it is often the practitioners who initiate the research and then invite the researcher as a facilitator to help the research process (Reeves, Herrington, & Oliver, 2005).

Originally, my plan was to do a case study of tertiary education institution in Ghana, which is doing mobile learning but I could not identify at that time any tertiary institution doing mobile learning in Ghana. What is prevailing in most universities and polytechnics is the use of short message service (SMS) to send alerts to students, and also allow them to interact with faculty and administration. I then decided to do design base by using a single class of about 300 student and 5 teachers at Wisconsin International University College in Ghana for the study. The idea was to design a mobile learning platform for them to use for some time and then assess the outcome. I however had to abrogate it because during my initial preliminary investigation, I found out that the management of Central University College (CUC) had entered an agreement with AD-CONNECT (a mobile learning content service provider) to implement m-learning in CUC. I approached them with my research proposal and they welcomed me to come on board to assist them in the training and implementation of m-learning in CUC. Thus action research strategy of inquiry was chosen for the study.

Action research is pragmatic and can be carried out in many different settings such as healthcare, community development, social work, management, information system, education etc. It pursues practical knowing and change (Checkland, 1991; Coghlan, 2011) and it may involve many different research methodologies which target the outcome of both the action and research simultaneously (McKay & Marshall, 2001). Different researchers have given action research varieties of names and classifications depending on their ontology, epistemology and research interest. Some of these names and classifications are technical/scientific/collaborative mode, practical/ mutual collaborative/ deliberate mode and emancipating/ enhancing/ critical mode of action research (Greenwood & Levin, 1998). Others also categorise them, as canonical action research, action science, action learning, IS action research, education action research, clinical fieldwork and more. However, all the classifications posit that action research seek to solve practical problem while generating scientific knowledge. It is iterative and has distinct characteristics – Diagnosing, Action planning, Action taking, Evaluating, and Specifying Learning. The ultimate expected outcome

of any action is to bring change. Most often, researchers align themselves to any of the classification based on the context, objective and research philosophy. In my case, I will say that, this study is participatory information system education action research, because I actively participated in the design and implementation of a mobile learning platform in an education institution. From the educational perspective, action research is recognized as a thoughtful, solution- oriented investigation, which is undertaken by either an individual or a group in collaboration with the practitioners. It is mostly carried out with the express intention of improving teaching and learning in a naturalistic environment using participant observation techniques of phenomenology ethnographic and hermeneutics research, including some characteristics of case study methodology.

In this study, there was mutual understanding between AD-CONNECT and Central University College and myself. I was not invited to be part of the project as a consultant, but rather as a teacher and researcher who has contemporary knowledge in the project area. My role was to collaborate with all stakeholders and actively participate in the project as a facilitator, guided by the principles of action research of pursuing both problem solving interest and the production of scientific knowledge. This affected my initial research questions and objective, which I modified in consultation with the project coordinators to match the purpose of the project, which was to improve teaching and learning with the use of mobile technology through the use of mobile computing devices such as smart phone, tablet, PDA, note-book and laptop. I was wholly involved in the project from start to the end. First, we did system configuration, which involved the migration of all the subjects, courses, faculty and students onto the m-learning platform system. My role at this stage was to assign system administrative roles to faculty and students. The next phase was where we planned and designed concise training program for the teachers / faculty, students, administration staff and technical support personnel on how to use the system. This was followed by the actual implementation of the m-learning platform. At the implementation phase, I helped teachers to format and upload content to the platform and also helped in programming automatic SMS which alerts students whenever content becomes available on the m-learning platform. I helped the participant both on face-to-face and on phone and also played different roles at different times as a way of getting deeper first hand understanding.

The use of action research for the study was consistent with IS research to systematically study how the use of mobile technologies could improve educational practice (Baskerville, 1999;

Mathiassen, 2002). My role was clearly distinct from that of a consultant whose primary interest is the fees and practical objective. However, I was motivated first by the research interest followed by the problem solving interest. This guided my collaboration with the teachers, students, management and staff of AD-CONNECT throughout the study as a participatory action researcher. Right from the onset, we developed trust and confided in each other, which was good for the success of the project. My involvement as a facilitator throughout the project contributed enormously to the project coordinators in making decisions at various phases of the implementation. I selflessly provided them with advice on the use of mobile-ICTs in education and its pedagogical implications, which was relevant to the project. This opened the door for all the stakeholders to approach me at any-time for discussions to the extent that teachers and students voluntarily arranged personal discussion with me on the project. It offered me the opportunity to get access to information, which I would not have gotten if it were a research such as experiment, case study or ethnography. In fact, the project was full of action and research involving iterative process of problem solving, action intervention, and reflective learning by all the stakeholders. The action and research framework we used concentrated on sustainable improvement of tertiary education delivery through the use of mobile-ICT. We reflected and assessed teaching and learning using mobile device. This enabled us to explore and test new ideas, approaches, and artefacts to assess our planned action through feedback, discussion and decision.

Using action research for the study was very appropriate because it offered us the opportunity to understand the interplay between humans, mobility, technology, information and socio-cultural context, which we would not have experienced in a laboratory experiment. My active participation in the project as a collaborative facilitator was a great experience. The whole phenomenon of blending face-to-face teaching and learning with mobile learning was motivating, exciting and attention-grabbing. With the dual purpose in mind, I used theoretical framework to substantiate the data I collected to generate new scientific knowledge out of the unfolded phenomenon. Thus, the study was grounded in theory and action in a real-world setting. I pursued the practical interest of solving problem in a faculty of a tertiary institution, teaching large classes. Large class sizes to some extent affect faculty delivery and eventually learning outcome. My collaboration with the stakeholders of the project which was rigorous and yet flexible provided easy data collection, enlightened me greatly and increased my understanding of the phenomenon and the emerged findings which satisfied both the action and the research objective.

3.5.2 Type of evidence

The type of evidence was guided by pragmatist philosophical underpinning of the study. Typically, of action research and mixed research methods, an amalgamation of qualitative and quantitative types of evidence is used to explain the subjective and objective data respectively. The use of both qualitative and quantitative types of evidence tends to cushion each other's inherent weakness or limitations. For example, evidence founded on quantitative data is numerical or statistical and is systematically gathered and is objective in description, which gives excellent overall picture of a population. On the other hand, evidence grounded on qualitative data is non-numerical and founded on interpretations, observation, contextual accounts and opinions that might appear to be subjective but more descriptive and depth in nature with richer, deeper and broader information related to individuals.

Although action research is characterized to be contextual, it is imperative to appreciate that the participant population vary. In this study, the participant population was over 10,000 so there was the need to draw sample for interviews and focus group discussion in addition to observations of activities and document analysis while questionnaires were used to gather objective data from the entire population of the study. The quantitative evidence provided statistical tracking data of activities of faculty and students on the m-learning platform while the qualitative evidence provided an in depth understanding of how faculty, students and administrative staff accepted and used mobile devices for teaching, learning and administration in the real-world setting of providing tertiary education in Ghana.

3.5.3 Unit of analysis

The activities of individual students, teachers and management of CUC including some external stakeholders from National Accreditation Board (NAB) and National Council for Tertiary Education (NCTE) were the core of the study to gather data aimed at answering the main question of the study, which seeks to find out "how" teachers, students and administrators will be able to use mobile computing devices to improve their academic activities in and out of campus. The investigation focused on daily academic activities specifically of teachers and students with the interest of understanding and interpreting how they use their mobile device for teaching and learning respectively. Because the introduction of mobile learning, like any

educational technology in tertiary schools is a phenomenon, which emerges as the teachers and students and administrators interact and construct meaning within their social context.

3.5.4 Population and Sample

Generally, tertiary education institutions in Ghana were the population for the study but the focus was on universities. Central University College with an entire population of over 10,000 including students, teaching and non-teaching staff was chosen as the main sample because they showed interest and had preparations in advance to use mobile devices for teaching and learning. Out of this population, a little over 5,000 actually used the system from which about 1600 students and 82 lecturers were purposefully and conveniently selected from level 100, 200, 300 and 400 as the core sample size for the research.

3.5.5 Data sources

A combination of different qualitative and quantitative data collection methods were used to gather data. The purpose was to gather a holistic data out of the emerged phenomenon within the academic and socio-cultural context of the participants because they used the m-learning platform differently to achieve their objectives. For example, the teachers mainly use the platform to monitor, design and publish content for students, while the students used the platform to learn and do assignment etc.

3.5.5.1 Interviews, focus group and discussions

Both unstructured and semi-structured open-ended styles of interviewing were used in gathering data because of the explorative nature of the research. I was particularly keen in the participants' points of view in giving insight into what they see as relevant and necessary to their daily academic activities as they use the mobile learning platform. The intention was to allow the participants who were mostly teachers and students to narrate their natural experience of using mobile computing device for teaching and learning respectively. They were posed with questions which granted them the free will to talk about their individual mobile learning experience at CUC using their personal smart & mobile phones, tablets and note-books in their teaching and learning experiences such that their verbal and non-verbal actions gave a clear view of what they make out of m-learning.

My role as a facilitator and a member of the project team was engulfed with countless conversation on both telephone and face-to-face interactions with teachers, students and administrative staff on daily basis, especially during semesters. I served as a liaison between the users (teachers, students & administrative staff) and the project team. The willingness of the project team and the users to cooperate with me in exploring the use of mobile computing devices for teaching & learning in CUC offered me the opportunity to create a good rapport with them. This served as an opportunity for informal conversations/discussions especially with the users at anytime and anywhere we met and had the chance to chat in the cafeteria, computer laboratory, summer hats, in the hostel, on the terrace and on the staircase and sometimes in my car when I offered any of the students or teachers free ride to their hostel or home after lectures. These conversations/discussions were spontaneous so I could not record most of them because I did not want to distract the natural flow of the context, but what I did for the ones I could not record was to quickly jot down the key points of the conversations immediately we parted company.

In the midst of the intermittent spontaneous conversations/discussions, formal individual interviews were conducted mainly on face-to-face with some of the teachers and administrative staff, but for the students, it was a mixture of face-to-face and on telephone. In all 15 teachers, 46 students and 4 administrative staff were formally interviewed in both campuses of CUC which are about 60 kilometres away from each other. As a part of ensuring smooth interviewing for the teachers and administrative staff, I prepared a tentative schedule chat for each interviewee to choose the day and time that he or she thinks would be suitable and convenient for him or her to invite me to come and conduct the interview. This exercise took a couple of days. Some scheduled for me to meet in their offices whiles others chose different venues, which they deemed convenient. All the interviewees warmly welcomed me when I arrived to interview them because I had already established a good rapport with them, through casual conversation/discussions. I informed them on my intention to record the interview but only a few of them allowed me to do so. For the students it was strictly informal, I only had to call them on phone to arrange for the interview. About 60% of the students' interviews were done on the phone while the rest were done face-to-face mostly in empty lecture halls, under summer hats, in the school cafeteria and in the assemble hall.

To complement individual interviews, there was an opportunity for focus group discussions, which was not originally part of the data collection methods but was suggested by some of the

students and teachers as a platform to get the views of some of them who could not be interviewed to share their m-learning experience at CUC. We had two focus group discussions with the teachers and 6 with the students with each session having different set of participants, ranging from 6 to 10 for the teachers and 9 to 20 for the students at all the campuses of CUC with each of the sessions lasting 1hour to $1^1/_2$ hours. During the discussions, I asked questions, which demanded collective discussion allowing the participants to throw more light on their opinions, feelings, attitudes and behaviours with the introduction of m-learning at CUC. One characteristic, which run through all the discussions was that participants asked their colleagues questions on their experiences with the m-learning platform. This I must say enriched the discussions with diverse views on the phenomenon of blending face-to-face classroom education with m-learning. The discussions were interesting and revealing in nature. Thus, the participants in a bid to prove their active use of the m-learning platform, openly in an objective and subjective dispositions shared their authentic experience in all facet of the use of mobile computing devices for teaching and learning at CUC. I recorded all the discussions and took down some notes where necessary.

3.5.5.2 Participant Observations

As a way of seeing through the eyes of the teachers and students being studied (Bryman, 2008), participant observation was one of the means which was used in gathering data on the everyday academic activities of the teachers, students and administrative staff as they use the m-learning platform. Observation of the participants gave me a better place for gaining a foothold on the social reality of the use of m-learning at CUC. Agreeing with (Lofland & Lofland, 1995), I took the role of the teacher, students and administrative staff at different times at CUC as a strategy to acquire in-depth social knowledge and understanding of the use of mobile computing devices for teaching and learning. I immersed myself in the activities of CUC, observing behaviour, paying attention to what is said in conversations among participants and asking questions. My role as a participant observer was not much different from that of an ethnographer.

My observing role took the form of both overt and covert in a closed setting, similar to Atkinson's research on the training of doctors in a medical school (Atkinson, 1997) as stated by Bryman (2008). Although I was an "open" observer with regard to the teachers and administrative staff, but for almost all the students I was a disguised observer. Luckily, as a

teacher from a sister University close to CUC, I was able to adapt culturally, which helped enormously in my observations. But I must be quick to say that it was not without hurdles as acknowledged by (Sarsby, 1984; Van Maanen & Kolb, 1982). Observing the m-learning activities of the teachers, students and administrative staff at CUC gave me extensive contact with their social setting which allowed their context to map out the behaviour. I had prolonged interactions with them in a variety of different situations which forged a link between their behaviour and context in a naturalistic manner. The inherent longitudinal characteristics of participant observation created the avenue for me to be present in the social setting of CUC for almost 30 months, thus 5 semesters of academic work. This enabled me to observe change and connections between learning and teaching activities.

We were given a temporal office at one of the campuses. This made it relatively convenient for me to monitor activities. Practically, what I did was that I took advantage of every opportunity I got to observe them. For example, while helping the teachers to design and format content for publishing on the m-learning platform, I made some observatory note. I remember at one time an adjunct lecturer at the economic department thought I was a lecturer at CUC when he was directed to see me for assistance on the pedagogic consideration for the m-learning platform. In the case of the students, I was registered on the m-learning server as CUC student and I was among them all the time chatting and sharing ideas on the use of the m-learning system without most of them knowing my identity because they thought I was a student worker, working with one of the departments. I can recollect an instance when an SMS alert was broadcasted whiles the students were interacting with each other, informing them of an available content. But unfortunately, administrative staff observation was not too interesting because currently on the m-learning platform as implemented at CUC, working activities of the administrative staff do not involve much use of the m-learning platform except the registry department. But that did not take away anything because the core participants were the teachers and students.

3.5.5.3 Workshop

Stakeholders' workshops were also used as part of the data collection process. In all, 3 major formal workshops were organized in addition to the focus group interview and meetings. One of the workshops was opened to all stakeholders in Education and ICT in Ghana, while the other 2 workshops were exclusively organized for the CUC community. The objective of the workshops was to offer people with diverse views, an opportunity to share their thoughts on

harnessing mobile technologies to facilitate tertiary education delivery through the use of m-learning platform. The title of the thesis, which is "Leveraging mobile technologies for tertiary education in Ghana: incorporating mobile leaning into tertiary education" was the theme for all the workshops.

One of the workshops, which was opened to the public was held on the 29th of November, 2011 at the Video Conference Room (VCR) at Ghana Telecom University College (GTUC). It was a whole day's workshop, which started at 9:00am and ended at 5:35pm with 96 participants out of which 3 participated online from Aalborg University Demark, through video conference whiles the remaining were drawn from the National Accreditation Board (NAB), National Council for Tertiary Education (NCTE), Ministry of Education, Ministry Communications, National Communication Authority (NCA), National Information Technology Authority (NITA), Mobile Telecommunication Companies, Universities, Polytechnics, Teacher Training Colleges, the media etc. The workshop, which was chaired by the president of Ghana Technology University College (GTUC) had 4 distinguished speakers in the area of education and technology who spoke on the theme from different perspectives, with each speaker picking on the research questions of this thesis as his or her point of departure. The program was designed to encourage all the participants to contribute on the theme. Thus, after the main speaker's address, the participants were put into 9 groups with about 10 people in each group to discuss specific issues raised by the main speakers. Some of the issues, which were discussed were but not limited to the following: the role of mobile phones and portable computing devices in tertiary education, the role of mobile telecommunication service providers in facilitating m-learning, which policy and regulation are needed for the sustainability of using mobile devices to teach and learn in tertiary education institutions, what kind of infrastructure is needed, cost, benefits and challenges of m-learning. After the group discussion, group leaders gave presentations on behalf of their group after which the participants were given questionnaires to answer, which they submitted at the close of the workshop.

The other 2 workshops were organized on different occasions at all the campuses of CUC and they were held specifically for the faculty, students and administrative staff at CUC. It had the same topic as the previous one, but this time the focus was on CUC since it is the only tertiary education institution, which is using m-learning platform in addition to face-to-face classroom education in Ghana. These workshops, which were for only CUC was nicknamed "local workshop" by the project team. Unlike the focus interview, which was segregated, the local

workshops brought together faculty, students and administrative staff in a single gathering to holistically discuss m-learning at CUC. The local workshops were held after the 3rd semester into the implementation of m-learning at CUC. At this stage, faculty, students and management had used the m-learning platform and thus had sufficient authentic experience to have a meaningful discussion on the theme. Both workshops were chaired by the project coordinator with three speakers each, representing faculty, students and administrative staff who spoke on specific topics derived from the research questions. There were plenary sessions with about 8 groups which discussed specifically the relevance, role, effectiveness, benefits, challenges, pedagogy and impact of m-learning at CUC. This gave all the participants the chance to contribute and share their rich experience in the use of their mobile devices for teaching and learning in the past three semesters at CUC. The workshops served as a rich source of data for constructing contextual understanding and interpretation of the m-learning phenomenon at CUC.

3.5.5.4 E-mails, SMS and Documents

E-mails and SMS were used as one of the less expensive and unobtrusive means of communication among the project team and the participants, which allowed us to share information rapidly at all times. The use of the e-mail and SMS were made easier and cheaper because the m-learning platform had an integrated single and bulk e-mail and SMS facility. This made it quiet convenient for teachers, students and administrative staff to send e-mail or SMS on any issue bordering them on the use of the m-learning platform to any of the project team members and myself. It was a great means of collecting data. The option to use e-mails and SMS helped in minimising the frequency of phone calls from the participants to me. At least there was not a week that no e-mail or SMS was sent to me on one issue or other. However, the asynchronous nature of the e-mail and SMS allowed me ample time to investigate what was happening before I answered. At the same time, I had automatic reply to all the e-mail and SMS, which informed the senders that they will receive feedback soon.

I also had access to reports and other relevant documents, some of which I got from the CUC website on the internet whiles I officially requested others which were not on the internet from the administration. Some of these documents included but not limited to the following: statistical data on teacher student ratio, class sizes, admissions, courses and strategic plans. This provided useful information to augment data, which have been collected from other

sources. These sources of information were very useful in shaping the focus of the research problem and the formulation of the research objective and questions.

3.5.5.5 Meetings

As part of my role as a researcher and facilitator for the project, I held a lot of meetings with the project team and the coordinators from the various faculties throughout the project implementation. We had both formal and informal meetings which were either planned or ad hoc. While I initiated most of the meetings, others were by the whole project team and faculty coordinators. The meetings were held face-to-face at designated venues and on Skype depending on the number of participants and the situation. These meetings were very useful in providing reliable and first-hand information on the implementation, adoption, usage and net benefits of the project. The meetings offered us the forum to present written and verbal reports and observations for deliberations.

The initial meetings concentrated on the designing, planning and incorporation of the m-learning technology into the educational framework of CUC to facilitate teaching and learning through the use of portable or mobile computing devices. This was followed by other meetings, which focused on user training, device compliance, mobile broadband services and network connectivity, policy and regulatory issues. Furthermore, other meetings were concerned with reported problems from participants as they use their mobile devices for either teaching or learning anytime from anywhere. There were also special meetings, which were arranged with the system developers and the technical support staff to discuss system efficiency, maintenance and technical support where I had numerous informal conversations and interviews with them.

Although discussions at the meetings were unexhausted and time consuming, it proved to be helpful to the project team, coordinators and me. After every meeting, where necessary, responsibilities were assigned to specific people. This was useful in investigating the CUC phenomenon of m-learning as the first tertiary education institution in Ghana to incorporate m-learning into their educational framework.

3.5.5.6 Questionnaires

As part of constructing holistic evidence, self-completion questionnaires were administered to the participants to complement the interviews, observations workshops, documents and

meetings. The Questions were designed electronically on the same m-learning platform that the teachers, students and administrative staff were using. Likert scale and "Yes" or "No" questions were designed and submitted to all the teachers, students and some administrative staff at CUC at once on their mobile devices. I received the respondents feedback on my smart phone and by e-mail immediately he or she finished answering the questions and pressed the submit button which was beneath the questions. It took almost two weeks with SMS reminders to receive about five thousand two hundred and forty one (5,241) responses out of five thousand five hundred (5,300) participants at CUC.

The purpose of the self-completion questionnaires were to obtain specific data from the participants on the computing capabilities of their smart phones, interest in m-learning, the m-learning platform system quality, service quality, information quality, usefulness and impact and issues which affected their intention to use m-learning. The data, which were collected were used for the quantitative analysis of the m-learning phenomenon at CUC. All the three categories of the participants (teachers, students &administrative staff) received different sets of questions, which were aimed at soliciting peculiar information from them. The questions were simple short sentences, which were easy to understand.

3.6 Data analysis and interpretation techniques

To make meaning out of the data which were collected in an attempt to answer the research questions, both qualitative and quantitative forms of data analysis and interpretation were used in this study in analysing and interpreting the data which were obtained (Miles & Huberman, 1994). The choice of analysis and interpretation were guided by the philosophical background of the study, research design and the intended objective of the study. The data, which were gathered from the interviews, observations, workshops, meetings, documents and questionnaires were in the form of texts, figures and signs and symbols, transcripts, notes and pictures including videos and voice recordings. Phenomenological combined with hermeneutics and descriptive statistical interpretation techniques were used in deriving both objective and constructive meaning out of the mixed data that were obtained from the teachers, students and management of CUC as they used the m-learning platform for teaching and learning in the real-world (Groenewald, 2004).

Phenomenological Hermeneutic (PH) analysis is fundamentally based on interpretive strategy of analysing data (J. A. Smith, 2007a, 2007b). It contrast other methods which belief in knowledge, which is objective and independence of interpretations. Instead, it grants researchers with the guts to explore thoroughly how participants make meaning out of their personal and social world, and more importantly reflections of individual participant's contextual experiences as the phenomenon unfold (Goulding, 2005). PH is predominantly about doing detailed assessment of the participant's real life-world and exploring their personal experiences and particularly interested in the individual's personal conception of a phenomenon, as opposed to obtaining an objective knowledge of the emerged phenomenon. In this study, my active role in the participant's personal context facilitated the use of PH analysis to produce extensive understanding of meanings from the teachers, students and administrative staff in the real world as they used their mobile devices in teaching and learning. In the process, I tried to make sense of the teachers, students and administrative staff as they construct meaning of their world of m-learning. Understanding was obtained through methodical interpretation procedures (J. A. Smith, Flowers, & Larkin, 2009). My understanding of the phenomenon was deepened by the use of both of Phenomenological and hermeneutic (Hycner, 1985) in analysing the qualitative aspect of the data which was based on discussion and reflections of the authentic perception and experiences of the participants. The whole idea was to understand from the participants' point of view and what it is like, to take their side.

In addition to the PH analysis, descriptive statistics (DS) were used for analysing the quantitative data (Yanow, 2003). The use of DS basically provides summaries on the sample and the measures with graphic analysis of the quantitative data. DS is for describing what the data indicates. The most common characteristics of quantitative analysis are the graphical representations of statistically analysed data. In this study, descriptive statistical analysis was used to show the quantities, frequencies, distributions and classifications of the m-learning phenomena. This provided detailed quantified analysis of the phenomena. The use of graphs, charts and figures helped me in the exploration, presentation and description of the quantitative data (Newman & Benz, 1998), (Rabiee, 2004).

3.7 Validity and Reliability Assessment

Validity and reliability of constructs are some of the measuring criteria for ensuring that the outcome of any scientific research meet acceptable standards of presenting research results to the general public. Both qualitative and quantitative paradigms of research accept construct

validity and reliability among others as tools for assessing the legitimacy of the outcome of a research in terms of generalisation, causal relationships and repeatability (Trochim, 2000). Thus, validity and reliability are the empirical combination of theory and observation to construct a concept as shown figure 3.2. As part of ensuring a presentation of valid and reliable results in this study; quantitative and qualitative data were gathered from multiple sources for complimentary and confirmatory purposes. In addition, statistical software SPSS.19 was also used to mathematically verify the validity and reliability of the results.

3.7.1 Validity Assessment

Construct validity as generally known in research refers to operational measure between construct and the degree to which correct measurement for the concepts understudy are established. Thus the extent to which inferences can be made legitimately out of the operationalization of a study in relation to the conceptual constructs it seeks to espouse. Yin in his contribution to the discourse of validity suggested three ways for improving the validity of constructs, which are (i) establishing a series of connected links of evidence, (ii) using multiple sources of evidence, and (iii) having a draft case study report reviewed by key informants (Yin, 2008). In this study, multiple sources of data were utilised. Within the scope of this, data were obtained from students, lecturers, administrative staff, official documents, official websites and key persons.

3.7.1.1 Internal Validity

The issue of internal validity has to do with the extent to which a causal relationship can be established, thus to show that certain conditions may cause certain conditions to occur (Cook, Campbell, & Day, 1979; Stuart, McCutcheon, Handfield, McLachlin, & Samson, 2002). As part of enhancing the internal validity of the study, a framework was designed based on related theories and research. Furthermore, pattern matching of existing theories (Grosshans & General, 1990) was conducted in addition with factor analysis using principal component analysis and varimax rotation. These methods helped in establishing the internal validity of the study.

3.7.1.2 External validity

External validity assessment refers to the extent to which the results of a study can be generalized (Trochim, 2000). Thus, the degree to which a pattern from a particular situation in a specific context can relate to the same situation in a different context. It must be noted that different research paradigms have different methods for establishing external validity. For

example most qualitative studies aim at analytical generalization whereas quantitative studies seek to establish generalization through the use of statistics (Yin, 2008). The mixed method approach to this study offered the flexibility for making use of both analytical and statistical generalization. The strength of the external validity of this study is founded on that fact the constructs of study were espoused from existing theories.

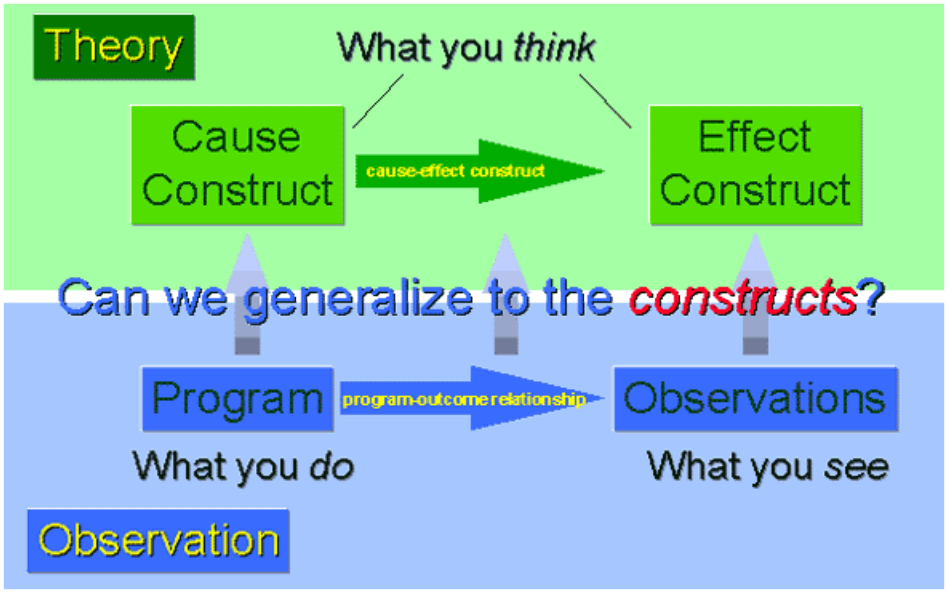


Figure 3. 2 the concept of validity
Source: Troachim, W (2000). The Research Method Knowledge Base 2nd Edition.

3.7.2 Reliability Assessment

Reliability has do with whether a study can be repeated with the same outcome (Yin, 2002, 2008). It refer to the quality of measurement in producing consistent or repeated results. Reliability can be achieved statistically with the use of SPSS to analyse the inter-item correlation and cronbach's alpha of the constructs being studied. (Stuart et al., 2002) also adds a suggestion that the reliability of a study can be enhanced by explicitly explaining procedure and making data sources available, so that other scholars who may conduct similar studies may obtain the same results following the same procedure. In this case study, both statistical and non-statistical reliability methods were utilised for establishing the reliability of the results.

3.8 Ethical Consideration

Action research as a strategy of inquiry is often criticised on ethical grounds. Most criticism of social science research such as case study, action research, ethnography, phenomenology among others include but not limited to ethical issues such as; validity versus causing harm, anonymity versus visibility, scientific understanding versus individual rights, detached inquiry

versus help, help giving versus confidentiality, freedom of inquiry versus political advantage (Morton, 1999), (Williamson & Prosser, 2002). For example, critics of action research perceive the participatory role of the researcher as an antecedent for compromise and bias. Thus the dual responsibilities of the researcher pose some ethical concerns which must be addressed.

Several literature on action research provide guidelines on how to conduct action research which is ethically sound (Coughlan & Coghlan, 2002). Ethics of action research demand among other things that the researcher must play his or her dual role as distinctively as possible, his or her involvement must be managed carefully to avoid conflict of interest and must officially obtain written agreement document, which authorises him or her to undertake the action research. Such document usually specify the terms and conditions under which the researcher is obliged to adhere. In this study all, the above-mentioned ethical issues were carefully complied with as a matter of urgency to ensure good ethical standard of the study. I was involved in this study as a student researcher with the intention of experiencing participants' practical use of m-learning while deducing theoretical understanding of their actions. In view of this, I wrote a letter of consent to the two organisations – Central University College and AD-CONNECT which they replied by giving their consent to allow me to carry on with the study.

3.9 Conclusion

The chapter gave an overview of the methodology, which was used in this study. It explained and gave reasons for my choice of philosophy, which is pragmatism, which supports both qualitative and quantitative data collection methods in analysing and drawing conclusions. The basis for the pragmatist position for this study is established in the fact that the study is multi-dimensional, in that, aspects of the study could be objective without the interference of the social setting and humans. However, other aspects are actually influenced by the human interaction in the use of their mobile devices for teaching and learning in the real-world context of CUC. This led to the adoption of mixed method approach of the study using Action Research strategy of inquiry. The type of evidence of the study, unit of analysis and the sources of data collection were thoroughly elaborated including the data analysis and interpretation techniques.

CHAPTER FOUR

THEORETICAL FRAMEWORK

4.1 Introduction

The purpose of this chapter is on the theoretical underpinnings of the study. This research was conducted using different but complementary theories in educational, information technology systems theories and activity theory. The foundational theories of the study are the three main philosophies, which are used in educational technology publications. These are Objectivism/Behaviourism, Cognitivism/Pragmatism and Constructivism/Interpretivism, which are the theoretical foundation for education and instructional technologies. Each of these theories has evolved as the psychology literature has evolved giving rise to various embedded and related views by theorist.

The objective of the study warranted the use of educational technology theories as the philosophical framework for studying the incorporation of mobile e-learning in higher education. In this chapter, I discuss the basic principles of these theories and their implications for technology mediated learning. The purpose of my argument basically, is on the assumptions of these theories and their connection to technology in education. The nature of the research was such that all the three basic philosophies on the use of technology in education had to be discussed. This was essential in providing a solid theoretical foundation for the Action Research approach adopted as the strategy of inquiry for this study. The discussion starts with the general overview of the theories, followed by their basic principles, instructional objectives and models, applications of technology in teaching and conceptual framework for incorporating technology in education.

4.2 Overview of the theories

The ontological and epistemological philosophies of behaviourism, Cognitivism and Constructivism are essential to any kind of human interactions. The human being and his / her interaction with the "object world" – that is the world of the non-human can be interpreted as either behavioural, cognitive or / and constructive mediated by artefacts (Vygotsky, 1978). Particularly, education and the use of technology as instructional or mediating device are to a

large extent motivated by the ideals of these theories. However, each of them has its own pros and cons. None of them is superior to the other because their drawbacks are augmented by each other's strength when they are used together. Since the time of their inception, they have all been used in different capacities by different people with different goals to achieve different desired results. They have all been criticised in one way or the other by philosophers and researchers for various reasons, either positively or negatively. But this has rather clarified their basic assumptions leading to the espouse of several embedded theories which includes but not limited to Pavlov's classical conditioning, Skinner's operant conditioning, Thorndike's laws and connectionism, Gestalt theory, dual coding theory, cognitive flexibility theory, generative learning theory, social-cultural learning and situated cognition. It is therefore necessary to have good knowledge of these theories to be able to effectively use educational technology for teaching and learning. In this research, the incorporation of mobile e-learning into the educational system in Central University College was rooted in these theories and their implication for using mobile technology for teaching and learning in higher educational institutes. This was rooted in technology enhanced learning (TEL) and the mobility of portable ICTs and users.

4.4 Basic Principles of the theories

Behaviourism, Cognitivism and Constructivism or otherwise known as Objectivism, Pragmatism and Interpretivism respectively differ from each other based on their fundamental principles. These principles are based on empirical study conducted by the proponents of the theories. The theory of behaviourism concentrates on the study of overt behaviours that are visible and measurable (Thorndike, 1932), (Chance, 1999), (Pavlov, 1927), (Todes, 1997). It concentrates more on the behaviour of the learner than with thinking, feeling, or knowing. Its main focus is on the actual and manifest constituents of behaviour. It perceives the sense of the learner as a "black box" where no one knows what happens in. John Watshon introduced behaviourism, but it became a theory based on the works of Burrhus Frederic Skinner ("Learning theory (education)," 2013) including the work of people like Edward Thorndike, Ivan Pavlov, Edward C. Tolman, Clark L. Hull and Guthrie ("A Science Odyssey: People and Discoveries: Ivan Pavlov," n.d.).

Behaviourism is a worldview, which works on the concept of "stimulus-response". Thus, an external stimuli influences a person's actions (operant conditioning) and can be interpreted

without taking into account the inner mental states or consciousness of the person. It presumes that the learner in reality is only responding to environmental stimuli. The learner comes on board as a clean slate and his or her behaviour is moulded by either positive or negative reinforcement. Positive means the use of stimuli while negative implies the withholding of a stimulus. This infers that learning occur only when there is a change in the actions of the learner. The presumptions of behaviourism are that it is realistic which means that the material world is the ultimate reality. Thus, the soul and mind of man is irrelevant to behaviourist, except the brain which responds to external stimuli ("Behaviorism Theory Overview," n.d.). The behaviourist believes that the feelings, intentions, thoughts, and cognitive processes of the student do not affect what he or she does. Rather, the student is a biological system without consciousness, which only responds to stimuli, that is action is the result of conditioning. Behaviourists view human beings as mere entities that are not responsible for their actions and anything they do is foreseeable, but Skinner developed the concept of "shaping" which paves way for the learner to be manipulated by controlling rewards and punishment to improve his or her conduct (Dews, 1955). His theory searches for more beyond the human response to predict and control ("B. F. Skinner," n.d.).

By principle, behaviourism asserts that learning only happens when the correct response takes place following the application of a particular environmental stimulus that can be noticed by observing an organism over time. The emphasis is on observable and measurable behaviours of the learner and the relationships between the change in the environment and behaviour. The learner is like the "black box" metaphor, where what happens inside the brain is unknown and so it cannot be observed and measured. Behaviourist teaching relies on outcome and reinforcement of changed behaviour guided by objective. Though criticized as focusing only on measuring of the behaviour of the learning outcome instead of understanding, attitude, values and beliefs, it is still common to learning because it is a systematic means for measuring knowledge and learning through tests and examinations ("the behaviourist orientation to learning @ the informal education homepage," n.d.). Behaviourism has many embedded theories including, but not limited to the following: Pavlov's classical conditioning, Skinner's operant conditioning, Stimulus-Response Theory, Thorndike's laws and connectionism and information processing. The option to use any of them is dependent on the intended learning objectives.

The criticism of behaviourism led to the emergence of cognitivist theories. It actually started as a shift from behaviourist thinking and practices which focus solely on external behavioural outcome, and not on cognitive system and how it could be used to promote effective learning (Tam, 2000) but both Cognitivism and Behaviourism belief in the objectivity of acquiring knowledge and what it implies to know something. According to Brenda Mergel, the transition from behavioural orientation to that of cognitive did not encounter much difficulty ("Classics in the History of Psychology -- Pavlov (1927)," n.d.), while the behaviourist will break down a task into small steps and try to get the most appropriate method of transforming the learner, the cognitivist will examine the activity, break it down into smaller operations and use the outcome information to design instruction that progresses from easy to difficult (Bednar, Cunningham, Duffy, & Perry, 1992). Cognitivism approach to learning actually emerged from Gestalt psychology (Carleson, Buskist, Enzle, & Heth, 2005), (Hothersall, 2003). Gestalt can be translated as "formation" or "configuration" or "unified" or "the meaningful whole" of the human experience (Yount, 2010). The leading theorists for cognitivism were Wertheimer, Kohler and Koffka, but Graf Christian Von Ehrenfels whose views motivated the trio of the theory (Wulf, 1996), (Sahakian, 1976) formulated the term "cognitivism". Cognitivist belief is that the "black box" of the mind must be opened to see what happens in there. Thus, the concentration of Cognitivism is on the central mental activities of the learner (Ausubel, 2000), (Merriam, Caffarella, & Baumgartner, 2012). The opening of the learner's mind is essential for understanding how he or she learns. It offers the opportunity to study cognitive processes such as memory, thinking, knowing and problem-solving. In cognitivism learning is a change in the learner's knowledge where knowledge is typical mental constructions (Myers, 2004). Cognitivism response to behaviourism is that people are not programmed animals that only respond to environmental stimuli; rather they are rational beings who require active participation to be able to understand. The learner's actions are as a result of his or her thoughts. Cognitivist sees the mind as a computer where information comes in (input), processed and produces an outcome (output) (Semple, 2000).

In Cognitivism, the interest is in the understanding of the brain-based learning instead of reaction. It looks at how the human memory acts to facilitate learning. For example, educators who are cognitivist are interested in cognitive processing of information and events into short term and long term memories (Lilienfeld, Lynn, Namy, & Woolf, 2009). The main difference between Cognitivism and behaviourism is the essence of control over the learning activity:

Individual's learning is relevant to the cognitivist while the behaviourist is concerned with the learner's environment.

Educators who choose cognitivist approach to learning usually perceive learning as internal mental process involving information processing, memory, intuition and understanding to create learner's capacity and skills to enhance learning. This goes with most educators because most often, learning content can be structured to focus on developing intelligence, cognitive and meta-cognitive development. Cognitivism can be seen as advancement on behaviourism, with the assumptions that it perceives learning as a change of consciousness level where the acquisition of knowledge is a cognitive process. The learner is an active participant in the entire learning process. The focus is on the building blocks of knowledge, structuring, organizing and analysing information to promote optimal processing. Learning is a dynamic process which takes place within the learner and which can be manipulated by how the learner remembers, retrieves and stores information in memory. To the cognitivist, the outcome of learning is not much on teaching, but on what the learner is able to do to process information ("Instructional Design Knowledge Base," n.d.).

The third opinion to behaviourism and Cognitivism is the constructivist worldview. Constructivism is a revolution in educational psychology founded on the work of Piaget and Bruner. Constructivism as learning theory emerged from the learning theories of John Dewey, Marie Montessori and David Kolb (Lombardi, 2011). It is a meta-concept for thinking and knowing. It is a communication theory which alludes that each listener or reader contextually uses the information and process the communication in their own constructive ways. Thus, constructivist belief that knowledge is not out there as posited by objectivist philosophers like Plato and that knowledge is an understanding of the real-world by learners constructing knowledge independently and socially, glued with meaning.

In constructivism, the focus is on the relevance of active participation of the learner in constructing knowledge by themselves and for themselves in a progressive manner. Learning as perceived by constructivist is a process where the learner consciously constructs or develops innovative ideas or thoughts based on current and prior knowledge or experiences. One can affirmatively say that constructivist method of learning is individualistic which has to do with constructing one's own knowledge from one's own experience in a practical real-world guided by personal conceptions, rules and principles. Jonassen states that what someone knows is

grounded in understanding of the physical and social experience which is comprehended by the mind (Jonassen, 1991).

The popularity of constructivism in education is that constructivism allows the learner to establish his or her own opinion from new information as they interact with the real-world. Constructivist designed learning environment oblige learners to make use of their previous knowledge and experiences to develop new, related and adaptive concepts in learning (DeVries & Zan, 2003). The role of the teacher in constructivist learning environment is not an expert instructor, but a facilitator who provides guidance to assist students in constructing their own learning. Jonassen asserts that in choosing technology for the purpose of constructivist learning, it must be based on the ability of the technology to enable reinforcement of previous learning in a problem-solving setting (Jonassen, 1997).

Constructivism has several perspectives, which include social constructivism theory, cognitive flexibility theory, generative learning theory, situated cognition and social-cultural learning theories, but they all believe that learning is a dynamic process, unique to the individual and involves the creation of conceptual relationships and meaning from the learner's existing knowledge and experiences. The principal assumptions of constructivist learning theory are that the learner constructs personal interpretation of the world based on experiences and interactions, using sensory input to perform an activity and make meaning out of it. The knowledge the learner acquires connects to the context of application. Knowledge is gathered from diverse sources appropriate to the problem background to make innovation and situation-specific learning, knowing that there are several means of structuring the world and its entities and that 'meaning' comes from the individual rather than existing separately.

4.5 Learning or Instructional Objectives

The three key learning theories being discussed here have different learning and instructional objectives. Their underlying principles indicate their intended goals and educational institutions are usually aligned to them based on their educational system and anticipated learning outcomes of their students. The learning objectives of any educational institution can be categorised to be behaviourism, Cognitivism, constructivism or a mixture of them. For example, most higher education institutions often use a combination of them, but one of them may dominate as shown in figure 4.1 – 4.3. In Ghana, almost all the tertiary education

institutions use a combination of them, but the most notable is cognitive learning with traces of behaviourism and constructivism. In Denmark, Aalborg University uses constructivist approach - problem based learning (PBL) as their principal pedagogic framework with a reasonable percentage of behaviourism and Cognitivism (Scott, 2010), (Kolmos, A. F., & Krogh, L., 2004). The adoption of these theories by educators helps them in selecting and designing appropriate pedagogical framework to meet their educational goals. It also provides them with the grounds to select appropriate technologies, which are capable of aiding them in their instructional delivery. In this dissertation, I think it necessary to examine all these three learning theories and their role in technology mediated teaching and learning because Central University College, the institution for this action research project, uses Cognitivism as its main pedagogic foundation, supported with behaviourism and constructivism depending on the course objectives (Annan et al., 2012). Learning theories emerges from the philosophical assumptions of educational psychology. From these assumptions have evolved current theory and practice about how learning occurs and how teaching in the classroom primarily affects learning. They have their advantages and disadvantages that make them suitable and unsuitable in some specific learning situations. Knowledge of Behaviourism, Cognitivism, and Constructivism are necessary to approaches in teaching.

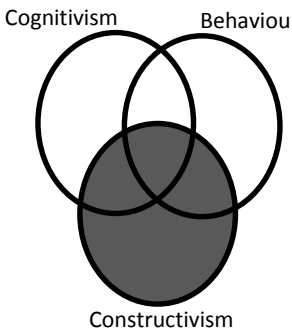


Figure 4. 1 PF dominated by Constructivism

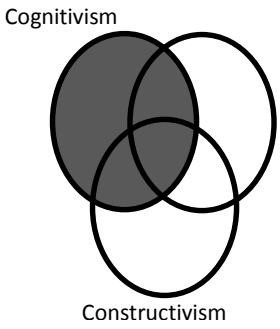


Figure 4. 2 PF dominated by Cognitvism

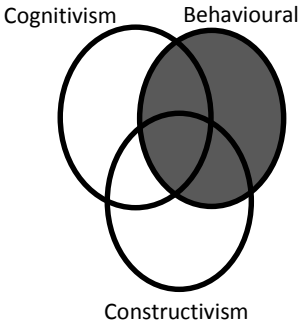


Figure 4. 3 PF dominated by Behavioural

In education, one must clearly understand the implications of using any of these learning theories (Dabbagh & Bannan-Ritland, 2005). For example, the decision to use behavioural philosophy implies that teaching is by direct instruction with the intent to transfer behaviours representing knowledge and skills to the learner, by way of instructing the student to carry out the required response when presented with stimulus. The learner or student must be able to know how to produce the correct answer as well as circumstances under which the responses occur. It teaches learners the skills of discrimination, facts recalling and generalization with the

ability to establish and illustrate concepts. With behaviourism, activity, repetition and reinforcement are hugely beneficial, and the entire learning process becomes effective when learners receive immediate feedback on their performance. In contrast to behavioural approach is the cognitivist approach to learning. The expected learning outcome of the cognitivist method of educating people is to disseminate knowledge in the most efficient and effective manner, where the instruction focus is to promote learning by encouraging the learner to use appropriate learning strategies. Learning is achieved when information is stored in memory in an organized and meaningful way, guided by the teacher. The anticipation is for the learner to develop learning through receiving, storing and retrieving information. In this sense, the teacher focuses on designing appropriate tasks needed to support the learner to effectively and efficiently handle the information received. The learner uses the information processing approach to transfer and assimilate new information. The concentration is on how the learner processes and store information as he or she goes through the learning process. Thus, Cognitivism focuses on the "brain", and it can be summarised using bloom's taxonomy of learning, which provides six stages of learning – knowledge, comprehension, application, analysis, synthesis and evaluation.

Different to behaviourism and Cognitivism pedagogic framework (PF) is the constructivism approach. This style of teaching and learning aims at enabling the student to make personal meaning of the world, based on his or her experiences and interactions with the understanding that learning is worthwhile if it is contextualised. A constructivist pedagogical framework focuses on constructing active learning process instead of merely acquiring knowledge. The teaching style is a way of helping knowledge construction rather than communicating knowledge. The learner is involved in the use of learning tools in a natural setting, and the learning activities are authentic and modelled around problem solving, based upon personal current or previous knowledge, social interactions and motivation affect the interpretation. This promotes reflective thinking and higher-order learning skills, which test the viability of ideas and seeks different views with the teacher as facilitator.

Constructivist educators focus on making connections between facts and fostering improved understanding in students. They adjust their teaching strategies to student responses and encourage students to explore, interpret, and forecast interpretation. Teachers also rely heavily on open-ended questions and promote extensive dialogue among students. They do not believe in standardized curriculum. Instead, they focus on using curricula customized to the students'

prior knowledge and emphasizes on "hands-on" problem solving. This method of educating people is geared towards how learners construct their own interpretation. The students ask questions and relate the feedback to understand the environment. Their actions lead them to incorporate new knowledge with prior knowledge to create new meanings. Multiple perspectives and representations of concepts and content are encouraged ("Teaching and Learning Resources / Learning Theories," n.d.).

The students construct their own objectives, or in consultation with the instructor where activities, opportunities, tools and conditions are provided to facilitate metacognition, self-analysis, regulation, reflection & awareness. The student plays a key role in mediating and controlling information. Learning situations, environments, skills, ideas and tasks are realistic. First-hand information is used in order to ensure authenticity and real-world complexity emphasising on knowledge construction, not reproduction. Learning occurs in contexts and through collaboration and experience. Explorative approach is used in order to assist learners to acquire knowledge in their own way. Assessment is authentic and interwoven with teaching. This Constructivism process of learning promotes a more open-ended learning experience, where the methods and results are difficult to assess and which varies for learners.

4.6 Pedagogical or Instructional Models

Pedagogic or instructional models are procedures or sets of strategies on which the styles of teaching by educators or instructors are founded. It serves as a scientific guide to the teacher on how he or she must deliver content to the students or learners based on a learning theory – Behaviourism, Cognitivism and/ or Constructivism to realize the desired result. The principles and learning goals of these learning theories have led to the design of different sets of pedagogic models. Each of them has several models. Educators must ensure that their pedagogic models are based on sound theoretical framework, so as to make teaching and learning effective and efficient to produce desirable outcomes. Table 4.1 provides a list of few of these models. No, single model fit all, but the appropriateness of the pedagogic framework, would be determined by the learners, teachers and context. Educators can either combine the theories or blend the pedagogic models to meet their needs. Mixing the theories imply using more than one of the learning theories as your pedagogic foundations while blending the models refers to using different pedagogic models under the same theoretical framework. Theoretically, learning styles could be used to predict which pedagogical strategies would be most useful for a given individual and learning activity. Current advancement in pedagogy development is making

teaching more than just an activity of transferring knowledge and skills to learners. Teachers need to create and explore new approaches to improve education delivery.

Table 4. 1 pedagogic models
Source: (Dabbagh & Bannan-Ritland, 2005)

PEDAGOGIC MODELS		
Behaviourism	**Cognitivism**	**Constructivism**
• Computer-Based Instruction • Contract Learning • Individualized Instruction • Programmed Instruction • Information Processing Model • Systems Approach • Computer-Assisted Instruction	• Collins & Stevens Inquiry Teaching Model • Keller's ARCS Model of Motivation • Merril's Component Display Model	• Action Learning • Anchored Instruction • Authentic Learning • Case-Based Learning • Cognitive Apprenticeship • Cognitive Flexibility Hypertext • Collaborative Learning • Communities of Practice • Computer-Supported International Learning Environments (CSILEs) • Discovery Learning • Distributed Learning • Epistemic Games • Generative Learning • Goal-Based Scenarios (GBSs) • Inquiry-Based Learning • Micro-world/ Simulations • Problem-Based Learning (PBL)

4.6.1 Learning Theories and Educational Technology

Learning theories have an impact on the use of technology in education and vice versa. There is a reciprocal inspiration between technologies and philosophical conceptions of learning, thinking and teaching. The attention in this part of the chapter is on the theoretical basis of using ICTs in education to promote effective and efficient teaching and learning. The purpose of the discussion is to understand the relationship between learning theories and the use of technology to mediate learning and their roles. Technologies are perceived to advance education, but they need psychological explanations and pedagogical justifications. For example, educational television, the Skinner box (Bouton & Bolles, 1979; Nastasi, 1990) and LOGO programming were all inspired by learning theories (Clements, 1987). Most often, the concerns of educators are on the pedagogical justification for using any technology and not just the availability of the technology. There are enormous ICT tools and platforms available for teaching and learning, but the ability to model these tools around the philosophical assumptions of behaviourism, Cognitivism and constructivism to create a specific pedagogical or instructional model has been the bone of contention for educational or instructional technologist. What needs to be understood is that the ICT hardware itself does not actually mean much, but it is the software and communication tools that come with it. For example, a personal computer (PC), laptop, tablet PC and smart phones do not necessarily align themselves to behaviourist, cognitivist or constructivist philosophies; rather, the way the software are designed and modelled to interact with the learner suggest its philosophical paradigm in education.

Enni-Cole in his paper, emerging theories of learning and pre-service teachers (2004), states that in behaviourism, technology is used to solve conspicuous weaknesses, promote mastery, and encourage practice through tutorials, drill and practice software, and other types of computer-based learning (Hung, 2001), (Rieber, 1992). The use of computers for learning started after the introduction of programmed instruction in the 1950s and 1960s. These were established on the philosophical and psychological theories of behaviourism propounded by Skinner. The behaviourist assumptions are found in the design and development of most of the traditional; computer-based learning systems. In consistent to the behaviourist beliefs, aptly designed drill and practice and tutorial programs provide packets of information, thoughtfully structured to render regular and positive or negative feedback to the learner (Shield, 2000). The system is developed and designed in such a manner that the learner starts to practice with much simpler tasks and progresses to learn more sophisticated ones in a well-defined conventional

model (Semple, 2000), (Boyle, 1997). The procedure is linear or nonlinear. The nonlinear approach offers the learner the opportunity to follow a different direction and provides he or she re-tries options. The process is more interactive than reactive, but if the learner follows the same route again, the same result is received. With this style of computer-based learning, the point of control normally lies with the content developer and the computer program instead of the learner. The rationale for using such technology in education lies in its ability to teach new skills, rote learning, strengthen existing learned associations and deepen learning. Some of the technologies designed and developed based on the behaviourist learning theory includes but not limited to Computer assisted instruction (CAI), drill and practice programs, assessment software, integrated learning systems and computer-based tutorial systems (Jonassen, 2000). The behaviourist notion of the use of technology reflects the traditional classroom practice where the learners are more or less reflexive. The content and interaction between the learner and the technology system is pre-set and restricted to few selections of reasonable responses (Mustafa, 2005).

In the USA, CAI and integrated learning systems are widely used by most schools as they fit the typical; traditional classroom setting of teaching and learning. According to Jonassen, CAI can promote progressive achievement, from lower level tasks to complex, through iterative practice. The computer, unlike humans, has extensive patience to monitor the learner as he or her practices. With CAI, the computer system offers help information to the learner in situations where an incorrect answer is given. This is repeated until the learner succeeds (Stultz, 2008). Mediating learning with such technologies motivates students. In this case, the designer decides what is relevant for the students to know and tries to transfer that knowledge to him or her. The characteristics of behaviourist learning technologies are that they are generally closed systems, which restrict the student to the designer's knowledge.

The evolution of computers and software with accurate input-processing-output design mirrors the philosophical and psychological assumptions of cognitivist theories of learning. Cognitivist view computer technologies as cognitive learning tools which are capable of developing learners' ability to store and retrieve information. The computer executes inauthentic activity, allowing the learner to focus on key concepts referred to as authentic activity. The cognitive tools of the computer stimulate thinking for learning to occur through the process of utilising the tools. It is such that one cannot use computer without thinking intensely about the subject he or she is learning. Computerised graphic applications tools such as free-mind, inspiration,

wise mapping, drop mind, flying logic and a host of them provide the platform for more sophisticated use of techniques such as linear chains, flow charts and scale maps (Boyle, 1997) cited in Semple (2000). These computer-based tools provide databases, which have an excessive amount of information which is used in different ways by the learner to meet individual learning needs. Unlike behaviourist, approach to the use of technology in education, cognitivist oriented computer-based systems allow learners themselves to articulate their thoughts and program their personal knowledge by the tools provided by the system. With this, the locus of control is less with the designer and more with the learner.

From the constructivist perspective, technology is used to improve metacognitive skills, emphasize transfer, encourage group activities and presentations, highlight the contributions and skills of individual learners and explore the relationship between information; not only that, it also helps them to collect information, solve problems and contribute in open-ended learning (Enni-Cole, 2004). Constructivism is based on the notion that teaching and learning are mediated by tools and signs. This assumption perfectly fits the computer as a mediating system with tools and signs to facilitate learning. The computing technologies in education are used as pedagogic tools for creating rich and exciting learning environment. The basic characteristic of constructivist learning technologies is that it focuses on the learner. The power of the technology is vested more in the learner than the designer. There are wide continuums of learning technologies, which incorporate the concept of constructivism in their design. These include but not limited to multimedia, constructive and informative software tools, simulation software, hypertext and hypermedia, computer-supported intentional learning environment, video conferencing and computer mediated environment. Constructivist learning technologies enable learners to construct knowledge bases, which eventually engage the student more, and yields significant and transferable knowledge. The learner takes full control, using the technology as tools for analysing the world, gathering information, organizing and interpreting it. For example, the use of multimedia authoring tools is perfectly appropriate to open-ended, non-linear and constructivist model of learning. Such technologies enable educators and students to develop interactive lessons and presentations through the integration of images, graphics, text, animation, audio and video. Using these kinds of tools enhances learning and cognitive process, including co-operative learning, group problem solving, critical thinking, reflection, analysis, inquiry, writing and public speaking.

I will like to summarize this discussion, by stating that the use of any form of technology in education for the purpose of teaching and learning must be backed by sound philosophical and psychological theories of learning. The use of technology in education should focus on teaching and learning processes for better learning outcome. The technology must have the flexibility to support pedagogies of different learning theories – behaviourism, Cognitivism and / or constructivism. The decision to use technology as a mediating tool in any educational institution to support and improve teaching and learning should be based on clear cut learning objectives and other relevant components relating to the use of technology in education.

4.9 The Basis of the Theoretical Framework

The motivation of the theoretical framework is rooted in grounded learning design model by Hannafin et al (Hannafin, Hannafin, Land, & Oliver, 1997), which is defined as a systematic implementation or processes and procedures that are based on established theory and research in human learning. Based on the objective of the research which seeks to investigate how tertiary education institutions can effectively leverage mobile technologies, through the use of computing devices to enhanced teaching and learning, it was necessary to choose a theoretical framework from literature which connects education and technology within the context of the research. The purpose is to understand the components of teaching and learning in theory and practice and the role of technology in education.

Hannafin and colleagues argue that grounded learning systems design, has no theoretical assumption or methodology, which is superior over the other. They have overlapping principles and perspectives. Their position is that different learning theories and technologies can be effectively blended to create a comprehensive theoretical framework for teaching and learning. For example, behaviourism, cognitvism and constructivism can be combined in one learning framework. The foundations of this approach are psychological, pedagogical, technological, cultural, and pragmatic. The philosophical understanding of these mentioned factors gave insight into the whole theoretical structure of the research.

4.10 Conclusion

The use of technology in education can be instructionist, constructionist or both, but the decision to use any of them must be based on the educational objective and philosophy of the

school. Technological advancement, especially ICT in instructional design is making teaching and learning in the 21st century more sophisticated. This, transcend through all levels of education, from nursery to tertiary. Teaching and learning as perceived by the philosophical assumptions of activity theory, is an activity which can be mediated by technology, but adopting the right technology and effectively incorporating in a school for teaching and learning is a difficult task which must be supported with learning theories. Educational psychology and philosophy have enormous theories for teaching and learning. These theories also have their psychological and philosophical expositions of technology, and its use in education. The idea to use any technology in education must be solidly and soundly grounded in teaching and learning theories. For example, the intention to introduce ICTs such as m-learning or e-learning in any school must be designed and implemented based on a defensible theoretical framework which connects technology and learning effectively. Introducing mobile eLearning at CUC was no exception. The three core learning theories – behaviourism, Cognitivism, and constructivism were used in the implementation of mobile eLearning at CUC based on grounded practice. Mobile eLearning can be modelled to promote the ideals of all the three key learning theories on one single platform, and this is what was done at CUC. In this implementation, the mobility of users and the mobile technology affordance in promoting teaching and learning anywhere anytime on any "mobile networked" computer devices were of great importance.

CHAPTER FIVE

THE "STUMP" CONCEPTUAL FRAMWORK

5.1 Introduction

This chapter is an introductory chapter of the empirical finding of this study with the purpose of giving detailed account of how the "stump" conceptual framework emerged out of the outcome of the m-learning project. The discussions is based on the interpretation and analysis of initial data obtained from the first two cycles of the case of using m-learning at CUC as the students, teachers and administration utilised the affordances of mobile computing and communication technologies in teaching, learning and performing other academic activities. The action research method, which was adopted for the implementation of the project provided an opportunity for data to be gathered in the natural setting of the CUC community as the users experienced m-learning in their daily academic life on and off campus. Data were collected based on the principles of ethnography, phenomenology and hermeneutics method of observing and interpreting human activities as a given phenomenon unfolds. Even though the empirical study was idiographic in nature, the outcome of the study is not peculiar to CUC.

The discussions in the chapter are organised as follows: Section 5.2 gives a brief overview of the precursors and context, which facilitated in constructing the "stump" framework. This is followed by section 5.3 with an exposition into the theoretical underpinning, which provided insight into the framing of the model. The objectives of the "stump" model are outlined in section 5.4. The main conceptualisation of the model is presented in section 5.5, which begins with the method that was employed in gathering data and establishing the premises for the model in subsection 5.5.1. How data was collected for the formulation of the model is presented in subsection 5.4.2. In subsection 5.5.3 the "stump" constructs are discussed. Subsection 5.5.4 elaborates on how the constructs emerged from the data. The focus of the conceptual framework is explained in subsection 5.5.5. The analysis of the data, its weighting and calculation are handles in subsections 5.5.6 to 7.5.8. The "stump" matrix analyser and how to use the model are discussed in subsections 5.5.9 to 5.5.10 and the conclusion in section 5.6.

5.2 Background

The application of ICTs in education has the potential to facilitate teaching and learning both at the individual and institutional level. As educators recognise the rewarding outcome, many educational institutions from primary to tertiary are making huge investment in ICTs for

various purposes, but many of them do not attain the potential benefits as anticipated (Dawes, 2001). In an attempt to address this over aching challenge, many researchers in IS and education have attributed it to numerous factors from different perspectives. Swanson (1988) and Trice & Treacy (1988) blame it on poor acceptance by users and their unwillingness to use technology for reasons best known to them[1] (Igbaria, 1994). Penni Tearle in her discussion of the implementation of ICT in UK secondary schools (Tearle P. , 2004) pointed out availability of the technology, leadership, time, support and training as practical factors, which make it difficult for technology implementation. She further cited some authors who look at this problem from the readiness of the educational institution to exhibit some characteristics for change. Davis et al (1989) argue that perceived usefulness and perceived ease of use among others are some of the issues, which impede users from accepting and using the technology. Some of which could be fear of computers, negative perception or attitude toward ICTs in general, little or no motivation to entice users to adopt the technology[2](David, F. D, Bagozzi, R. P, & Warshaw, P. R, 1989). Several others add their bit to the discourse with other factors.

Introducing a new technology in education organisation involves several stakeholders whose collaborative efforts are needed to ensure the success of the technology in the organisation. These could be external – Policy & regulatory authorities, software and hardware suppliers, infrastructure providers and parents and guardians, or internal – management, teachers, students and none teaching staff. Diverse input from all these actors play an important role in making an implementation of technology successful within the framework of education organisations, but the internal players comprising of the teacher, student and administrative staff are the actual users of the technology if it is implemented. The need therefore arises for educational technologist and educational technology implementers to approach the challenge of technology implementation failure within the context of the user's concerns. (Soong, M. H. B, et al, 2001) Posits that the main critical success factors of learning technologies are human factors concerning the users' motivational skills, investment of time and commitment, technical competency, collaboration, user-friendly and adequate quality technical infrastructure, but this may vary because according to Becta (2003), incorporating new technology into education

[1] In information system implementation by Swanson (1988) and Utilisation as a dependent variable in MIS research by Trice & Treacy (1988) made their augment along these path that the more the users use a system, the greater benefit they are likely to experience, but most often educators are not able to fully realized this because of users reluctant to accept and use the technology.

[2] David, F. D (1989) gives elaborated discussion on the various constructs essential to users' adoption of technology in his article "perceived usefulness, perceived ease of use, and user acceptance of information.

varies from institution to institution, place to place, curriculum to curriculum and class to class, depending on how they are used.

Bingimlas in his paper 'barriers to the successful integration of ICT in teaching and learning environment', stated that lack of confidence, lack of competence, lack of time, lack of training, lack of accessibility, lack of technical support, resistance to change and negative attitude are factors which hinder successful implementation of technology in education (Bingimlas, 2009). Ely and Donald's study on the conditions that facilitate the implementation of educational technology innovations came out with these eight conditions: (i) dissatisfaction of the status quo (ii) knowledge and skills (iii) resource availability (iv) time availability (v) rewards or incentives (vi) encouragement for participation (vii) commitment by stakeholders and (viii) evidence of leadership as being what pose challenges to educational technology implementation (Ely, 1990).

In concluding it was observed from Tearle (2004) that generally, most projects and literature on implementation of ICTs depending on the interest or the purpose of the implementation of the technology in schools, there are some that give attention to the barriers to implementation (Zammitt, 1992; National Council for Educational Technology, 1995; Robertson et al., 1996; Fabry & Higgs, 1997; Wild, 1996; Williams et al., 2000; Dawes, 2001; Joint Advisory Panel on IT in Education, 2001) others focus on the attitudes and concerns of individual users on the use of the technology for teaching and learning (Davis et al., 1989; Preston et al., 2000; Zhao & Cziko, 2001). Some also look at the entire school or external factors (Quintana & Ruiz, 1995; Ridgeway & Passey, 1995; Kennewell et al., 2000), Selwyn (1999). Although there are uncountable numbers of research literature on the factors, which obstruct the implementation of ICTs, they are highly fragmented.

The focus of this conceptual framework is to identify all factors, which have the potential to hamper effective leveraging and incorporation of mobile computing and communication technology in tertiary education. This is approached from the users' perspective because from all the works cited in this study, it shows up clearly that all barriers to ICT implementation are linked to the user in one way or the other. Here the user is considered to be the pivot to the success of integrating the technology in the school. For example, if the problem is technical, it is the users who complain. If the problem is cultural related, it is the users who complain. If the problem is motivation, it is the users who complain. If the problem is skill and knowledge

of the technology, it is the users who complain and it goes on and on. No matter what the problem is, it is the users' view of the problem, which affects the implementation be it positive or negative. Thus, the STUMP framework helps in identifying critical factors in relation to using m-learning at CUC and provides a guide for assessing the readiness level of the users – teachers, students and administration staff for the technology.

5.3 Objective

The research agenda was to investigate how mobile computing and communication technology can be effectively leveraged and incorporated into tertiary education. This was motivated by the challenge facing educational institutions on implementation of technology. The institutions know the end benefit of integrating ICTs into their teaching and learning methods, but most often the problem is how to achieve it. This has been attributed to many factors as observed from relevant literature within the area of technology implementation in relation to educational technologies, ICTs and MIS. Depending on how the implementation is conceived, the factors may vary or overlaps.

The STUMP as proposed in this study is to provide a framework for analysing the users' skill, interest and knowledge of the technology being implemented; their take on the time and technical issues such as system quality, service quality and information quality; the user's demographics, social cultural, attitude and ethos; their motivational level and the pedagogic relevance of the technology within the framework of tertiary education. The analysis of these factors is to assess and measure the user's concerns relating to the technology to be able to determine their level of readiness to use the technology for the intended purpose. To achieve this, five main questions were asked as the key determinants of what is happening, why it is happening and how to tackle the problem. These were (1) Do the users have the needed skill, affect and knowledge to use the technology? (2) What is their view on time and technical issues of the technology? (3) How do their social cognitive composition affect them in using technology? (4) Are the users well motivated to use the technology? (5) Do they perceive the technology to be pedagogically useful?

5.4 Analogy of the framework

The abstraction of STUMP is motivated by the literal meaning of the English word 'stump' as it is used in normal life. Stump is defined in the Cambridge advanced learner's dictionary as being the remaining part of something such as tree trunk and its root, tooth, arm or leg, which is left after it has been removed. It is further explained in Merriam Webster dictionary as anything that frustrates the progress or effort of something from happening. This could be tangible or intangible elements, which stand in the way of individuals, organisations or projects from achieving their goals. Some of the things, which manifest themselves as stumps in an individual's life, organisation or project are finance, human factors, time, improper planning, lack of knowledge and other unforeseeable constraints.

In this STUMP framework, a school is likened to a farm land or a piece of plot to be developed. The land must be prepared and cleared off all unwanted objects be it trees, stones, hills and valleys etc to pave way for a farming or construction project to take place. In the case of a farm, all stumps need to be uprooted to keep the land in good shape for planting. It is necessary for the farmer to do this to avoid a future situation where the stumps in the field will choke the plantation and the land from bearing fruits as expected. These stumps sometimes serve as bleeding hood for termites, which destroy or prevent plants from growing. In addition, the roots of the stumps in the land can sap the entire nutrient in the soil, leaving the crops with nothing to feed on. Such a situation deprives the farmer from realising a bumper harvest. There have been other circumstances where the roots of stumps left on a civil construction site grew strong to generate cracks in buildings and roads after construction.

Based on this exposition, the STUMP framework postulates that for a school to effectively leverage and incorporate mobile technology into its educational framework, it is the duty of the school management or implementers of the technology to identify all the stumps in relation to the use of the technology in the school and see to it that they are all removed. The stumps in a school are the issues, which strangle the implementation of ICTs and prevent them from excelling. In this study, the users' concerns on the use of their mobile devices for teaching and learning were identified as the stump factors critical to the success of the m-learning technology

at CUC. These factors were user centric in nature, which connects to every aspect of using the technology for teaching and learning. The factors, which were identified for the conceptualisation of the STUMP model are as follows:

- S – Skill, interest and knowledge of the technology to be used
- T – Time demands and technical issues in using the technology
- U – User's social cognitive composition
- M – Motivation
- P – Pedagogic relevance of the technology

These factors emanated from the concerns of the users as they used the m-learning platform in their daily academic activities. They were grouped under the STUMP acronym based on their characteristics and connotations to make it easier for the educators and educational technology implementers to use it as a tool for making sure that the ground (ie: school) is free from stumps to pave way for successful implementation of the technology. In this model, the user is the core subject whose use of the technology predicts the success or failure of the implementation. They are at the centre of the implementation process. They are between the implementers and the technology as shown in figure 5.1.

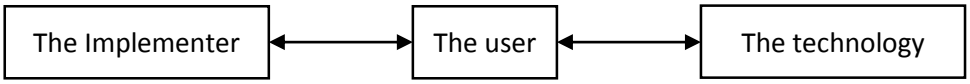


Figure 5. 1 the relationship between implementer, technology and the user

5.5 Theoretical Background

The theoretical underpinning for the conceptualisation of the STUMP model is mainly drawn from IS and educational technology implementation models and theories from the works of the following: Thompson et al (1991) – Model of PC Utilisation (MPCU), Rogers (1995) – Innovation Diffusion Theory (IDT), Compeau and Higgins (1995b) – Social Cognitive Theory (SCT), Sheppard et al (1988) – Theory of Reasoned Action (TRA), Davis et al (1989) – Technology Acceptance Model (TAM), Vallerand (1997) – Motivational Model (MM), Ajzen (1991) – Theory of Planned Behaviour (TPB), DeLone and McLean (1992) – IS Success

Model, Goodhue and Thompson (1995) – Task Technology Fit (TTF), Venkatesh (2003) – Unified Theory of Acceptance and Use of Technology (UTAUT), Mishra and Koehler (2006) – Technological Pedagogical Content Knowledge (TPACK). All these theories and models have constructs of similar characteristics, which have been amalgamated to formulate the STUMP model.

5.5.1 Technology Acceptance Model (TAM)

Davis in his doctoral dissertation, made a significant contribution by developing TAM for empirically testing new end-user information system. His further works with other colleagues which led to TAM2 and TAM3 has deepened understanding and use of the model in different areas of technology application (Davis, 1985), (Davis, Bagozzi, & Warshaw, 1989). TAM was extracted from Theory of Reasoned Action (TRA) and adapted to the context of IS as framework for predicting information technology acceptance and usage. The model postulate that perceived usefulness and perceived ease of use determine an individual's intention to use a technology with the intention of using acting as a mediator of actual use of technology. As an off shoot from TRA, TAM inherited strong behavioural constituents and belief in the assumption that when a person constructs his or her intention to act, he or she will be free to act without impediment, but in reality constraints such as insufficient time, ability, environmental or organisational limits, and unconscious habit interfere with the freedom to act.

The development of TAM was to aid in predicting individual adoption and use of new technologies, specifically information technologies (ITs). It emphasizes on the perceived usefulness and perceived ease of use as the fundamental elements, which determines an individual's intention to use IT. Perceived usefulness is explained with the context of TAM as the level to which a person believes that using a particular IT system would enhance his or her job performance, while perceived ease of use is the extent to which a person believes that using any specific IT system would be effortless (Davis, 1989). TAM2 and TAM3 build on TAM to solidify its theoretical argument. TAM2 introduces subjective norm and image as the determinants of perceived usefulness which stand for social influence processes (Venkatesh & Davis, 2000) based on three social influence mechanisms – compliance, identification and internalization, and other four determinants – result demonstrability, perceived ease of use, job relevance and output quality as affecting the cognitive processes on perceived usefulness. In TAM3, experience of the individual moderates the relationships between (i) perceived ease of use and behavioural intention; (ii) perceived ease of use and perceived usefulness; and (iii)

computer anxiety and perceived ease of use. The combination of all the TAMs theorised that a person's intention to use an IT system is dependent on perceived usefulness and perceived ease of use. These are both determined by subjective norm, image, job relevance, output quality, result demonstrability, computer self – efficacy, perception of external control, computer anxiety, computer playfulness, perceived enjoyment, objective usability and moderated by experience and voluntariness (Venkatesh & Bala, 2008).

5.5.2 Unified Theory of Acceptance and Use of Technology (UTAUT)

UTAUT's principal objective is to interpret user intentions to use an IT system and of behaviour on usage. The theory presents four major constructs: social influence, facilitating conditions, effort expectancy and performance expectancy as being the direct determinants of usage intention and behaviour (Venkatesh, Morris, Davis, & Davis, 2003a). The assumption of the theory is that experience, gender, age and voluntariness of use moderate the effect of the four main constructs on usage intention and behaviour. UTAUT was developed as a result of review and integration of constructs from eight models - theory of reasoned action, technology acceptance model, motivational model, theory of planned behaviour, a combined theory of planned behaviour/technology acceptance model, model of PC utilization, innovation diffusion theory, and social cognitive theory which previous studies had used to elucidate IS usage behaviour.

The theory embeds all the constructs of above eight models and posits that performance expectancy, effort expectancy and social influence directly affect behavioural intention whereas facilitating conditions affect use behaviour. All of them put together are influenced by gender, age, experience and voluntariness of use. Gender moderates performance expectancy, effort expectancy and social influence. Age moderates performance expectancy, effort expectancy, social influence and facilitating conditions. Experience moderates effort expectancy, social influence and facilitating conditions and voluntariness of use moderates only social influence.

5.5.3 Task – Technology Fit (TTF)

TTF theory is with the assumption that IT system is highly possible to have a positive impact on individual performance and be used if the abilities of the system correspond to the tasks that

the user is required to perform (Goodhue & Thompson, 1995). An instrument was designed for measuring task-technology fit, which consists of 8 factors: quality, locatable, authorization, and compatibility, ease of use/training, production timeliness, systems reliability, and relationship with users. It was found that the TTF measure, coupled with utilization, to be a significant predictor of user reports of improved job performance and effectiveness that was attributable to their use of the system under investigation.

The model functions at the individual level of analysis, but the work of (Zigurs & Buckland, 1998) give an analogous model which operates at the group level. The model has been used in the context of a diverse range of IS including electronic commerce systems and combined with or used as an extension of other models related to IS outcomes such as the technology acceptance model (TAM). Researchers modify the TTF measure to make it applicable to a given context of study.

Task is composed of levels: structure, repetitiveness, complexity of cognitive processes, and ambiguity among others. Tasks are normally assessed based on the nature of complexity – simple to complex (Gebauer & Shaw, 2002). The theory of TTF posits that a match between business tasks and IT is relevant to explain and predict the success of IT systems. This implies that the success of IT system is related to the fit between task and technology. Cited by (Gebauer & Tang, 2008) in "Applying the theory of task-technology fit to mobile technology: the role of user mobility". According to (Junglas & Watson, 2006) the TTF model has the potential to contribute to the success of technology innovations and identify areas which are essential to support a particular business task.

5.5.4 IS Success Model

DeLone and McLean built on the three levels of information as espoused by (Shannon et al., 1949)[3] and (Mason, 1978) extension of the effectiveness level, to define six interdependent variables of IS success: system quality, information quality, use, user satisfaction, individual impact and organizational impact (DeLone & McLean, 1992)[4]. This was later updated to include service quality, (intention to) use and net benefit. Individual impact and organizational impact was taken out. The model explain that an IS can be assessed in terms of system, service

[3] Shannon and Weaver explained the technical level of communication as being accuracy and efficiency of the communication system which generates the information. The semantic level is the success of the information in carrying the intended meaning. Effectiveness level is the effect of the information on the receiver.

[4] DeLone McLean IS model: System quality measures technical success; information quality measures semantic success; use, user satisfaction, individual and organisational impacts measures effectiveness success.

and information quality. These features influence subsequent use or intention to use and user satisfaction. Using the IS comes with some benefits. The net of these benefits positively or negatively affect the user satisfaction and continuous use of the system.

The constructs in the model are explained as follows (Petter, DeLone, & McLean, 2008):

System quality is a desirable characteristic of an information system. This focuses on the usability and performance characteristics of a particular system. For example, perceived ease of use, flexibility, system reliability, access, convenience, efficiency, accuracy and ease of learning.

Information quality is a desirable characteristic of a system output. This measures the quality of the information that the system generates and its usefulness to the user. For example, accuracy, adequacy, availability, completeness, conciseness, consistency, precision, relevance, reliability, timeliness, and format as well as usability, uniqueness and usefulness.

Service quality refers to the support that system users receive from the IS department and IT support personnel or the IS service provider. For example, assurance, empathy, flexibility, interpersonal quality, intrinsic quality, IS training, reliability, responsiveness and tangibles.

System use is considered as the degree and manner in which users utilise the capabilities of the information system. For example, actual use, daily use, frequency of use, intention to use and reuse, nature of use, navigation patterns, and number of transactions.

User satisfaction examines the users' level of satisfaction in using the system. For example, adequacy, effectiveness, efficiency, information satisfaction and support service.

Net benefits are the extent to which information system are contributing to the success of the users – individual, groups, organisations and industries. The measure of success depends largely on the system under study, the purpose of the study and the level of analysis. The net benefits are the cumulative impact of the system usage on the individual and organisation.

5.5.5 Model of Personal Computer Utilisation (MPCU)

Triandis' model on TRA was adapted and modified by (Thompson, Higins, & Howell, 1991) for IS contexts and used the model to predict personal computer (PC) utilisation. The model concentrates on the individual's behaviour, which influences him or her to use a PC or an IT system. It uses selected constructs from TRA which were deemed relevant within the context of IS utilisation. Thompson et al in conceptualising the MPCU identified six determinants: (1) social factors (norms) influencing PC use (2) affect toward PC use (3) complexity of PC use (4) job fit with PC use (5) long-term consequences of PC use and (6) facilitating conditions for PC use which they hypothesized to influence PC utilisation. They studied the direct effects of social factors, affects, perceived consequence and facilitating conditions on behaviour and modelled complexity, job fit, and long-term consequences as three distinct elements of perceived consequences (beliefs) (Thompson, Higgins, & Howell, 1994).

The assumption of the MPCU is that the extent to which an individual believes that using a technology can enhance the performance of his or her job; the degree to which an innovation is perceived as relatively difficult to understand and use; outcomes that have a pay-off in the future; the feelings of joy, pleasure, depression, disgust, displeasure or hate exhibited by the individual toward a technology; the individual's internalization of the reference group's subjective culture, and specific interpersonal agreements that the individual has made with others in specific social situation in relation to a technology and objective factors in the environment that are recognised as useful in making the use of a technology easy for accomplishing task influence the individual's behaviour in utilising a technology.

5.5.6 Motivational Model (MM)

Vallerand, examined and adapted the fundamental elements from motivational theories and applied it within the context of information systems (Vallerand, 1997). The main forms of motivation are intrinsic and extrinsic, but (Deci & Ryan, 1985) added amotivation which refers to relative absence of motivation. Intrinsic motivation connote the perception that a user will want to perform an activity for no apparent reinforcement other than the process of performing the activity per se (Davis, Bagozzi, & Warshaw, 1992). It means that doing something for the pleasure and satisfaction inherent in the activity (Deci, 1975). Further understanding of intrinsic motivation is presented in a tripartite taxonomy by vallerand and his colleagues (Vallerand et al., 1992): intrinsic motivation – 'to know' implies engaging in activities because

of the pleasure and satisfaction derived from learning, exploring and understanding new things; intrinsic motivation – 'to accomplish' implies engaging in activities because of the pleasure and satisfaction derived from trying to surpass oneself, creating, or accomplishing something; intrinsic motivation – 'to experience stimulation' this is evident when a person is engaged in an activity because of the stimulating sensations associated with it.

In contrast, extrinsic motivation refers to the perception that a user will want to perform an activity because it is perceived to be useful in achieving valued outcomes that are distinct from the activity itself, such as improved job performance (Davis et al., 1992). It involves different behaviours because activities are engaged in not for reasons inherent in them but for instrumental reasons. An extrinsically motivated behaviour is performed to achieve an end result which is distinct from the actual behaviour of the user. (Deci & Ryan, 1991) identified four types of extrinsic motivation which are: *external regulation* – this is explained as when a person performs an activity to attain a positive end state (eg: to get reward) or to avoid a negative end state (eg: to avoid reproach) which is separated from the activity itself. *Introjected regulation* – delineates the first stage of internalisation process, where an individual takes prompts from the environment and brings them inside themselves. In this case, the individual begins to internalise the reasons for his or her behaviour while acting out of obligation to avoid feeling shame or internal pressure. *Identified regulation* – this refers to a situation where the individual's reason to engage in an activity are internalised such that the activity is considered valuable to him or her. This way, he or she is most likely to perform the activity with a sense of preferences. *Integrated regulation* – this explains that the outcome of identification is reflected in choices, but the choice to perform any activity is not necessarily coherent with other self-structures, but the choice underlying a person's behaviour is in consonant with other structures within the self which brings coherence (Edward L. Deci & Ryan, 2004). In IS systems, motivation is identified as a construct which influences users' affect, cognition and behaviour (Vallerand, 2000).

5.5.7 Theory of Planned Behaviour (TPB) & Theory of Reasoned Action (TRA)

TRA postulates that the behaviour of a person is propelled by behavioural intentions where behavioural intentions are a function of an individual's attitude towards the behaviour and subjective norms surrounding the performance of the behaviour. Attitude towards the behaviour is defined as the individual's positive or negative feeling about performing a behaviour. It is determined through an assessment of a person's beliefs regarding the

consequences arising from a behaviour and an evaluation of the desirability of these consequences. The theory assesses overall attitude of the individual as the sum of the individual consequence *multiplied by* desirability assessments for all expected consequences of the behaviour. It explains subjective norm as a person's perception of whether people who are important to him or her think the behaviour should or should not be performed. The contribution of the opinion of any given referent is weighted by the motivation that an individual has to comply with the wishes of that referent. Thus, overall subjective norm can be expressed as the sum of the individual perception multiplied by motivation assessments for all relevant referents. Algebraically TRA can be represented as $B \approx BI = w1AB + w2SN$ where B is behaviour, BI is behavioural intention, AB is attitude toward behaviour, SN is subjective norm, and w1 and w2 are weights representing the importance of each term.

Although TRA predicts behavioural intentions and behaviour well (Sheppard, Hartwick, & Warshaw, 1988) and has been used in many IS studies, it has some drawbacks. TRA mainly relates to voluntary behaviour but later it was realised that behaviour is not hundred percent voluntary (Madden, Ellen, & Ajzen, 1992). This among other things led to the introduction of perceived behaviour control, which modified TRA to TPB. The extended construct was theorised to be an additional determinant of intention and behaviour. This construct – perceived behavioural control is defined as the perceived ease or difficulty of performing a behaviour. This is expressed by Taylor and Todd within the context of IS research as being the perception of internal and external constraints on behaviour (Taylor & Todd, 1995).

TPB views the control that people have over their behaviour as lying on a continuum from behaviours that are easily performed to those requiring considerable effort, resources, etc. Although Ajzen suggested that the link between behaviour and behavioural control outlined in the model should be between behaviour and actual behavioural control rather than perceived behavioural control, the difficulty of assessing actual control is what led to the use of perceived control as a proxy. It must be noted action, target at which the action is directed, context in which the action is performed, and time at which it is performed are constituents of attitudinal and behavioural entities (Ajzen & Fishbein, 1977).

5.5.8 Social Cognitive Theory (SCT)

SCT is a widely known and used theory of human behaviour across many fields. The theory presents a framework for understanding, predicting, and changing human behaviour. It sees human behaviour as an interaction of personal factors, behaviour and the environment

(Bandura, 1986). The assumption of the theory is that a person's thoughts and actions influence the interaction between his or her and behaviour. The interaction between the person and the environment involves human beliefs and cognitive competencies that are modelled and modified by social influences and structures within the environment (Bandura, 2001). The third interaction is between the environment and behaviour. This involves a person's behaviour determining the aspects of their environment and in turn their behaviour is modified by that environment.

The fundamental understanding of SCT is that environmental influences in the form of social pressure, cognitive and other personal factors including personality as well as demographic characteristics, and behaviour are determined by reciprocal interaction. That is a person chooses the kind of environment preferable to him or her and in addition to being influenced by the environment. This means that behaviour in a given context is affected by environmental characteristics, which is also affected by behaviour. Furthermore, behaviour is influenced by cognitive and personal factors (Compeau & Higgins, 1995a). In all this, people construe situations differently which affects their behaviour but this does not necessarily imply that the person's behaviour is controlled by the situation (Jones, 1989).

The interest of Compeau and Higgins for adapting SCT for IS research was on the role of cognitive factors in individual behaviour. According to Bandura there are two forms of expectation which are the main cognitive factors which influence behaviour. The first is one relates to outcomes where the individual is likely to put up behaviours he or she believes will produce a valued outcome than those with unfavourable consequences. The second expectation engulfs self-efficacy or judgement of one's ability to perform a particular behaviour. For example, to use a technology to accomplish a particular job or task. Self-efficacy influences an individuals' decision to exhibit a behaviour.

5.5.9 Innovation Diffusion Theory (IDT)

IDT is grounded in sociology and has been used to study a variety of innovations. Within information systems, Moore and Benbasat 1991 adapted the characteristics of innovations presented in Rogers and modified a set of constructs that could be used to study individual technology acceptance. They came out with seven constructs: Relative advantage – this refers to the degree to which an innovation is perceived as being better than its precursor; ease of use

– this means the level to which an innovation is perceived as being difficult to use; image – this connotes the extent to which the use of an innovation is perceived to enhance a person's image or status in his or her social setting; visibility – this is the degree to which an individual can see others using a technology in an organisation; compatibility – this implies the degree to which an innovation is perceived as being consistent with the values, needs and past experiences of potential adopters; results demonstrability – this refers to the tangibility of the results of using the innovation, including their observability and communicability; voluntariness of use – this is the degree to which use of the innovation is perceived as being voluntary, or of free will.

The use of IDT in information systems provides the means for assessing the characteristics of a new technology and its impact on usage. It is used to seek understanding of how, why and what rate an introduction of a new technology takes to become incorporated with the users daily life.

5.5.10 Technology Pedagogical Content Knowledge (TPACK)

Koehler and Mishra in 2006, built on Shulman's framework on "Pedagogical Content Knowledge" (PCK) and came out with Technology Pedagogical Content Knowledge (TPACK). The addition to PCK was the introduction of the technological component (T). The purpose of the framework is to provide educators, educational technologist and other ICT implementers in educational institutions with good understanding and be able to describe the kind of knowledge needed by a teacher for effective pedagogical practice in using a particular technology to enhance teaching and learning (Mishra & Koehler, 2006), (Koehler & Mishra, 2008). Koehler and Mishra's argument is that for a teacher to be able to use a technology effectively to achieve the purpose for which it was meant, he or she must have technological, pedagogical and content knowledge. Good knowledge of these three constructs – technology, pedagogy and content are key to ensuring effective use of technology in education. The emphasis of TPACK is that effective incorporation of technology for teaching any content requires understanding and negotiating the relationships between the three constructs mentioned above. (Graham et al., 2009) articulates that the extension of PCK to TPACK becomes meaningful when teachers get to know (a) how technological tools transform pedagogical strategies and content representations for teaching specific topic, and (b) how technology tools and representations impact a student's understanding of these topics.

Mapping the links among the various constructs in TPACK framework presents a mesh relationship between content, pedagogy and technology knowledge which is useful for defining and explaining what a teacher needs to know to integrate technology effectively (Archambault & Crippen, 2009). The framework proposed seven distinct relationships or categories of teacher knowledge as shown in figure 5.2. (i) Content Knowledge (CK), (ii) Pedagogical Knowledge (PK), (iii) Technology Knowledge (TK), (iv) Pedagogical Content Knowledge (PCK), (v) Technological Content Knowledge (TCK), (vi) Technological Pedagogical Knowledge (TPK), and (vii) Technological Pedagogical Content Knowledge (TPCK).

5.5.10.1 Technology Knowledge (TK)

Technology Knowledge, in the context of technology integration in schools, refers to literacy of digital technologies including but not limited to desktop computers, laptops, internet, and software applications (Harris, 2008), but TK goes beyond just literacy of these technologies to ensure that teachers have knowledge of how to make pedagogical meaning of a technology to facilitate education delivery.

5.5.10.2 Content Knowledge (CK)

The TPACK framework defines content Knowledge as "thorough grounding in college-level subject matter" or in depth understanding of subject to be taught. This include knowledge of theories, conceptual framework and knowledge on best practice on developing knowledge (Shulman, 1986).

5.5.10.3 Pedagogical Knowledge (PK)

Pedagogical knowledge constitutes knowledge on students learning styles, teaching approaches, methods of assessment and knowledge of various theories and models on learning (Harris, Mishra, & Koehler, 2009), (Shulman, 1986), but according to Koehler and Mishra, this knowledge is not sufficient for teaching purposes, thus a teacher must add content knowledge.

5.5.10.4 Pedagogical Content Knowledge (PCK)

These two forms of knowledge are knowledge on how to put together pedagogy and content in an effective manner to make better use of technology. PCK boarders on how to make a subject or lesson understandable to the students.

5.5.10.5 Technological Content Knowledge (TCK)

This refers to knowledge on how technology can be used to facilitate new ways of teaching content (Niess, 2005). TCK enables the teacher to understand the characteristics of the

technology to know which type of content is suitable for it and how to design it using the technology tools.

5.5.10.6 Technological Pedagogical Knowledge (TPK)

Technological pedagogical knowledge refers to the affordances and limitations of technology as an enabler of different teaching methods (Mishra & Koehler, 2006). TPK helps teachers to relate technology to learning theories based on the features and how the technology works to develop a technology enabled pedagogy. For example, web 2.0 technology is suitable for social constructivist form of teaching and learning.

5.5.10.7 Technological Pedagogical Content Knowledge (TPCK)

This is the combination of all the knowledge constructs in the TPCK framework. It refers to the knowledge and understanding of the relationship between CK, PK and TK within the context of teaching and learning using technology (Schmidt et al., 2009). TPCK is the total knowledge of using technology with a pedagogical framework to deliver a particular content to students. It encompasses an understanding of the complexity of relationships between students, teachers, content, pedagogy and technology (Archambault & Crippen, 2009).

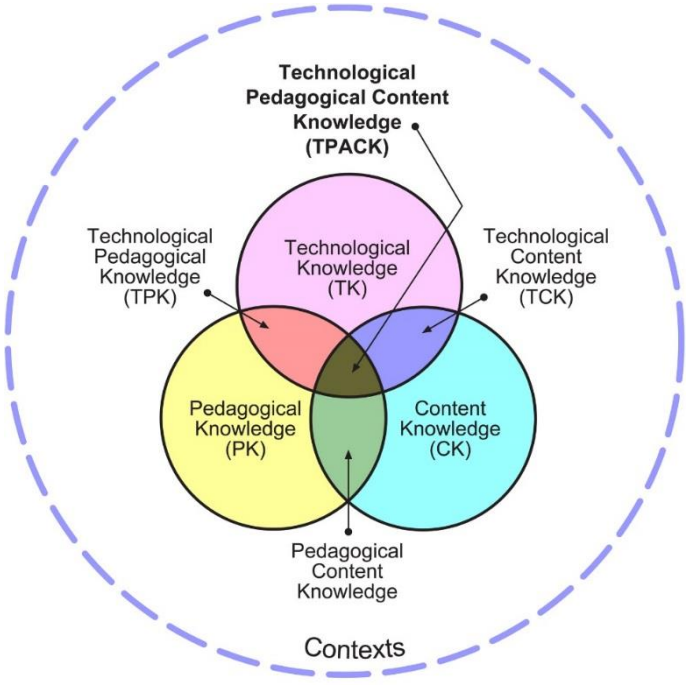


Figure 5. 2 TPACK diagram

5.11 Conceptualising the model

Based on the initial m-learning pilot project at CUC, STUMP was conceptualised as a tool for effective leveraging and incorporation of educational technology in tertiary education. The

study is described in detail in chapter five. The outcome of the study revealed relevant data as the teachers and students engaged in using their mobile devices for teaching and learning. Among the data collected were users' concerns which cut across all the constructs and determinants espoused by most IS and educational technology theories of which some have been discussed in this chapter in section 5.5. The concerns of the users within the context of this study was deemed as the most critical factors to successful implementation of the m-learning technology at CUC because it was observed as the phenomena that the users' concerns connect to every aspect of the implementation process of the technology. These factors were grouped and put into five categories – (1) SKILL, INTEREST and KNOWLEDGE (2) TIME and TECHNICAL ISSUES (3) USER'S SOCIAL COGNITIVE COMPOSITION (4) MOTIVATION and (5) PEDAGOGIC RELEVANCE of the technology within the context relevant to education institutions.

Table 5. 1 determinants of the STUMP factors and their supporting models/theories

CONSTRUCT CATEGORIES	SYMBOL	MAIN DETERMINANTS	SUPPORTING MODELS/THEORIES
SKILL, INTEREST, KNOWLEDGE	**S**	Skill & Ease of Use Interest Knowledge	TAM*(Davis, 1989)* IDT *(Moore & Benbasat, 1991)* SCT *(Compeau & Higgins, 1995b)*
TIME & TECHNICAL ISSUES	**T**	System quality Service quality Information quality Relative advantage Time	Delone & McClean (IS Success Model) (*Delone & McLean, 2002)* IDT *(Moore & Benbasat, 1991)*
USER'S SOCIAL COGNITIVE COMPOSITION	**U**	Attitude Social Cultural factors Affect Self-efficacy Personal Expectancy	TAM(Davis, 1993) UTAUT*(Venkatesh et al., 2003a)* TRA *(Ajzen & Fishbein, 1977)* TPB PC UTILISATION SCT *(Compeau & Higgins, 1995b)*
MOTIVATION	**M**	Extrinsic Intrinsic Facilitating conditions	MM*(Davis et al., 1992)* PC UTILISATION *(Thompson et al., 1991)* UTAUT(Venkatesh et al., 2003a)
PEDAGOGIC RELEVANCE	**P**	Task fit Compatibility Perceived usefulness Performance Expectancy	TPACK *(Mishra & Koehler, 2006)* TTF *(Goodhue & Thompson, 1995)* IDT *(Moore & Benbasat, 1991)* PC UTILISATION *(Thompson et al., 1991)*

These factors, which were identified from the study, were mapped to eleven theories to establish their empirical relevance and justification. The factors as shown in table 5.1 are common to most IS and educational technology theories and models. One of the gaps that was

identified from these theories was that although they have been used excessively and successfully in their individual capacities in assessing usage of technology by individuals and organisations, no single one of them exhibits characteristics that could holistically address users' concerns especially in the application of technology in education. This was capitalised by this study to conceptualise a model, which assess the readiness of users to use a technology and their actual use of the technology within the context of education institution. The model recognises the valuable contributions of these theories and used them as the basis to formulate a new model called STUMP. The purpose of the model is first to help technology implementers to measure the readiness level of the users and second assess their use of the technology. The basis of the constructs of the model are as follows:

- **SKILL, INTEREST, KNOWLEDGE (represented by the letter S)**
  These three constructs relate to the individual user's level of understanding and ability to use a technology for the love of it or the joy derived from using the technology. The absence of these elements in the user most often than not jeopardises the successful integration of technology in organisation irrespective of huge investment made in the acquisition of the technology. The technology normally is either tangible or intangible innovations, which require people with the skill and knowledge of the technology and also with the interest in using new technologies. No matter the kind of users available in an organisation, it is very important to ensure that users are well oriented and trained to acquire the needed skills and knowledge to use the technology and with affection. Doing this is an act of removing from the organisation the '*stumps' of lack of skill, lack of interest and lack of knowledge*[5] *in using a technology.* It was observed in the first implementation that the absence of these elements in the teachers, students and others of the m-learning technology had adverse effect on the implementation. The improvement in the level of their skills, knowledge and affect to use the technology yielded dividend in the second implementation.

  Skill: Is defined within the scope of this model as the individual's ability to use a technology (eg: educational technology) to perform a task with the minimum outlay of time, energy or both. That is to be able to use the tools of a technology in the right

[5] Knowledge and understanding from work of Penni Tearle (2004) on 'A theoretical an instrumental framework of implementing change in ICT in education, she posed a question 'Do people understand how ICT can enhance teaching and learning and see the value in using it?

manner to accomplish a job in the way it was intended for. It entails the individual's experience with a technology and the training they have in using the technology. It is noted that an individual's willingness to use ICT depends partly on his or her level of skill in the technology (Nelson, 1990), (Igbaria, 1994). Lack of ICT experience and user training contributes to user's computer anxiety and creates doubt on the usefulness of the technology (Igbaria & Chakrabarti, 1990). The individual's ICT skills have the potential of improving their perception and attitude towards using a technology by minimising or taking away any fear they might have had. TRA and TAM confirm in their models that skill affect users' behaviour through their effect on beliefs and subjective norms whereas TPB postulate a direct effect of perceived behaviour control on intention (Ajzen, 1989, 1991). This is explained as the individual lacking the needed resources and opportunities to perform a behaviour; where such resources and opportunities include skills needed among other things to use a technology (Ajzen & Madden, 1986), (Mathieson, 1991). Thompson et al (1991) also stated that an individual's skills of a technology directly or indirectly affect his or her computer anxiety, perceived usefulness, attitudes, and usage. This issue of lack of skill was evident among the teachers and students as they attempted to use their mobile devices for teaching and learning which demoralised most of them in using the m-learning technology. The only antidote to this 'stump' was making room for adequate training for them to again an appreciable level of skill to raise their self-efficacy in using the technology. Lack of effective training to equip users with the skills to use a technology reflects in their lack of confidence and competence in using the technology.

Interest: This refers to a person's liking or pleasure to put up certain behaviour. In the context of technology usage, an individual's affect for innovative technology can influence his or her intention to use the technology. The higher an individuals' affect for technology use, the higher his or her use of the technology. (Compeau & Higgins, 1995a), (Fishbein & Ajzen, 1975), (Triandis, 1989). In this study it was observed that users' ICT self-efficacy, ease of use, ease of learning, convenience, pedagogic relevance, visibility and results demonstrability, as well as outcome expectations had influence on them to develop a like or dislike for the technology. A positive influence of these determinants increased their like to use the technology whereas a negative influence discouraged them. This type of 'stump' can be removed or reduced by

ensuring that users are well oriented and the determinant of 'affect' are in good shape to have positive impact on the them.

Knowledge: This is defined as a person's understanding or information about something which he or she acquire by experience or study, and which is either in his or her mind or known by people generally. In this context, it refers to the user's understanding of the technology and its application to his or her job. Knowledge and skill go together; a person can have a skill on how to do something but may not have any knowledge of how that thing can be used effectively to achieve the intended objective. The same way, a person can have knowledge of how beneficial something he or she has learnt is to society, but may not have the prerequisite skill to put the acquired knowledge into practise. Such a situation was encountered in this study where we had users who had an idea of how m-learning can facilitate teaching and learning but did not have any skill as to the usage of their mobile devices effectively to achieve this purpose. Similarly there were others who had good skills in using their mobile devices but did not know how to utilise it for teaching and learning. The way to remove this 'stump' is to take the users through an in depth orientation, seminars and training to give them adequate exposure to the technology.

- **TIME and TECHNICAL ISSUES (represented by the letter T)**

These two constructs relate to the actual technology being introduced to the users, the amount of time allocated for the implementation and the time demand on the side of the user to perform an activity with the technology. These elements influence people to either use or discontinue using a technology. For example, if a technology being implemented has poor system quality, information quality and service quality, then users may not find it interesting to use it because the poor quality of the technology may consume much of their time to perform a task.

Time: Implementing and using information technology system in an organisation involves two dimensions. Time needed for the technology implementation and users' time demand in using the technology. These two go together. In implementing new technology, a good technical assessment must be done to determine the required amount of time needed for the implementation. This could depend on the complexity of the technology and technical expertise of the implementers. A poorly developed system

may create chronic technical problems for the individual users and the organisation, which may require sufficient time for it to be solved if the organisation wants to integrate the technology into their work processes successfully. The user on the other hand also faces challenges with time if the system has poor system quality, information quality and service quality. For example, a system with bad human computer interaction may require a user to spend so much time on trying to perform some simple task. Such situations discourage continuous use of the system. In this study we had a similar situation with the teachers not using the m-learning platform because its user interface was not human friendly. This made it difficult for most of them because it ended up taking much of their time in developing simple content using the m-learning authoring tools. Improvement in the technical quality of the system during the second implementation was significant in reducing the amount of time teachers spent in developing content with the m-learning authoring tools. This improved their perceived ease of use of the m-learning technology. This 'stump' called 'time' can be removed by making sure that the system to be implemented has good technical features and that the users are given adequate training to enable them use the system efficiently.

Technical Issues: The use of an information technology system as postulated DeLone and McLean's IS success model (DeLone & McLean, 1992), (Petter et al., 2008), is depended on the quality of the system, service and information. This study gathered from the concerns of the users some determinants which related to system quality, service quality, information quality and relative advantage of the m-learning technology which are found in DeLone and McLean's IS success model, (Rivard, Poirier, Raymond, & Bergeron, 1997) Quality of User Developed Application model and (Sedera & Gable, 2004) Validated Measures for IS success. These models explain that absence of any of these elements have undesirable consequences on the user's intention to use, use and satisfaction which have negative impact on the individual and the organisation at large. This implies that if an IT system lack these elements, then it is likely that users are not going to have good usage experience with the system, which will eventually discourage them from continuing using the system. A system with good quality must have some features, which allow a user to find it easy to use, easy to learn, convenient to use, flexible and reliable among others as shown in. In this study, the first implementation had a lot of challenges concerning system quality but this was and gave users better experience in the second implementation.

Information quality refers to how the user perceives the output information from the system to be meaningful and useful to him or her. That is the output product of the system must be timely, usable, understandable, relevant and current as well as adequate. Experience from the m-learning project at CUC shows that information quality was a challenge at some point as the teachers and students used the system. Students were having problems in accessing content at the time they needed it and at times the content were not displayed in the correct format for them to access among other pertinent issues such as incomplete, inconsistent, unreliable and out dated information.

The service quality of an IT system is essential in keeping users abreast of the technology and maintaining their continuous use. This involves good quality technical support from both the external technology providers and internal IS department and IT support staff. Their duty is to ensure that users receive the best of attention from them when they encounter difficulty in using the system at any time. The users expect well trained and groomed technical team to be prompt in responding to their needs in relation to the system with empathy. The m-learning project had some challenges regarding service quality where some teachers and students complained of poor technical support during the first implementation, but this was minimal in the second implementation.

In addition to time, quality of system, service and information is the relative advantage of the system. Individuals and organisations are more enthused to use a system if it perceived as being better than its precursor (Moore & Benbasat, 1991). For example, people would use m-learning platform as against traditional e-learning platform if they perceive the former to be better than the latter. In the case of this thesis, most of the users did not perceive m-learning to be better than e-learning in the first implementation because they were some basic challenges in using the system, but this was different in the second implementation. Both the teachers and students began to appreciate the mobility affordances, portability, pervasiveness, flexibility among other characteristics of the m-learning technology, which made them to perceive the system as being better than traditional e-learning.

- **USER'S SOCIAL COGNITIVE COMPOSITION (represented by the letter U)**
  This construct refers to the user's behaviour towards the use of a technology and the relationship of his or her thoughts, actions, environment, beliefs, cognitive competence, attitude and ethos as well as self-efficacy, ethics, demographics among others on his or her behaviour. Social cognitive theory covers a broader scope of human behaviour, cognitive and other personal factors, and interaction with their environment (Bandura, 1986). A person's social cultural make- up, age, gender, and other factors shape up their attitude and behaviour, which influence their actions. These elements have been empirically proven in most IS research as factors which affects an individual's perception and behaviour towards usage of IT system privately or within an organisation. In SCT, UTAUT, MPCU, TAM2, TRA/TPB constructs such as outcome expectation, self-efficacy, affect, age, gender, social influence, subjective norms and experience were identified as determinants which impacted on individual's behavioural intentions to use technology (Compeau & Higgins, 1995a), (Thompson et al., 1991), (Venkatesh, Morris, Davis, & Davis, 2003b).

  The attitude and behaviour of the teachers, students and other staff at CUC towards the m-learning project was a sum reflection of their fragmented constructed social cognitive towards new technologies in their daily life. There were individual and organisational beliefs, subjective norms, self-efficacy, perceive usefulness, perceive ease of use, image, affect, visibility, compatibility, anxiety, behavioural controls, result demonstrability and other social factors which confronted the m-learning pilot project at CUC. Through observation, interviews and discussions it was observed especially from the teachers and students that their willingness or unwillingness to use their mobile devices for teaching and learning was partly influenced by some of the above mentioned determinants.

  These factors had varied influence on the individual users depending on their gender, age, self-efficacy, affect, behavioural control, and subjective, social image and beliefs. For example, it was observed that majority of the students who were between the age of 18 to 35 and some teachers who were young in age showed appreciable level of interest in the m-learning concept than their other colleagues. There were some of the teachers and students who irrespective of their age, had affect and positive attitude toward using new technologies. Some were mainly influenced to use the system

because of recognition and belonging. Others were internally and externally convinced to use the m-learning technology because of their perception on usefulness, ease of use, compatibility and how they saw others use their mobile devices in teaching and learning and the evidence of the outcome. Lack of affect and self-efficacy to use information technology and anxiety on the part of some of the users were hindrances, which discouraged them from using the m-learning technology.

These social elements among the STUMP factors were quite difficult to handle by the implementation team of its fragmented nature. Several sessions of orientation and psychic were done to realise some level of improvement in this regards. It was observed from the users that most of the negative influences of the social elements began to pave way for positives as they saw their colleagues use the technology every day. These concerns as were expressed by the users, needed to be resolved so that they would be able to use the m-learning system in a more efficient and effective manner to achieve the intended purpose. The focus of this model is on the users as individuals and corporate, thus every concern of the users in relation to use of a technology is an essential element, which must be addressed to ensure that they are in good standing to use the technology.

- **MOTIVATION (represented by the letter M)**

Some of the lukewarm attitude and behaviour put up by the users especially the teachers towards the use of the m-learning platform was partly due to lack of motivation apart from the S, T and U factors. This was not met with much surprise because there is significant reference from research in psychology, which supports general motivation theory and postulate that motivation influences peoples' behaviour in one way or the other. The motivation issues were grouped under extrinsic and intrinsic with peculiar obstacles, which were identified as the users expressed their concerns. On the side of the teachers, their main motivation issues was extrinsic - monetary incentive, free device, free airtime and internet access, and other facilitating condition as well as their involvement in decision making. These were quite different from what Davis et al 1992 meant by extrinsic motivation. They looked at the user being motivated by achieving a value outcome that is distinct from the activity itself such as improved job performance. This was not the case with the teachers; their motivation to use the system was purely external. Absence of these motivational items reflected the attitude and behaviour of

the teacher to use the system. It can be said that the kind of motivation in this context was a small aspect of what general motivation theories talk about. Some of these observations are peculiar to education institutions. For example, a teacher has to use his or her own money to buy airtime and internet access to connect to the m-learning platform which most of them would not do unless some allowances were made available for that. In this study, the motivation concerns of the teachers were major issue, but it did not receive much attention as expected.

On the other hand, the students' need of motivation was slightly different from that of the teachers. Their motivation to use the m-learning system was based on what they perceived it would help them to achieve in their academic life such as making learning flexible, interesting and ubiquitous. Their focus on motivation was on what the system could do for them in learning. Their concern on motivation was on having a good mobile device such as tablet to use for their m-learning activities. For example the mere fact that a student could have access to teaching materials and other learning resource on the m-learning at anytime from anywhere on his or her mobile device and be able to learn to interact with the teacher and colleagues without any technical hitches was enough motivation for them to use the technology. At CUC some of the students complained on the need for the school to supply them with tablets to make their m-learning experience interesting. In addition, skills, knowledge, perceived ease of use, perceived usefulness, time and good technical support were also indirect forms of motivation to both the student and the teacher. Motivation played an important role in getting the teachers and the students to use the system.

- **PEDAGOGIC RELEVANCE (represented by the letter P)**
  Ultimately, using the m-learning platform for teaching and learning at CUC was largely based on the perceived relevance of the technology for teaching and learning. Both the teachers and students made their intentions clear that their willingness or unwillingness to use their mobile devices for teaching and learning was grounded on the ability of the m-learning technology to meet the task of teaching and learning. The following were found from the teachers and students that the determining factors of pedagogic relevance of the m-learning technology were: (i) Task fit – this refers to the extent to which the users believe that using the m-learning technology can match and enhance the performance of their teaching and learning activities. (ii) Relative advantage – This

refers to the degree to which the users perceived the m-learning technology as being better than other learning technologies. (iii) Conformity – The extent to which the users believe the use of the technology is consistent with the norms, values and needs of teaching and learning. (iv) Appropriateness – This refers to applicability or suitability of the technology in the context of teaching and learning. (vi) Customisation – This is the extent to which the users believe that system can adapt and be tailored to different methods of teaching and learning. These factors constituted the overall perceived usefulness of the technology for teaching and learning.

Among all the STUMP factors pedagogic relevance is the most rated as being critical to the effective leveraging and integration of the mobile technology in tertiary education. The teachers' concerns were for the technology to provide the right support for them to meet their teaching obligations in a much better way than before without compromising on quality of delivery. During the first implementation, it was observed that pedagogic relevance concerns contributed enormously to teachers' unwillingness to use the technology because they could not perceive the usefulness of teaching with the technology. Thus, they were not able to use the technology effectively to meet their teaching objective as was anticipated. This was partly due to the fact that they had not grasped the technological pedagogical and content knowledge on how to use the system in a more meaningful way to achieve better results. These issues were resolved to a certain level before the commencement of the second implementation and it was observed that their perception on the pedagogic relevance of the m-learning technology had improved as compared to the previous time.

Most of the concerns of the students regarding the pedagogic relevance were on the appropriateness and how it supported their learning of different subjects. For example, it was noticed during the first implementation that it was quite difficult for them to use the m-learning platform for performing learning activities in architecture because the system at that time could not support complex drawings and it was tedious for a teacher to create drawing content with the m-learning authoring tools. This situation was improved in the second implementation and yielded a better usage experience.

The lesson from this is that in the educational sector, the most influential factor, which affects the use of a technology is the pedagogic relevance of the technology. This must

be clearly known and experienced by the users to enable them to construct their perceived usefulness of the technology for teaching and learning. This means that before introducing any technology in a school, that technology must be well tested and tried to establish its pedagogic relevance for various teaching and learning activities and teachers and students must be adequately oriented and trained to understand how to use the technology so as to get the best out of it to meet a particular educational objective.

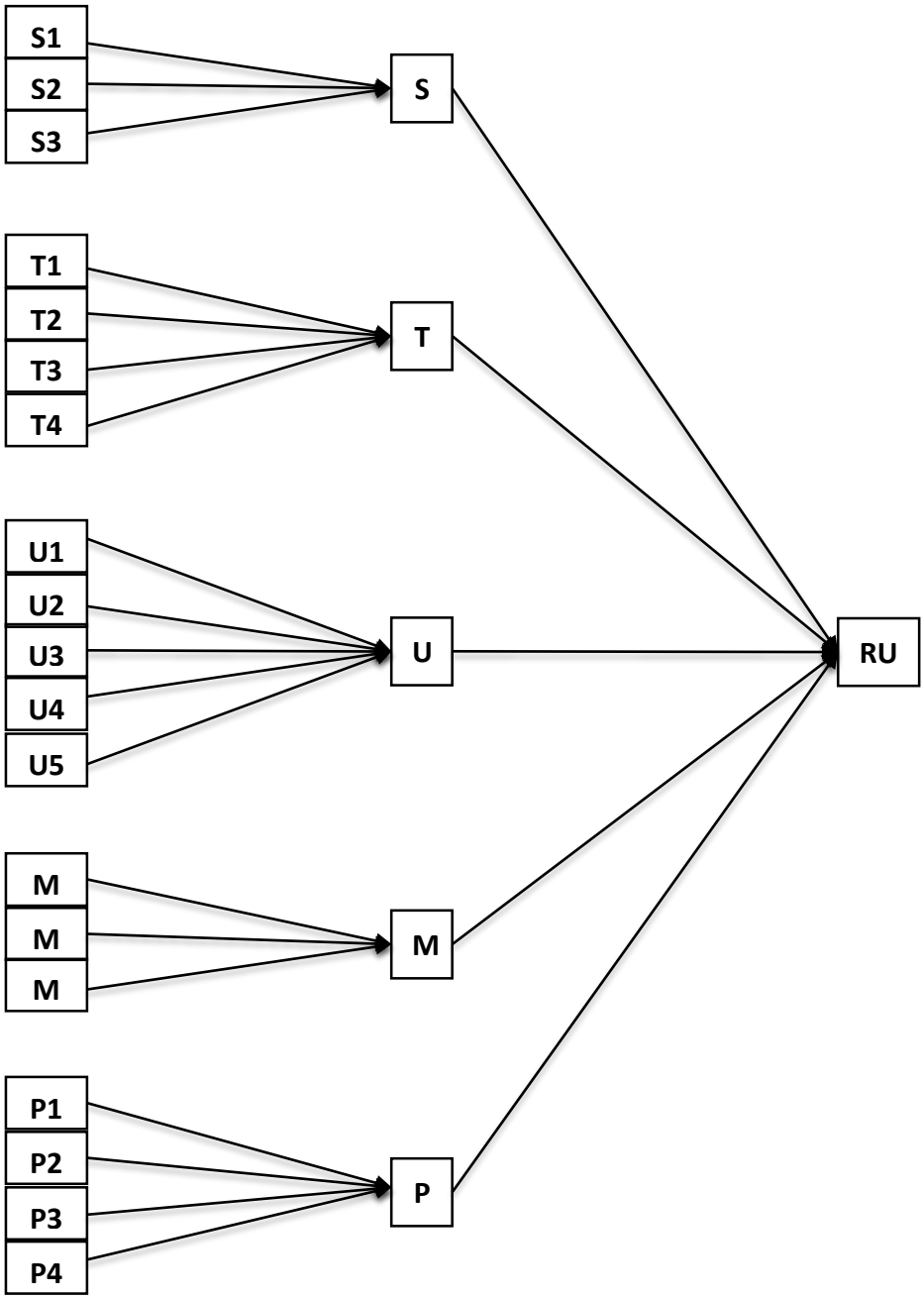


Figure 5. 3 STUMP and its determining constructs

5.12 Formulation of the STUMP constructs

The constructs for the formation of the STUMP framework are based on empirical data gathered from the users as they started using their mobile devices for engaging in teaching and learning activities at CUC. These data were obtained during the first and second stages of the pilot implementation of the m-learning system at CUC. The STUMP factors were constructed from several determinants, which were gathered from the users as being their main concerns, which influence their readiness to use and actually use the m-learning technology. The instruments for the data collection were observation, interview, focus group, workshop and survey questionnaires. The data was categorised into groups. This process resulted in putting the concerns into five general groups with each category represented by a general construct as shown in figure 5.3. The main constructs of each of the groups were assessed to determine their impact on the users. Questionnaires were developed for each of the categories to solicit data from the users. The questionnaires were designed to meet the different expectations from the various groups of users – teachers, students and administration staff in relation to their collective concerns. Separate sets of questions for all the STUP factors were developed for the teachers, students and administration staff. Finally, a flow chat and formula for assessing and analysing the data was developed for the conceptual framework.

5.12.1 How data was obtained

By watching the teachers and students as they tried to use the m-learning platform, it was observed that there were some constraints, which impeded them from using the system to the full. Regular monitoring of their teaching and learning activities showed that they had problems with issues pertaining to perceived ease of use, perceived usefulness, self-efficacy, time, task fit, appropriateness, training, knowledge, device, internet connectivity, user friendliness of the system, reliability, availability, access, affect, attitude among others. See appendix C. Confirmations of these observations were sought through interviewing some of the teachers, students and administration staff. Different focus group discussions with a section of the teachers, students and administration staff and a stakeholder's workshop revealed additional data to support existing data obtained from observation. All the data were put together and organised into a simple easy to answer questionnaire which was used as a follow-up to survey and confirm the data obtained from the observations,

interviews, focus group and workshop. The outcome of the survey was compared with the existing data and categorised into five main groups of factors that were identified as critical to the successful implementation of the m-learning project. The constructs forming the five main groups were put into questionnaires and administered to the users as a second follow-up to ensure that the constructs represents their concerns as they had been expressed by them in previous data. This process was used to strengthen the empirical foundation of the STUMP model.

5.13 Development of Main STUMP Survey Questionnaire

In order to collect data for the various STUMP factors, comprehensive questions were designed and given out to the users to respond. Each factor had its set of questions designed to gather relevant data from the users. The questions were in the form of "Yes" or "No" and likert scale. See appendix B. The administration of the STUMP survey questionnaires were used to gather data from the users to assess and measure their level of readiness to use the m-learning technology.

The cumulative of all the users' results were put together to determine the overall STUMP clarity level of the users. The result from the matrix analyser gives information on whether to go ahead and do the implementation or to hold on and resolve major STUMP issues.

The formula for calculating each of the STUMP factors is as follows:

- The matrix value for each of the STUMP factors is obtained by finding the means of all the responses.

- The total matrix value for all the factors for each group of users is obtained by finding the mean of means of all the STUMP factors.

Based on the STUMP clarity level scale explained in section 5.13 above, each matrix for each user or group of users must score a minimum of 2.5 to qualify for implementation. Any matrix value, which does not attain the minimum score, must be worked on until it is improved and is able to get at least the minimum score before proceeding to implement the technology. The

scoring scale for each of the matrix value ranges from 1 to 5 which are represented as follows: not ready at all – '1', not ready – '2', fairly ready – '3', ready – '4', very ready – '5'. On the matrix scale one and five are the minimum and maximum values respectively.

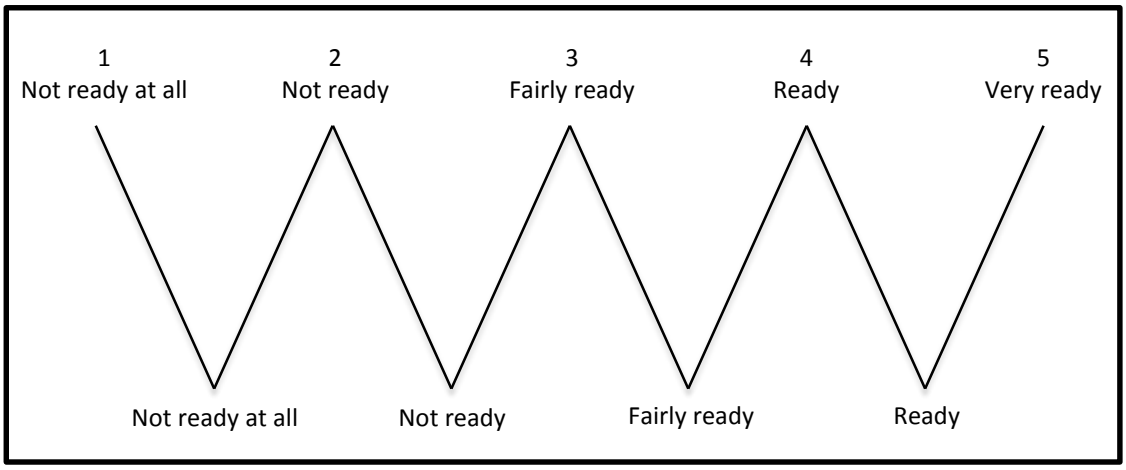


Figure 5. 4 STUMP matrix scoring scale

5.13.1 Construct Validity

With the help of SPSS 19.0 principal component analysis and Varimax with Kaiser Normalisation were respectively used as the extraction and rotation methods for conducting factor analysis to establish the validity of the constructs. Factor analysis was conducted for nineteen determinants, which extracted five components with eigenvalues above 1.0. These determinants, which were put into five categories were the sub-constructs of the main STUMP factors. As shown in table 5.6, each category of the determinants extracted one component with good convergence and discriminant values with Cronbach alpha above .70. Variables representing sub-constructs of the same factors were all significantly correlated.

Table 5.2 shows that the standardised coefficients for S, T, U, M and P are statistically significant (.01). The significance impact of the various items on RU are as follows: S (β=.405), T (β=.270), U (β=.195), M (β=.172) and P (β=.237).

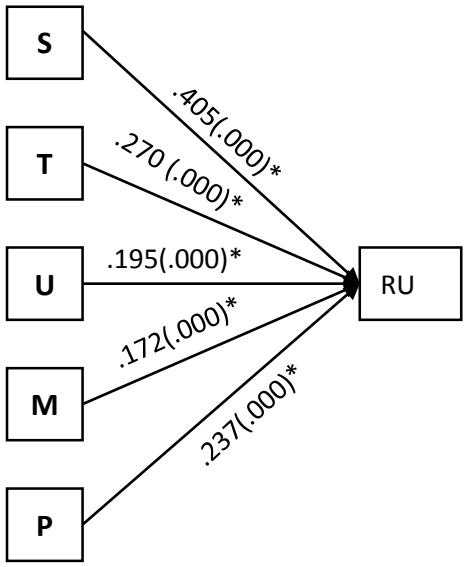


Figure 5. 5 the STUMP conceptual framework

Table 5. 2 Regression coefficients for predictors

Predictor Variables	Standardized Coefficients	Significance
S	.405	.00
T	.270	.00
U	.195	.00
M	.172	.00
P	.237	.00

Table 5. 3 correlations

		S	T	U	M	P	RU
S	Pearson Correlation	1	.816**	.756**	.699**	-.026	.886**
	Sig. (2-tailed)		.000	.000	.000	.716	.000
	N	196	196	196	196	196	196
T	Pearson Correlation	.816**	1	.891**	.834**	.050	.929**
	Sig. (2-tailed)	.000		.000	.000	.489	.000
	N	196	196	196	196	196	196
U	Pearson Correlation	.756**	.891**	1	.955**	.068	.921**
	Sig. (2-tailed)	.000	.000		.000	.347	.000
	N	196	196	196	196	196	196
M	Pearson Correlation	.699**	.834**	.955**	1	.025	.872**
	Sig. (2-tailed)	.000	.000	.000		.732	.000
	N	196	196	196	196	196	196
P	Pearson Correlation	-.026	.050	.068	.025	1	.257**
	Sig. (2-tailed)	.716	.489	.347	.732		.000
	N	196	196	196	196	196	196
RU	Pearson Correlation	.886**	.929**	.921**	.872**	.257**	1
	Sig. (2-tailed)	.000	.000	.000	.000	.000	
	N	196	196	196	196	196	196

**. Correlation is significant at the 0.01 level (2-tailed).

5.13.2 Construct Reliability

Cronbach's Alpha method and inter-item correlation matrix were used for analysing the reliability of the constructs to ascertain the internal consistency or reliability of each construct. As shown in table 5.4, the alpha values range from .751 to .915 which satisfies the generally acceptable reliability coefficient of .70 or higher in social science research. The results shows that S has cronbach's alpha of .841, .751 for T, .796 for U, .769 for M and .915 for P which are all acceptable alpha values confirming the validity and reliability of the constructs. The result positively implies that S, T, U, M, and P significantly affect the RU of the users.

Table 5. 4 internal factor reliability by Cronbach's alpha technique (n=196)

Construct	Cronbach's Alpha	Mean	Std. Deviation
S	.841	3.8265	1.09672
T	.751	4.0242	.72966
U	.796	4.2226	.52633
M	.769	4.2699	.46596
P	.915	4.6977	.64062
RU	.866	4.2085	.54127

Table 5. 5 Rotated Component Matrix

	Component				
	1	2	3	4	5
S1	-.031	.188	-.098	.115	**.811**
S2	-.138	-.012	.083	-.056	**.792**
S3	.126	-.077	-.053	.075	**.714**
T1	.029	.008	.021	**.713**	.217
T2	.032	.013	.054	**.782**	-.051
T3	.019	-.103	-.066	**.607**	-.069
T4	.091	-.042	.012	**.749**	.080
U1	-.032	**.707**	.048	-.154	.053
U2	.040	**.784**	-.068	-.048	-.087
U3	-.067	**.776**	.058	-.024	.087
U4	.154	**.656**	.184	.096	.063
U5	.016	**.764**	.005	-.019	-.030
M1	-.022	.069	**.889**	.159	-.027
M2	-.082	.142	**.829**	-.065	-.011
M3	-.104	-.025	**.830**	-.071	-.028
P1	**.826**	.050	-.009	.112	.006
P2	**.852**	.039	-.082	.020	.016
P3	**.908**	.104	-.048	.068	-.057
P4	**.759**	-.087	-.081	-.004	-.003

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 5 iterations.

5.14 Conclusion

The discussion in this chapter was on the STUMP model, which was developed out of the outcome of the m-learning implementation project. The discussion unveiled that STUMP is an acronym which represents S for SKILL, INTEREST, KNOWLEDGE; T for TECHNICAL

ISSUES & TIME; U for USER'S SOCIAL COGNITIVE COMPOSITION; M for MOTIVATION; P for PEDAGOGIC RELEVANCE of the technology. These factors which were put together to develop the STUMP model came from the data which was gathered from the users as they engaged in m-learning activities with their mobile devices. Thus, it was observed that lack of the above mentioned factors had unfavourable consequences on the implementation because it rendered the users handicapped in using their mobile devices for teaching and learning. The STUMP factors were identified as critical to the success of the implementation because it had direct influence on the behaviour of the users to use the m-learning technology as shown in figure 5.6. The overall impact is a reflection of a thorough use of the technology and could have favourable or unfavourable impact on both the individual users and the organisation as well.

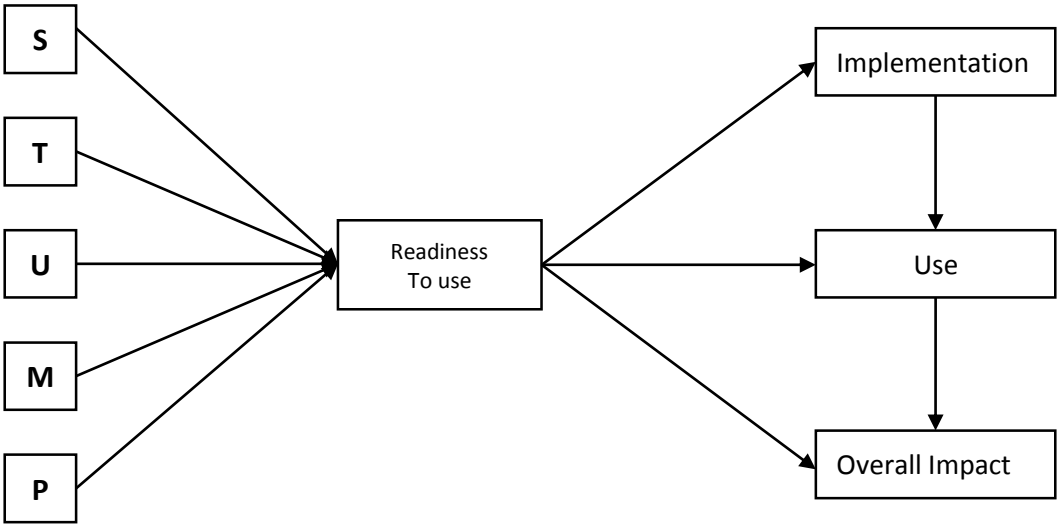


Figure 5. 6 the effect of STUMP on implementation, use and overall impact

Empirical evidence of the determinants that constituted the STUMP model was supported with eleven theories that were used to establish the theoretical foundation of the model. STUMP is a composite model for assessing and measuring the readiness level of users and their intention to use and use of technology. The model provides a matrix analyser that makes it easy to calculate and determine STUMP factors of users. The model focuses on the users and ensures that they have the right perception towards the use of the technology.

CHAPTER SIX

THE IMPLEMENTATION OF MOBILE LEARNING AT CUC

6.1 Introduction

This chapter is an extension of the methodology chapter. It provides detailed description of how the 'designed methodology' was practically done. This chapter gives a comprehensive account of the empirical work, which was done to answer the questions and to achieve the objective of the study. The problem of most educators as identified by this study's literature review and at CUC is mainly associated with implementation and framework, which can support and sustain the use of technology for teaching and learning. Mobile technologies are fast growing and influencing the way we interact, work, teach and learn, but its pedagogical relevance can only be evident when educators are able to successfully integrate it into their educational framework. To do this, a conceptual framework was designed to aid in the integration of m-learning platform at CUC.

Despite the fact that the study is idiographic in nature, the case at CUC and for that matter this study, is an embodiment of several cases of utilising mobile computing and communication technology in the form of m-learning to support tertiary education delivery to meet the educational needs of the 21st century learner. To obtain a good understanding and first-hand experience of how mobile computing devices are used for teaching and learning in tertiary education institution, I adopted an action research strategy of inquiry for this empirical study.

A thorough presentation of the whole empirical process is explained in this chapter as follows:

6.2 Background

As part of CUC's objective to educate people to become useful in society, it also appreciates the fact that society is dynamic and changing fast hence, the need to adopt and adapt to new ways of framing and presenting education especially to the 21st century student. The university takes cognisance of the rapid growth in ICT and comes to the conclusion that today's learner must be trained with tomorrow's technology to make them employable tomorrow. CUC is one of the biggest and fast growing private universities in Ghana, established in 1997 with a current student population of over 10,000. In 2009, CUC decided to introduce into its educational framework, an educational technology, which offers students and faculty the opportunity to engage in teaching and learning using their handheld mobile computing devices anywhere

anytime. The whole idea as conceived by the academic board and board of regent was to explore and utilise ICT for the betterment of university education. Knowing that ICTs can be used in different ways in education, and appreciating the mobility of students and high penetration of handheld mobile device, the university's board was particular in getting a teaching and learning system which utilises mobile computing and communication technology, capable of supporting academic activities outside bricks and mortar. Thus, a ubiquitous platform which allows 24/7 access to academic resources and without geographic limitations.

The university finally settled on m-learning as the technology to be used to complement the traditional face-to-face classroom model of education because it inherently comes with all the features of traditional e-learning and other advantages like portability and ubiquity. To do this, CUC engaged the service of AD-CONNECT consulting services an IT company based in Accra, Ghana to provide them with an m-learning platform. The company was to develop an m-learning platform which enables faculty to develop and publish content from anywhere on any time for students to access with their mobile computing devices at any-time from anywhere and must include features like forum, chatting, SMS, blogging and activity tracker. The anticipation of the project was to transform teaching and learning at CUC to reflect current trends of using educational technologies to facilitate education delivery which is learner centred and able to meet the educational needs of the learner.

Among the urgency of CUC as the first educational institution in Ghana to implement m-learning were but not limited to (1) delivering education in different ways which accommodates diverse learning styles of students to make learning flexible, interesting and enjoyable (2) help faculty to manage large numbers of students in terms of conducting exams and marking scripts. For example, a lecturer may have a total of about 600 to 1000 students in his or her class. The lecturer may have to conduct about two class work or assignments and a mid-semester examination as stipulated by the accreditation board. Conducting and marking the script of this number of students is sometimes onerous and lecturers are thus deterred from effectively adhering to these rules. This eventually affects the performance of the students at large. One way is for the m-learning platform to enable lecturers to conduct multiple choice examinations and have them marked and recorded immediately by the system without any human intervention. (3) to keep students and faculty daily updated on academic activities through the SMS alert functionality of the m-learning platform such as 'schedule', 'prompt' and 'reminder'

(4) to foster collaboration among students and faculty through the social media forum on the m-learning platform for discussions, feedbacks and sharing.

CUC earmarked five years for the full incorporation of the m-learning project out of which we have spent three years. Although the project is still ongoing, this thesis is giving empirical report on the first three years of the implementation of m-learning at CUC. The empirical study done so far is what is serving as a guide for the remaining two years of the project implementation.

While doing my initial literature review and investigation of m-learning projects in Ghana and Africa at large, I came across AD-CONNECT and they in collaboration with CUC expressed interest in allowing me to use the project as a case study for my research work while assisting in the implementation of the project. This was a welcomed idea, but my role as a collaborator and facilitator in the whole implementation process changed the research from case study to action research. It is against this background that the dual action research approach was adopted as the strategy of inquiry for this thesis. I joined the project implementation team as an action researcher right from the beginning of the project in 2010. My scientific role in the project was to identify how CUC could effectively leverage mobile computing and communication technology to advance teaching and learning.

6.3 Project Outline

The project as envisaged by the stakeholders was to effectively harness mobile computing and communication technology and incorporate it into the pedagogical framework of CUC to enhance teaching and learning among other things. The project was motivated by (i) enormous literature review which revealed the rapid advancement and proliferation of m-learning projects worldwide (ii) the unprecedented development of mobile computing and communication technology which makes it possible for it to be used as mediating tool for teaching and learning activities anywhere anytime (iii) the mobility affordance of mobile technologies in the delivery of education (iv) the availability of portable mobile computing devices in the hands of teachers and students – high adoption and diffusion among students (v) the improvement in mobile telecommunication service and infrastructure in Ghana which now has the capacity to support 3G and LTE with high speed data transmission and (vi) competition among mobile telecom operators which make services relatively cheaper.

The whole project was considered as experimental in phases. It started with an initial pilot (1st phase) in all the two campuses of CUC, Mataheko campus and the main campus at Miotso near Prampram all in the greater Accra region of Ghana. This lasted for two semesters of three months each with 500 students and 22 lecturers with 44 subjects including English, physician assistant, nursing, economics and accounting. The subjects were picked randomly from level 100 (1st year) to 400 (4th year) with each level having a taste of the new learning technology. The trial was quite successful, but had some challenges that needed to be resolved before moving on to the next phase of the implementation, some of which were (i) software in ability to meet pedagogical needs (ii) poor human computer interaction (iii) lack of constant 3G coverage anywhere anytime (v) additional cost and (vi) most students had clone mobile devices from china which did not connect well to the 3G network at all times.

To ground the project as a scientific research, a theoretical background was established from educational psychology and instructional technology as the philosophical underpinning of the research. As a dual action research, it was characterised with two interest (1) empirical interest and (2) practical problem solving interest. Both interests were pursuit concurrently throughout the project. An implementation framework was designed based on Mckay and Mathision's dual action research concept as shown in figure 6.1 & 6.2. The project was designed such that each semester served as one iteration of the implementation process. This gave us the opportunity after each semester to evaluate the whole process and specify learning, make necessary amendments to suit the objective and research question before initiating another iteration. Iteration in AR is a tool which is used for number of times until a desired result is achieved. For the purpose of this thesis and time constraint, we are able to empirically report on three iterations of the implementation process of incorporating m-learning into the educational framework of CUC.

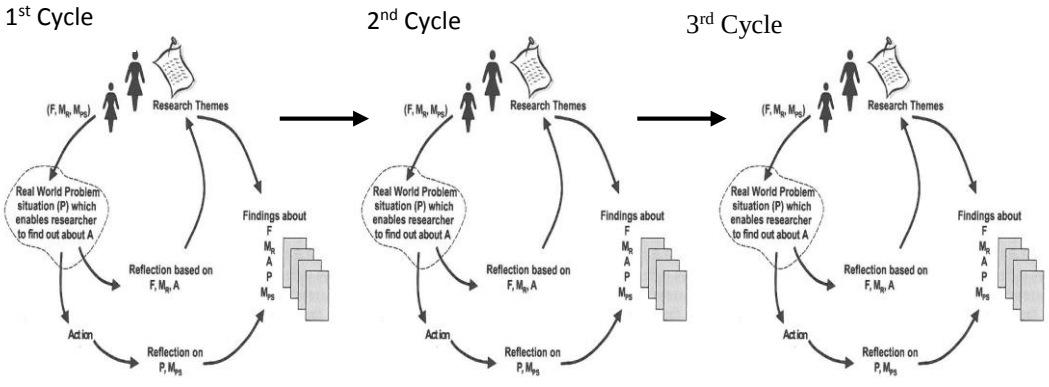


Figure 6. 1 the iteration process of the implementation

Source: adopted from McKay and Marshall dual action research concept

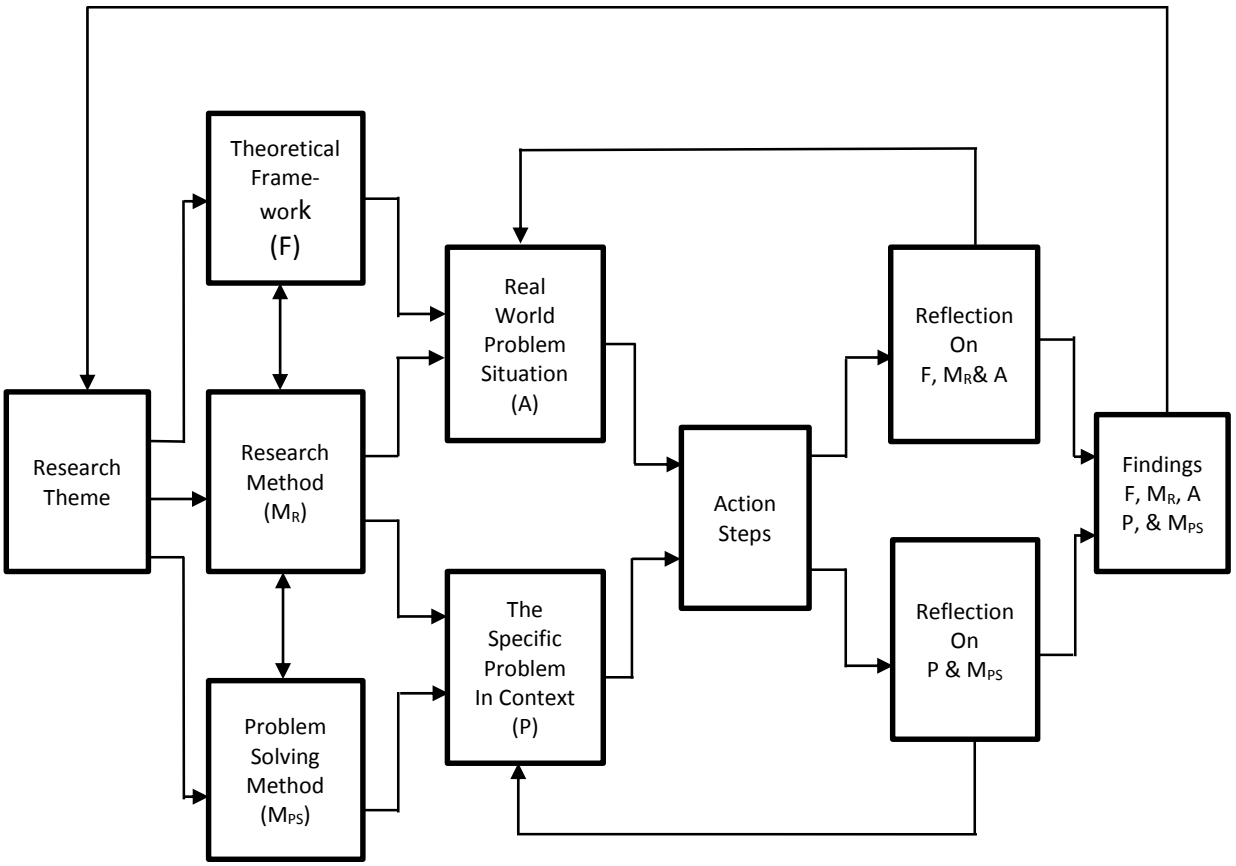


Figure 6. 2 the dual action research process in block diagram

6.4 Second Phase

The second iteration of the m-learning implementation started in the beginning of 2010/2011 academic year. The details on how it was done are explicitly outlined from 6.4.1 to 6.11.2 guided by action research principles.

6.4.1 Using the conceptual framework

The art of teaching and learning are based on psychological theories, which by their assumptions embrace different forms of technologies in different ways to facilitate its processes, therefore thinking about technology and education demands a conceptual model which can systematically amalgamate the two to achieve a desirable result. In the study in chapter four, a model was conceptualised to aid in ensuring effective incorporation of m-learning into tertiary education. This served as the theoretical guide for the project implementation.

Prior to the commencement of the second implementation, as part of the planning and designing process, the lecturers were taken through series of seminars to train them on how to use the model. In the training, they were taught how to set the learning objective of their courses, followed by how to select suitable pedagogic model and design effective teaching methods with the appropriate technology and link it to any of the learning theories - behaviourism, cognitivism and constructivism.

6.5 Conceptual Framework for incorporating technology in education

The overarching problem of educators in the area of integrating technology in education to augment teaching and learning is a complex issue not only to them, but also to researchers. The problem is the inability to develop and implement technology in schools to meet distinctive needs due to lack of appropriate frameworks. Educators need sound framework to enable them take appropriate decisions on incorporating technology in their schools. Yes, we see from research articles, televisions, newspapers and other sources on using various forms of technology in schools, but only a handful are successful in incorporating technology in their schools. This in most cases is due to the fact that we separate technology and education from each other rather, technology and education must be viewed from a common philosophical and psychological background so as to ensure successful partnership – so to speak. For example, ICT tools such as e-learning and m-learning (or Mobile eLearning) must be understood and related to the basic philosophical worldviews of education which are behaviourism, Cognitivism and constructivism to determine their appropriateness in a given educational context before one can go ahead to integrate them in schools for teaching and learning. This is what this conceptual framework suggests as shown in fig 6.2. Based on Dabbagh's conceptual framework, each philosophy provides basic principles and theories about learning which inform the goals and models that philosophy has for instruction, which in turn influences the perspective on the design of pedagogical media.

This conceptual framework was arrived at after the first iteration of the action research of the implementation of Mobile eLearning in CUC. It identified seven possible linear stages of ensuring holistic incorporation of Mobile eLearning in higher education institutions (HEI). The stages are (A) Set learning objectives, (B) philosophical background, (C) pedagogic model, (D) technology, (E) delivery method, (F) implementation and (G) evaluation. The whole idea of the concept is that pedagogy, learning objective, delivery method and technology must all connect to a common theory as shown in figure 6.3. The assumption is that implementers of

technology in school must have sound theoretical and practical understanding of 'what' they want to do, 'why' they want to do that, 'how' they will do it and effect of their actions. It must be noted that 'technology' do not teach rather, teachers do. This implies that the teacher must find educational need of the technology or must be able to model the technology to suit his or her teaching method to achieve the intended objective. Learning objective determines the kind of pedagogic model to use. The kind of technology to use depends on the pedagogic model and the delivery method. It was observed from the initial experiment of the m-learning at Central University College that there was no proper lay down and documented framework for using the m-learning technology. This affected the affected the project initially until it was rectified during the second stage of the implementation when a conceptual framework was designed as a guide for using the system. The framework explains from both theoretical and practical view point, the pedagogic relevance of the m-learning technology and how it can be utilised to meet teaching and learning objectives within the framework of any pedagogic model.

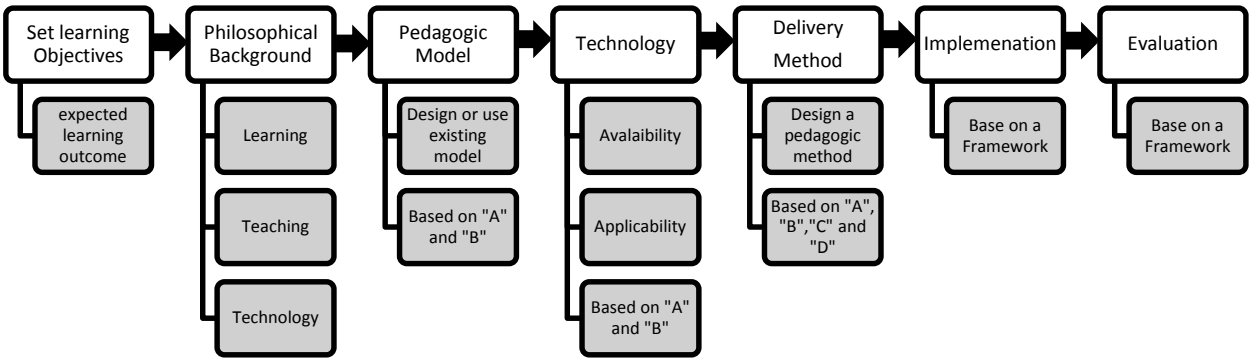


Figure 6. 3 Conceptual Framework for Incorporating Technology in Education

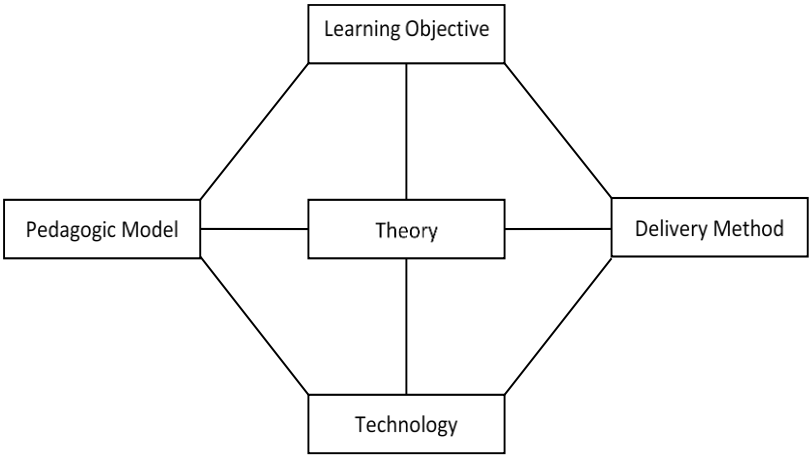


Figure 6. 4 theoretical connection between Pedagogy, technology, learning objective and delivery method

6.5.1 A – Set Learning Objectives

Setting learning objectives is a vast subject which cannot be fully discussed in this thesis. The concern of this conceptual framework is to consider just the need to set learning objectives as one of the component for incorporating technology in schools. Educators can make significant headway in using ICTs in learning if they have clearly stated learning objectives. Learning objectives must be explicitly defined to reflect the expected learning outcome. Setting the learning objective must begin with the "end" in mind. It must unambiguously describe the level of competences that a student must have after successfully completing a course. Every Tertiary Educational Institution (TEI) has aims, which inform faculties and departments to set their goals, which assist them to set learning objectives for their various courses. The learning objectives come from the overall goals of the school. It must explain what a student is expected to learn from a course and provide a detailed description of what the student will be capable of doing upon completion of the subject (Simon & Taylor, 2009), (Anderson, Krathwohl, & Bloom, 2005), (Harden, 2002), (D. Kennedy, Hyland, & Ryan, 2007). Setting course objective must be based on scientifically proven framework. For example, Bloom's taxonomy among others can be used as a guide for setting course objectives. The learning objectives show or give a clue on how to approach the teaching of the subject and the technology mediating tools, which may be helpful. Learning objectives are set differently in the cognitive, psychomotor, and affective domains, which encompasses interacting knowledge, skills and attitude (Soulsby, 2011). Learning objective must be "SMART". That is Specific, Measurable, Attainable, Relevant and Targeted at the student and to the desired level of learning ("http://ccoe.umdnj.edu/forms/EffectiveUseofLearningObjectives.pdf - Google leiting," n.d.).

6.5.2 B – Philosophical Foundation.

The learning objectives must align to learning theories, which may prove to be suitable for teaching to achieve the targeted objective. The learning objective must provide clues to which learning theory to use – Behaviourism, Cognitivism and / or Constructivism. This will determine the appropriate teaching methodology. In addition, it will give indications on appropriate learning technology based on the learning theory adopted. At this stage, educators must make sure that they have a firm grasp of the learning objectives and the philosophical assumptions that support it. The details of this have been discussed already in previous sections of this chapter.

6.5.3 C – Pedagogic or Instructional Model.

Based on the philosophical understanding of the learning objectives, appropriate pedagogical or instructional model can be designed from scratch or chosen from existing ones. For example, a constructivist learning objective will require the use of pedagogical model, which will allow the student to create their own knowledge in a real-world situation with the teacher working as a facilitator. Behaviourist model requires a hierarchically structured curriculum which allows students to learn systematically from basic to intermediate and advance level of knowledge. Cognitivist model are designed, such that the student will be able to store information and retrieve for future use and be able to create thought individually or in a group. There is no single set of educational ICTs, which is universal for teaching and learning. One best way to integrate a particular educational technology into teaching and learning is to thoroughly examine the kind of curriculum, learning goals, students and teachers in order to be able to select an appropriate technology.

6.5.4 D – Technology

At this stage, one must choose an appropriate technology as a mediating tool to match the pedagogic model. The intention must be based on using the technology to facilitate teaching and learning to achieve the set objectives. The decision to use any technology must be based on the learning objectives, theoretical background and pedagogical framework. In addition, the applicability and availability of the technology must be taken into consideration. The technology must be clearly useful to the pedagogic model, and context to help achieve the learning objective. The availability of technology to the teachers and students must be

considered. Applicability and availability of technology to the users is vital in ensuring successful use of the technology.

6.5.5 E – Delivery Method

The "delivery method" stage is where one design detailed methods on how the students must be taught. It must explain all the steps, activities, rules and roles of the teacher and student. The delivery method must be designed based on the learning objectives, philosophical background, pedagogic model and the chosen technology. Well-defined pedagogic strategy will not only help students to accomplish the desired learning outcome, but will also allow teachers to teach effectively and efficiently. For example, if you are designing a behaviourist pedagogic strategy, then the technology you are going to use must be able to support behaviourist teaching and learning style.

6.5.6 F – Implementation

Implementation is the main stage where the actual incorporation of the technology takes place. The entire implementation process must be based on a framework which stipulates well defined procedures to ensure successful, effective and efficient incorporation. The implementation must be done bearing in mind the learning objective, philosophical background, pedagogic model and pedagogic strategy. For example, in the case of this research, action research was used as the main implementation strategy.

6.5.7 G – Evaluation

Finally, the entire process must be assessed to know the outcome of the implementation. An assessment instrument or framework must be adopted for assessing the outcome of the implementation. The purpose of the evaluation is to determine whether the outcome of the implementation meets the targeted learning objectives.

6.6 PEDAGOGIC METHOD

A blended learning approach was adopted as the pedagogic model for the implementation. The traditional face-to-face classroom teaching and learning was blended with a mobile learning platform. Teaching and learning took place both in the classroom and on the mobile learning platform. It was structured such that the classroom and the mobile learning platform were effectively utilized for teaching and learning at CUC. The lecturers were trained to design their teaching materials to suit the classroom setting as well as the mobile learning environment. Activity theory was used as the theoretical foundation. The approach to teaching was open and

very detailed which encompassed behaviourism, Cognitivism and constructivism assumptions in teaching to meet diverse learning needs of the students in the appropriate context. The teaching styles included but not limited to problem solving & project based learning in groups and individually, didactic lectures, reciprocal, hands-on practice, class presentation and discussions, and using the mobile learning platform for online forum & discussions, blogging, animations & short videos and simulations. The role of the teacher and the students varied, depending on the teaching style. For example, the teacher becomes a facilitator, delegator or expert instructor based on the chosen teaching method.

It was compulsory for students to attend and participate in class activities. Meanwhile activities on the mobile learning platform were time bound. Students had time durations to participate in a discussion or respond to questions and exercise posted on the learning portal. This in a way helped the students to observe the rule of working within time to meet deadlines. The flexibility and versatility of the pedagogic strategy allowed teaching options, which promoted re-production of existing known or previous learning experience and also the creation of new knowledge to the learner, teacher and the community at large.

The teaching style was framed based on Tarasewich's context concept (Tarasewich, 2003) and Activity Theory (AT) which believes that learning is an activity mediated by tools or artefacts to achieve a target (Vygotsky, 1978), (Leontjev, 1978). Tarasewich in his three-category context model as depicted in fig 6.4, explains that the environment mostly have to do with the properties of objects in the physical environment.

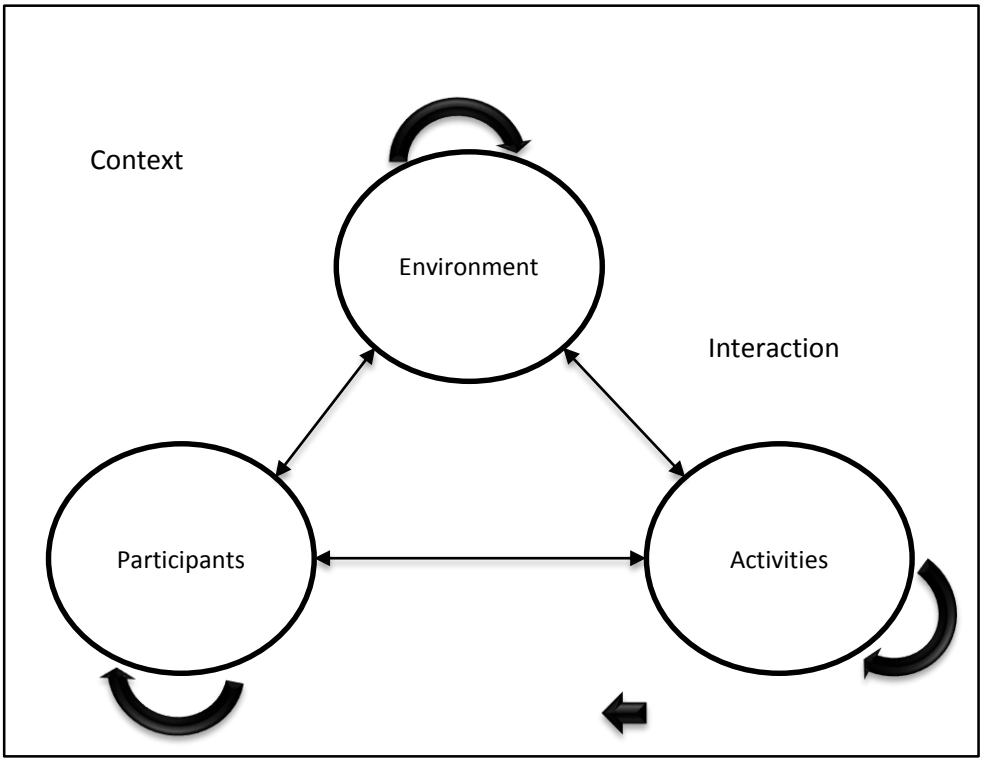


Figure 6. 5 Tarasewich's Context Model
Source: (Tarasewich, 2003)

From the model, participants comprises of the status of the user and other participants in the environment. Activities include users, participants and environmental activities. The model attempts to explain the interaction between these three elements – participant, environment, and activity. Context can be considered as any information which can be used to illustrate the state of a person, place or an object which is deemed relevant to the interaction between a user and a computer system (Dey, Abowd, & Wood, 1998). Context is also understood from the perspective of Tessmar and Richey (Tessmer & Richey, 1997) to have multi-levels of factors in which learning and performance is inherent as cited by Lorna Uden (Uden, 2007). The other factors including physical, social and teaching interact to affect learning. Context is essential and inevitable to every learning experience because learning cannot take place in a vacuum. And it is impossible as stated by Greeno (Greeno, 1989) that all cognition and reasoning is situated and we cannot do away with the context in which humans operate.

Tessmer and Richey argue that context is an invaluable tool for advancing the implementation of cognitive and behavioural goals, but it is sparingly given the needed amount of concern in designing pedagogic models. (Brown et al., 1989) also argue in the same direction by saying

that the act of knowing is an activity which is co-influenced by the individual and the environment which makes it impossible to separate the learner from he or she going to learn and the milieu which the learning will take place from each other. Knowing usually occurs in circumstances and it is connected to an activity. This explains that acquiring knowledge is a contextualised and reciprocally constructed activity which is objectively or subjectively conceived (Barab & Kirshner, 2001). This assumption is better conceptualised in activity theory.

The origin of activity theory can be traced to the former Soviet Union as a cultural-historical philosophy by Vygotsky (1978) and Leont'ev (1978). The notion of the theory is that an individuals' interaction with the world is mediated by artefacts. Vygotsky related this idea to a subject and a learning object mediated by artefacts. The theory has been used across many disciplines as framework for understanding human activities in different perspective. Its use in education and IS research is to link teaching and learning to information technology systems as artefacts which are used as mediating tools by the subjects. Activity theory views teaching and learning as a social constructive interaction mediated by physical and cognitive tools. The use of activity theory at CUC as a supporting theory for designing a pedagogic framework for teaching and learning was appropriate. Mobile learning platform was used as a supporting and mediating tools for teaching and learning to augment the traditional classroom face-to-face approach. This allowed teaching and learning to be extended far beyond the confinement of the classroom walls to a larger social environment making the whole process of disseminating and acquiring knowledge a more situated and constructive engagement. For example, in the physician assistant courses, students were able to use the mobile learning platform to simulate clinical procedures and also share ideas with their colleagues at different locations via mobile broadband internet. Activity theory enables us to understand human activities and work practices in a given context. It integrates the assumptions of intentionality, mediation, history, collaboration and development (Nardi, 1996) which have been used in many subject areas including education, information systems, human-computer interaction and communities of practice (Kuutti, 1996), (Engeström, 1993), (Nissen, Klein, & Hirschheim, 1991). Fig 6.5 depicts Engeström's expanded activity theory which identifies seven components as follows: (1) subjects in the activity (the people involved in the activity), (2) object of the activity (that is the actual, goals or intentions), (3) tools which are used to mediate the activity (could be physical such as computer hardware or software system, and it could also be psychological such as heuristics or models, (4) division of labour (for example, individuals activities within

a group or the role of an entire group), (5) rules and regulations (norms that define the activity), (6) community (other people who are directly or indirectly involved in the activity) and (7) outcome (that is the anticipated results of the defined objectives) (Zurita & Nussbaum, 2007).

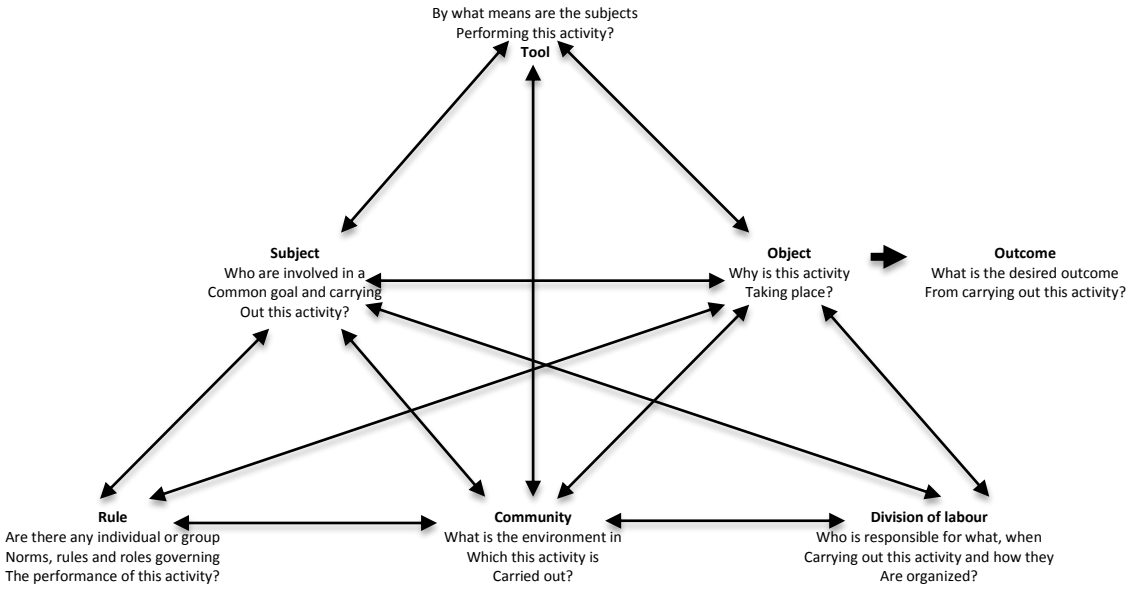


Figure 6. 6 activity theory model

Source: Engeström's expanded activity theory (1993)

The following is an example from one of the lecturers who participated in the seminar.

Course Title: - Management Information System

- *Learning Objectives: After the completion of the course, the student will be able to:*
  - *Apply critical thinking skills in decision making in the context of system development*
  - *Demonstrate interpersonal skills needs in the development of organisational information system*
  - *Apply system theory and information concepts in the analysis of organisational problem and opportunities*
  - *Demonstrate the ability to design and implement information system*
- *Theoretical Background: The learning objectives require the student to thoroughly understand what he or she does, gain some practical experience in knowledge construction and be able to assimilate theories.*

  - *Behaviourism*
  - *Cognitivism*
  - *Constructivism*
- *Pedagogic Model: Blended classroom mode of delivery with technology*
  - *Instructional*
  - *Problem base learning*
  - *Technology mediated learning*
- *Technology*
  - *M-learning Platform*
- *Delivery Method*
  - *Classroom lectures*
  - *Group Discussions and collaboration*
  - *Students' presentation in class*
  - *Field work*
  - *Class work*
  - *Lecture summaries, short notes, assignments and multiple choice quizzes on the m-learning platform.*

6.7 Planning and Design of Action Plan

Drawing on the outcome of the initial implementation and taking cognisance of the challenges that were encountered, the implementing team had fore knowledge on how to plan and design an action plan for the incorporation of the m-learning platform at CUC. Unlike the 1st phase, which was a trial with a selection of the school, the 2nd phase was a full implementation involving a student population of about 10,000 in four faculties of eighteen departments with about 143 teaching staff. To do this effectively, an implementation team was to be formed and tasked to ensure that they facilitate in harnessing mobile computing and communication technologies through the m-learning platform to the advantage of enhancing teaching and learning anywhere anytime.

6.7.1 Implementation Committee

To ensure that the teachers and students at CUC are able to effectively use their portable handheld mobile devices for teaching and learning, a team was formed to plan and design a framework for the implementation. The team was supposed to be of about 21 members consisted of faculty officers, department representatives, IT support staff, SRC representative,

three technical staff from AD-CONNECT, one project coordinator each from CUC and AD-CONNECT and myself (a PhD student) including other sub-committees which include training, system administration and configuration team which consisted mainly of technical persons. However, unfortunately in reality the implementation committee was virtually nonexistence. The entire responsibility of supervising the project was left in the hands of the coordinators and AD-CONNECT technical team.

6.7.2 Responsibilities

The responsibilities of the implementation committee were to prepare a detailed plan on how the whole implementation process will look like, from start to end, stating clearly the steps and actions to be undertaken. The responsibilities of the committee were documented as follows:

- To liaise with the mobile telecommunication operators for them to understand the educational need of 3G service so that they will expand its coverage to enable high speed access to content anywhere anytime.
- To review other m-learning projects elsewhere and learn from their strengths and weaknesses to serve as a guide to ensure effective and successful implementation.
- To be abreast with how teachers and students use their mobile devices on and outside campus for teaching or learning.
- To take a survey of what mobile devices are owned by students and teachers of CUC.
- To meet regularly and document all activities from the beginning to the end of the implementation.
- The committee had to update the academic board and board of regent on the status of the project at the end of every semester.
- To ensure that teachers and students are well oriented and trained on how to use the m-learning platform in their various capacities.
- To make sure that there is an effective technical support 24/7 for both teachers and students.
- To design a pedagogical framework for the use of m-learning that is able to meet the educational objective of CUC.
- To monitor and evaluate the entire project and advise the academic board and board of regent.
- To see to the compliance of the technical specification of the system.
- To make sure that every activity is executed as scheduled.

- To seek expert advice when it becomes necessary.

The above stated responsibilities of the committee were subsequently shared among the members. Each member of the implementation committee was assigned a responsibility depending on his or her level and area of expertise in relation to the project. Responsibilities were shared among the committee members as follows:

- The chairman of the committee who was also the project coordinator appointed by the university was responsible for calling for meetings to ensure that members were adequately informed on the implementation process as pertained to the situation on the ground. He was also obliged to hold informal briefing meetings with the vice president of the university in charge of academic to update him on the progress of the project.

- The duties of the faculty officers were mainly to liaise between the heads of department and the project committee. Some of their task included: (i) to coordinate with their departmental heads to reciprocally ensure that all information needed for the implementation are provided as and when needed (ii) to see to it that faculty members have adequate training on how to use the newly introduced m-learning platform, for example, to ensure that faculty members are able to develop and publish content in accordance with the pedagogical framework of the platform (iii) to monitor and track departmental performance on the use of mobile computing and communication technology in their education delivery (iv) to report any challenge that the faculty may encounter to the committee for immediate attention.

- The responsibilities of the heads of departments were as follows: (i) to ensure that students and lecturers are well oriented and informed on the use of the m-learning platform by allowing them to attend training sessions and workshops organised by the training sub-committee (ii) to make sure that lecturers and students are able to use the system for the intended purpose. For example, lecturers were obliged to develop and publish content on regular basis onto the m-learning platform while the reciprocal obligation of the students were to promptly access content and act accordingly (iii) to report any challenge that lecturers and students may meet to the committee for shift rectification.

- The role of the CUC IT unit representative on the committee was to coordinate with the technical staff of AD-CONNECT to ensure that the system run smoothly 24/7. Some of their duties were (i) to ensure that students and lecturers are able to login onto the m-learning portal without much difficulty (ii) to help students and lecturers to configure their mobile devices where necessary (iii) to monitor 3G connectivity and advise appropriately (v) to take charge of the administration of the system (vi) to report any system failure to AD-CONNECT and inform the committee (vii) to monitor the security of system and make recommendations (viii) to ensure that the computer laboratories were in good shape for training at any time. For example, they are to make sure that all the necessary software packages needed for training are installed on all computers in the lab (ix) they must in consultation with AD-CONNECT identify user requirement and take necessary steps (x) to observe and report any misuse of the system to the committee for appropriate steps to be taken (xi) to migrate all data on students, lecturers, faculties, departments, programmes and courses onto the m-learning platform.

- The SRC's representation on the project committee was to ensure that the committee obtain from the students first-hand information on their views on m-learning project. The responsibilities of the SRC were (i) to interact with their colleagues and report their observations to the committee (ii) to make special training arrangement for students who have difficulties in using the m-learning portal (iii) to observe and report any abuse of the system to the committee for appropriate action to be taken.
- The training sub-committee was formed by the project committee with the express interest of ensuring that adequate training are provided for both lecturers and students and are capable of using the system as intended.

- The system administration and configuration team was mainly made up of AD-CONNECT technical staff in close collaboration with the IT director of CUC. The responsibilities of the team were (i) software development (ii) server administration and configuration (iii) provide technical support 24/7.

6.7.3 Researcher's Role

My role as an action researcher on the project was in two folds. To pursue the research interest while helping to solve practical problems in a real world situation. My role as a member of the project committee was as follows:

My general role was to collaborate and facilitate the project implementation. This called for my immense involvement in the project right from the onset to the end. I performed my duties in close collaboration with the project committee members and all the other stakeholders. In doing this, I categorised my responsibilities to meet the dual interest of the project as follows:

6.7.3.1 Research Interest – RI (roles which were aligned to the RI)

- To provide a theoretical underpinning for the project.
- To develop a conceptual framework that will ensure effective incorporation of mobile computing and communication technology through the use of m-learning platform in CUC.
- To help in designing a pedagogical framework suitable for the m-learning.
- To design an action research framework for the implementation of the project.
- To review state of the art literature on the use of portable mobile computing devices for teaching and learning in tertiary education.
- To collaborate with the project committee in setting research/project objective and questions.
- To identify and state the real world problem situation which has necessitated the project.
- To find out more facts about the project.
- To empirically monitor the project implementation process through participant observation, interviews, focus group, workshop and survey.
- To document every aspect of the project using dairy, journal, voice and video recorders.
- To evaluate and specify learning.

6.7.3.2 Problem Solving Interest – PSI (roles which were aligned to the PSI)

- To understand the context of the real world problem situation in relation to CUC education delivery.
- To join the technical staff of AD-CONNECT and the IT support staff at CUC in the pursuant of their duties.
- To recommend and give advice where necessary.
- To collaborate and facilitate the physical implementation of the project
- To monitor, evaluate and specify learning.
- To personally make myself available throughout the project to facilitate close collaboration and observation.

6.8 Pedagogic Framework

The most relevant aspect of the whole project was to identify pedagogical use of portable mobile computing devices for the advancement of teaching and learning. The mobile technology as we may all be aware has come of age and has the capacity to support education delivery, but the onus is on users to develop meaningful ways of using the technology to enhance teaching and learning. This implies that there is the need to thoroughly examine the technology to find an appropriate pedagogical use of it in the delivery of education. For this reason, this project is theoretically grounded in the fundamental educational psychology theories of learning which are behaviourism, cognitivism and constructivism as the basis for designing a pedagogic framework for this project using the framework of activity theory, which says that teaching and learning is a human activity, which is mediated by various kinds of artefacts.

Another understanding in developing a pedagogic framework for this project was that m-learning will be used to complement the traditional face-to-face classroom mode of teaching and learning. Thus creating a technology blended teaching and learning environment for CUC students and teachers. The m-learning platform was to be used in three ways at CUC; for academic administration, summaries and as a complementary module. With this in mind we were equipped with the necessary pre-requisite information to model an appropriate pedagogic framework for the project as follows.

- Depending on the course, content were designed with either behaviourist, cognitivist or constructivist objective.

  Examples:

  - The requisite Content was designed by a lecturer from the nursing department with the primary objective of enabling students to recall facts, define and illustrate concepts, apply explanations, and automatically perform a specified procedure. This was intended for them to be able to memorise medical terminologies and also be able to reflexively perform certain routine task.
  - Another lecturer from the accounting department created a content such that students were required to read a short document after which they were asked some questions, if a student was able to answer all questions correct he or she was awarded a mark and was then allowed to move on to the next document, but if a student was not able to answer all questions correctly he or she is asked to repeat until he or she is able to attain the desired result. This type of content allows the learner to progress slowly by mastering simple things through to complex ones.
  - Some content were designed to enable students construct meaning by collaborating and interacting with their peers in a real world situation where they had the opportunity to discuss and contribute to knowledge building on discussion boards on the m-learning platform. Some of the content were such that the students were required to find out from people around whenever the content is made available to them on their mobile device anywhere anytime.

- Style of Content
  - To ensure effective use of the mobile device; content were made to be in the form of short notes, lecture summaries and review questions with hyperlinks for more information.
  - The content were in the form of text, audio, animation or video.

- Assessment
  - Students received assignment and homework questions on their mobile device, which required them to answer the question in a typed document and send as attachment to the lecturer.

  - Only multiple choice examinations could be conducted on the m-learning platform at CUC.

- Rules
  - All content on the m-learning platform must be very concise and have some activities attached.
  - Assignment and examination on the m-learning platform must have the finished date and time of completion, after which the system automatically removes the content.
  - Lecturers have to develop content regularly to engage students in using their mobile devices for learning.
  - Teaching and learning on the m-learning platform will be complementary to the traditional classroom mode of teaching and learning.

- Mediating tool
  - Lecturers could develop from their personal computers or laptops and publish onto the m-learning platform via the internet.
  - Students could access content from anywhere at any time with any of the following mobile devices; tablet PC, smart phone, mobile phone, laptop and note book.

- Interaction/Collaboration
  - Students can interact with their lecturers and their peers, using the social forum and blog on the m-learning platform.

6.9 User Requirements

To undertake such a project, one must take into account the user requirement before implementing the project. In this case, the main users were the lecturers, students and administrative staff at the academic registry's department. For the users to be able to use the mobile devices for the purpose of teaching and learning, technical and other non-technical needs were considered. Among them were (i) basic ICT skills to enable them to use the system effectively (ii) essential knowledge about the technology and its application (iii) technical issues relating to devices, operating systems, interoperability among others.

6.10 Implementation of Action Plan

Putting what has been planned into action was the practical aspect of the project using action research approach. The implementation of the action plan was founded on the learning objective, psychological background, pedagogic model, technology and delivery method based on the conceptual framework espoused from the theoretical background of this study. The implementation stage of the project was where the teachers and students were going to have a practical experience of using their portable mobile computing devices for ubiquitous teaching and learning. This process was approached systematically with linear and multi-task activities. Details of the activities are explained in 6.10.1 to 6.10.8.

6.10.1 System development, Administration and Configuration

From the findings of the initial pilot, it was recommended that a more user friendly, easy to use and less time consuming m-learning authoring tools be developed and adopted for the actual implementation of the m-learning at CUC. With this term of reference, both the local and international technical staff of AD-CONNECT worked assiduously to develop a new m-learning system, which is easy to use with good human computer interaction and above all less time for authoring content. The new m-learning authoring tool is a plug-in, which is installed and appears on Microsoft power point as an add-on. This add-on is a mobile device enabled version of power point, which allows lecturers to author content using the familiar power point tools with new simple to use additional tools and a connection link to a web-based server, which enable content to be published via a mobile delivery engine for students to have access to the content via internet. The authoring tool supports different forms of documents including text, audio, video and animation. The add-on authoring tool was installed for the lecturers on all their computer devices available to them so as to enable them to create and publish content from anywhere at any time.

The system has a web-based database as its backend with administration and configuration tools for setting up the complete m-learning platform. This allows the system administrator(s) to program the m-learning platform to incorporate the users, faculties, departments, courses and other relevant details onto the system. Some of the administration and configuration activities included but not limited to (i) creating user roles and login details (ii) assigning courses from departments and faculties to teachers and students (iii) setting up server connectivity on lecturers' computer devices to enable content publication onto the m-learning platform (iv) populating the data base with users, faculties, departments and course details and

(v) setting up interoperability connection on the platform to enable connectivity to different mobile computing devices.

6.10.2 Data Migration

One of the tedious aspects of the implementation process was the migration of all essential academic data on students, faculties, departments and courses onto the database of the m-learning platform. This was a collaborative responsibility between the system administrators of CUC and AD-CONNECT to ensure that all data, which were needed for the effective use of the m-learning platform were correctly populated onto the systems' database with a continual update of new students, lecturers and courses. To speed up the migration process, some selected staff at CUC and AD-CONNECT were trained by the system administrators to help in populating the database. After everything was completed, students and lecturers automatically received SMS alert on their user-name, password and how to login to the m-learning platform. In all about 8,838 students, 143 lecturers, 4 faculties with 18 departments and 23 courses with over 200 subjects were migrated onto the system before the commencement of the second phase of the implementation.

6.10.3 Training

The ability of users to effectively use the system as intended was partly linked to the kind of orientation and training they received. As part of ensuring that users were well trained on how to use the system, users were categorised and were given adequate training on every aspect of the system essential to their various level of use of the system. For example, the students did not need much training because they were at the receiving end of the system, that is, logging into the system to access content either for lecturer summaries, assignments, quizzes and forum discussion. The lecturer in this case was a major user of the system both as a content developer / author and an end user as well. He spent time to author content, publish it and then join the students in the access environment to interact with the students, track performance and give rapid feedbacks among others. The students and lecturers were concurrently given different training based on their peculiar user demands and were given detailed training materials both soft and hard copies. All the training session for the lecturers were held in the CUC computer laboratories in modules of three to five days and it was purely on the practical use of the system. The students were grouped into levels and departments and were given general orientation and basic training. To compliment this, an idea was conceived to create m-learning front desks at various faculties and the SRC office was opened to users for further inquiries.

The students were mainly trained on how to login, navigate and access relevant content while the lecturers were taken through several sessions of training on how to do the following: (i) to login with their username and password (ii) to create short note and summaries from their teaching materials (iii) to insert multimedia content such as voice recording, still pictures, videos, flash, graphics and more (iv) to create questions, assessments and polls (v) to publish the content via the mobile delivery engine (vi) to track student records and activities (vii) to give prompt feedback to students (viii) to collaborate and engage students in online interactions and (ix) to generate reports. Questionnaires were prepared and given to the trainees for evaluation after every training module. This helped in identifying training areas that needed to be improved.

6.10.4 Content Development & Publishing

After a series of training, some of the lecturers were able to author their own content using the m-learning authoring tool as shown in figure 6.7 and 6.8, others could only do it with some help while there were others who could not author anything at all for numerous reasons, which are discussed. Those who could develop content, did it and published it onto the m-learning platform for ubiquitous access. Publication of content is done remotely by connecting to the webserver with the right credentials.

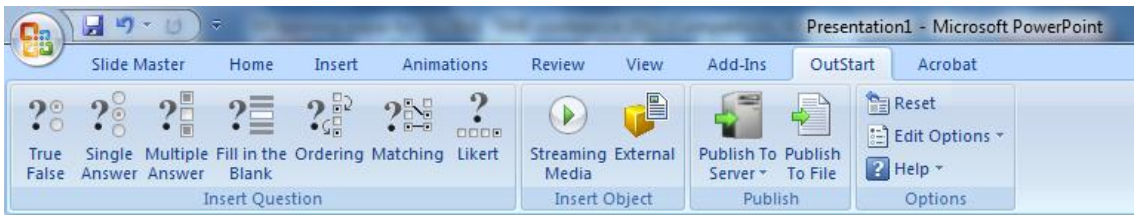


Figure 6. 7 m-learning authoring tools - 1

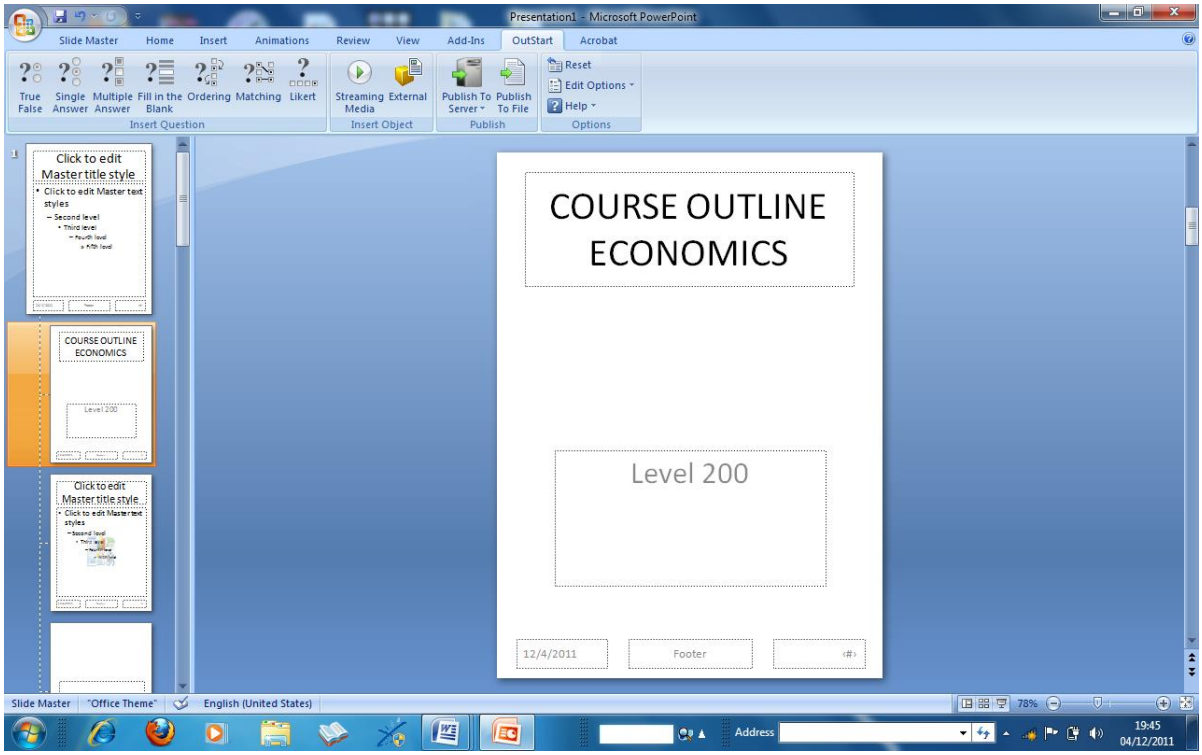


Figure 6. 8 m-learning authoring tools - 2

6.10.5 Access to the M-learning portal

The whole system is web-based, which implies that access is only possible through the internet by logging in with a username and password using any portable mobile computing device from any geographic location with wireless internet coverage at any time.

6.10.6 How the system was used

The lecturer performs two relevant roles on the m-learning platform. He or she doubles as a content developer and mentor user. First of all, he or she develops appropriate content based on the institution's pedagogical framework. The content is then uploaded onto the m-learning platform which is connected to the internet. Users with their mobile devices using mobile broadband internet connect to the m-learning web server to access content for learning. The users in this context were two; the student who is basically a user as a learner and the lecturer who is also a user as a mentor for the student in a ubiquitous learning environment. The lecturer finally takes feedback from students to make updates and modifications to content for future development.

6.10.7 System Performance Monitoring

To ensure that the lecturers and students use the system with satisfaction, the project team kept monitoring the use of the system to ensure that system, service and information qualities were excellent to the expectation of users based on Delone and Mclean IS success model. For example, monitoring system downlink and uplink transmission among others.

6.10.8 System Architecture

Figure 6.9 and 6.10 are schematic presentation of the CUC m-learning system and figure 6.11 is an actual real life experience of how teachers and students at CUC used their mobile devices for engaging in m-learning activities.

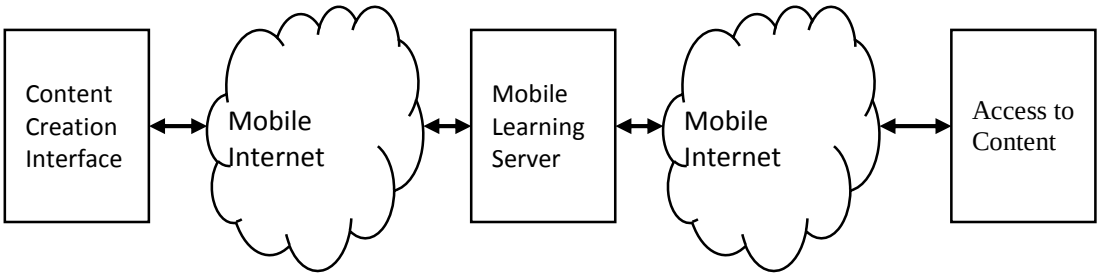


Figure 6. 9 mobile learning system architecture

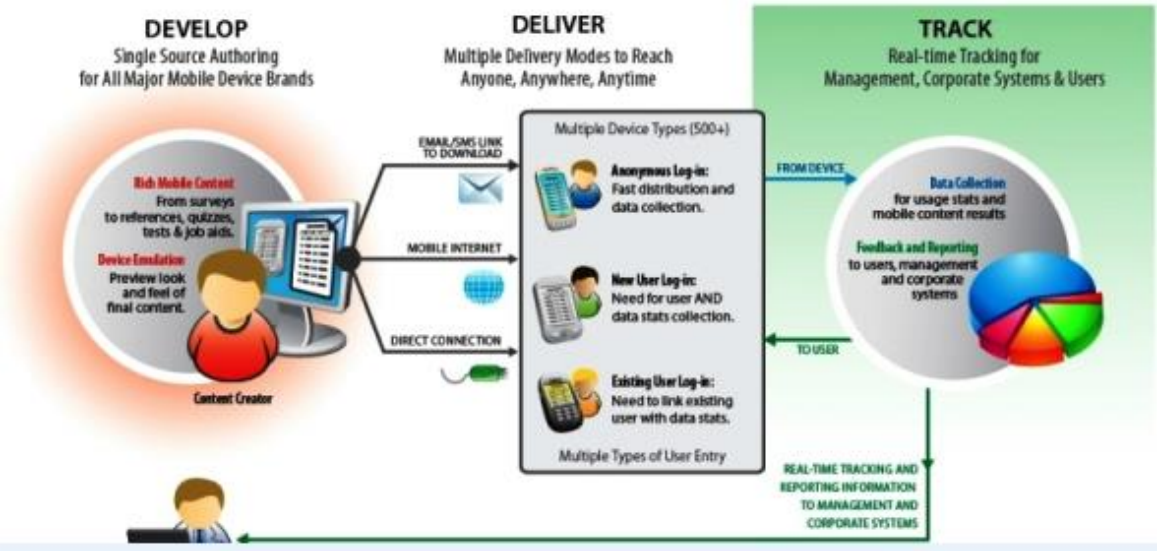


Figure 6. 10 schematic diagram of the AD-CONNECT m-learning system

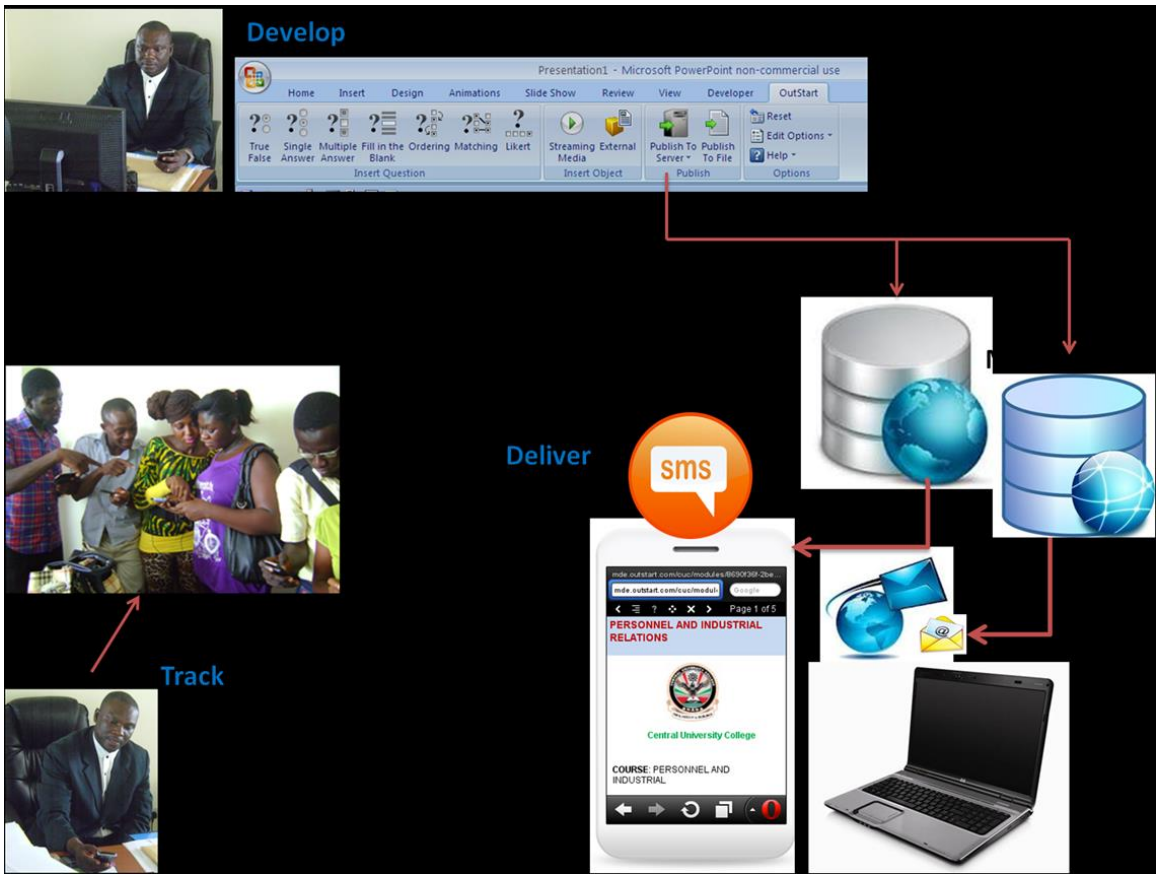


Figure 6. 11 a typical teacher and student's m-learning experience at CUC

6.11 Monitoring and tracking user activities

This was in two folds, monitoring in the interest of problem solving for the ultimate purpose of research interest.

6.11.1 Problem solving monitoring

The project coordinator in collaboration with the system administrators were responsible for monitoring and tracking activities of students and lecturers on the m-learning platform. Their job included (i) monitoring individual lecturer's activities on the system. For example, how often a lecturer authors and publish content onto the platform for students (ii) students' activities on the system. For example, how responsive students are to content mounted on the platform (iii) create polls on the platform to gather feedback from lecturers and students on their experience in using the m-learning platform (iv) monitor internet connectivity and traffic and (v) generate report on the system for decision making.

6.11.2 Research interest monitoring

The activities of the lecturers and students including all stakeholders who were involved directly or indirectly in the project were monitored from a research perspective with an empirical instrument. For example interviews, observations, focus group discussions, workshops and surveys were used in gathering first-hand information from the users' experience as the phenomenon of using mobile computing and communication technology for teaching and learning at CUC unfolds. Information came spontaneously from all angles any time I had the opportunity to interact with the users either through normal conversations or formal discussion. Typically, lecturers and students activities were meticulously monitored.

An example of a typical scenario (lecturer and students activities)

A lecturer from the accounting department on one Tuesday morning had principles of accounting one with level 200 accounting students which lasted for 2hours. He then went to his office and quickly prepared lecture summary with twenty objective questions. He gave it an expiring duration of 25 minutes. He published it onto the m-learning platform and rushed out of the office to observe the students around. To our surprise, as soon as the students received SMS alerting them of new content, they excused their friends whom they had been conversing with to quickly respond to the call of the content. Some of them started moving away from their other colleagues who were not part of the class to concentrate on the assignment. After 15 minutes, I went with the lecturer to his office to track the activities of his students. When the 25 minutes lapsed, all the students had submitted their work and received their results instantly including those who could not attend the class that morning. The lecturer and the students were all amused about the way the system worked.

6.12 Evaluation

At the end of the first semester of academic year of introducing the m-learning project, the implementation committee formed a joint evaluating sub-committee to assess the effect of the implementation on the delivery of education at CUC. The committee was made up of members from CUC, AD-CONNECT and the action researcher (myself). All the data, which were gathered by the various parties involved in the project were brought together for analysing. The data were categorised into quantitative and qualitative to enable the appropriate method of analysis to be done. Descriptive statistics were used for the quantitative data while phenomenological hermeneutic was adopted for the qualitative data analysis. The findings from the data obtained revealed some issues which suggested that a third iteration of the project

must be implemented taking the unveiled issues into consideration. The project committee made amendments to the implementation plan while the action researcher did further inquiry into literature to facilitate the third round of the implementation. The evaluating team presented their findings and recommendations to the project committee, which subsequently presented it to the academic board and board of regent. The details of the findings are discussed in the subsequent chapters.

The key findings from the evaluation were significant in ensuring effective incorporation of the m-learning platform into the educational framework of CUC. It must be mentioned that as much as the implementation committee put in place all the necessary measures to ensure the smooth and effective usage of the mobile computing devices of the lecturers and students for teaching and learning, the process was not void of draw backs, some of which were anticipated while others were unexpected. The theoretical framework for the implementation, which hitherto was not available for the initial pilot proved very useful in keeping the whole phenomenon of harnessing mobile computing and communication technology to the advantage of tertiary education on focus. It helped in deepening the understanding of the lecturers especially to appreciate the need to use technologies such as mobile computing and communication technology as mediating tools, which can be very helpful for teaching and learning.

The empirical deduction from the outcome of the evaluation led to the development of a major conceptual framework, which served as the basis in addition to the theoretical framework for the initialisation of the third iteration. The constructs of the framework are more related to users' concerns which when taken into consideration will ensure effective and successful implementation of m-learning. The elements of the framework are put together to form the acronym called "S.T.U.M.P" which is the title for chapter seven of this thesis. It was used prior to the commencement of the third implementation, first to predict the success or failure and then used to evaluate the final outcome of the project. The STUMP framework states that for the m-learning implementation to be effective and successful, the needs of all the users involved must be mutually taken care off. The need analysis must be quantifiable and measurable. This gave the implementation committee a heavy task to be completed before the commencement of the third iteration of the m-learning project.

The STUMP factors as shown in figure 6.12 are as a result of issues which bother users on the usage of the technology. The factors are (i) skills, interest and knowledge of users in the area of the technology being used (ii) time and technical consideration with reference to system quality, service quality and information quality (iii) users' social cognitive composition in terms of cultural background, beliefs, attitude, self-efficacy, perception toward the use of technology among others (iv) various forms of motivation to encourage users to use the system (v) the ability for the technology to fit into their style of working. These factors are put in a matrix and analysed

The evaluation of the second implementation at the end of the semester was very helpful in streamlining things and preparing adequately for the commencement of the third iteration of the implementation. Though the research objective and questions did not necessarily change, the evaluation contributed greatly to sharpen the focus. For example there were strong indications from all the data gathered that the user's concerns as reflected in the STUMP model were very essential factors in ensuring the effective integration and use of mobile computing and communication technologies in the delivery of tertiary education.

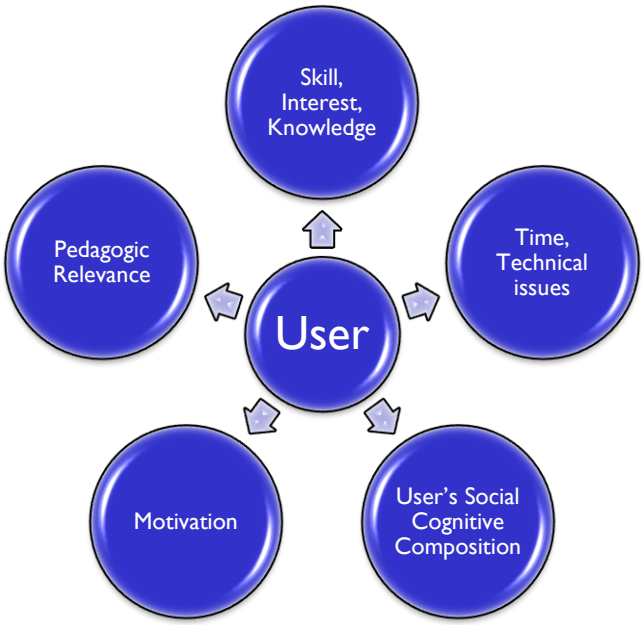


Figure 6. 12 Factors, which affected the usage of the m-learning technology

6.13 Third Cycle

One of the unique characteristics of action research is the principle of iteration. This gives room for the researcher or a project team to review and reapply an intervention in a particular context until a desired outcome is obtained. The introduction of lecturers and students to the use of mobile computing and communication technology on an m-learning platform for the purpose of teaching and learning as part of the education delivery framework of CUC entered its third cycle of implementation. This was basically informed and guided by the outcome of the first and second implementation, in line with action research principles on evaluating effect of intervention in terms of research objective and questions, and to terminate the implementation cycle if questions are satisfactorily resolved and objectives attained or make amendments to the research project design and action plan if further explanation or research are required to repeat the intervention.

The implementation of the m-learning project was initialised for a third time with the express purpose of pursuing the interest of finding answers to the research questions and objective while practically helping in solving a problem. After evaluating how the implementation fared in the previous implementation, the project committee came to the conclusion that the success of the third implementation was dependant on how the outcome of the former implementation is understood and interpreted to aid in making necessary amendment to focus on specific aspects of the whole concept of m-learning. This have shown strong indications of requiring urgent attention. It was observed by the project committee that the action plan and design for the third implementation was not necessarily going to change much, rather, the change emphasis was going to be on the user need factors, which have conspicuous empirical evidence of facilitating effective implementation and integration of m-learning at CUC, based on the theoretical background of the study and the conceptual model, which was designed in this study for the incorporation of educational technologies in tertiary education.

In the previous implementation, users were well oriented and introduced to the m-learning technology with a clear understanding of the conceptual model for the implementation which actually paid off well in helping them to appreciate the usefulness of the m-learning technology in education if it is appropriately used. The real application of using the technology for the intended purpose however, was ensnared in the inability of the project committee for not being able to fully meet some critical user needs, which were later identified through the evaluation

as being crucial in ensuring a successful implementation and integration of the m-learning platform in CUC. The project committee equipped with empirical data spear headed by the action researcher did a thorough analysis on the user concerns as a prerequisite for commencing and evaluating the outcome of the third implementation.

The third iteration of the implementation commenced after the STUMP analysis has been completed although the result of the analysis showed that there were still some minor issues to be resolved, but the implementation had to start because it was the beginning of the next academic year after the completion of the second implementation. The responsibilities of the members of the implementation committee did not changed much, however some few additions were made to strengthen the process. One of the most significant was the seminars and workshops, which were organised for the users based on the evaluation results of the previous implementation. The seminars and workshops were organised for the users purposely to address the STUMP factors as found from the evaluation of the previous implementation. In addition, individual users with similar challenges in relation to the use of the m-learning system were identified, grouped and given special attention in orientation and retraining. Several of such cases were found among lecturers from different faculties and departments. Thus the concentration of the project committee in ensuring an improvement in the level of success this time around over the previous one, was to effectively handle user related challenges. This started with the development of survey instrument based on the STUMP framework, which was given out to lecturers and students to respond and submit.

Other preparations, which were made before the take-off of the third implementation included the following:

- The system administration team ensured that data on freshly enrolled first year students as well as newly employed lecturers were populated and configured to grant them access onto the m-learning platform.
- As part of ensuring that students and lecturers are able to use their mobile devices to access content on the m-learning as often as possible anytime anywhere, AD-CONNECT and CUC went into negotiation and came into agreement with zain, a mobile telecommunication operator in Ghana (now Bharti Airtel) to prepare a special data package, which is cheaper for the students and lecturers.

- CUC entered into partnership with Main One Cable Company, one of the region's leading broadband network infrastructure providers, to make superfast broadband internet available on campus. Main One's submarine fibre optic cable runs from Portugal to South Africa with landing points at Accra and other major West African ports. CUC was the first university in Ghana to tap into their network infrastructure to provide unlimited high-speed Internet access across all campuses. The move was to ensure that CUC has adequate internet capacity to cover the needs of students and staff.
- AD-CONNECT in collaboration with CUC started separate negotiations with two local companies in Ghana, Zepto and rLG, and UTL in India to manufacture affordable, but good quality tablet PCs for the students and staff. This was anticipated to offer the students and lecturers a better m-learning experience. The negotiations were however not conclusive at the time the second implementation began.

6.14 Evaluation

The evaluation account given in this section is an overview of the detailed outcome of the implementation, which is fully presented and discussed in chapter 7.

The work done after the evaluation of the previous implementation in amending the action plan to resolve some of the challenges that were identified actually yielded some good result in the third implementation as anticipated. This time around, the evaluating team started their work from day one that the implementation took off. The strategy was to enable the team to gather enough data from the day to day activities of lecturers and students as they use the m-learning platform. It showed strongly from their work that the maturity of the implementation in fully integrating the m-learning system into the academic work in CUC will take some time, however the evaluation of the third implementation gave positive indications that everything is on course, but the caveat is that it must be a systematic gradual process. The third implementation gave the project committee and the users a better appreciation of the use of mobile computing and communication technology for teaching and learning anywhere any time.

The evaluating team adopted various methods in gathering data as the phenomenon of using mobile devices in teaching and learning at CUC unfolded and members of the team were assigned specific responsibilities to ensure that relevant data were obtained. The evaluating team at the end of the implementation collated all the data which have been gathered by the team members for analysis and interpretation. A few heads of departments submitted a

comprehensive report on how their departments fared in using the m-learning system. Their reports touched on general teaching and learning activities of lecturers and students in using the m-learning system, benefits and challenges and technical issues. Faculty officers independently monitored and reported on their faculty's performance in using the m-learning system across their departments. The project coordinators adopted a collaborative method in monitoring and gathering data on students and lecturers activities by encouraging students to monitor each other as they use the new technology for academic activities and also observe lecturers' performance. They received a lot of feedback from the students which they documented and submitted a report on it to the evaluating team.

Other individual members of the evaluating team filed their report on their observations in specific areas of the implementation process as they were obliged. This included users' adaptation to the new style of using their mobile device for teaching and learning. The attitude of new users (fresh men and women) and (new lecturers) towards the system and technical issues which needed urgent attention.

The researcher on the other hand, though a member of the evaluating team, also gathered data privately by observations, interviews and focus groups while collaborating with all the stakeholders involved, which were all put together for the evaluation. For example in a workshop organised for all the stakeholders, the national accreditation board and director of ICT of the Ministry of education on different occasions made comments on their observation on using the m-learning system in CUC.

The outcome of the third implementation showed some improvement over the previous implementation. Although it was below what was anticipated, it was still better than the first two iterations. With the iterative nature of the whole project, the project committee believes the challenges will reduce while the success level will increase as the project iteration continues. For example, more lecturers were able to create content for students on the m-learning platform than the first time. The introduction of the STUMP model contributed enormously to the relative success of the implementation, but as it was recorded before, the third implementation took off, the STUMP matrix analysis indicated that there were still some issues to be tackled to ensure effective and successful implementation and integration of the m-learning project in CUC.

The project committee after analysing all the data came to the conclusion that the introduction of the m-learning system has the potential among other things to transform education delivery in CUC, but in a slower pace than what was projected. As their recommendation, the committee also stated that subsequent iterations of the project will not necessarily need changes in the implementation action plan, but rather, the focus should be on making sure that the user's concerns found in the STUMP conceptual framework are taken seriously and resolved.

6.15 Conclusion

In this chapter, a comprehensive description of the empirical study, which was carried out on the use of mobile computing and communication technology for teaching and learning in tertiary education has been discussed. The coverage of the discussion comprised; how m-learning platform was incorporated into the educational framework of CUC through action research. The account of all the iterations of the project implementation were distinctively given. The introduction of lecturers and students to the concept of using mobile devices for teaching and learning uncovered relevant user needs which led to the discovery of the STUMP model. This was found to be critical for ensuring effective implementation and integration of m-learning in tertiary education. The rich data gathered and the findings from the empirical study are inexhaustibly discussed in the following chapters.

CHAPTER SEVEN

THE MOBILE LEARNING EXPERIENCE

7.1 Introduction

In this chapter, I present the results, analysis and discussions of the empirical study conducted in CUC on the implementation of mobile computing and communication technology in tertiary education for teaching and learning anywhere any time using an m-learning platform. The main question which necessitated the empirical study was – how to effectively harness or leverage mobile computing and communication technology and incorporate it into tertiary education to facilitate teaching and learning. In an attempt to contribute to the community of knowledge to help in resolving the problem, an intervention was applied as reported in chapter five, based on a theoretical framework and the state of the art from relevant literature on technology and education, the philosophy of teaching and learning, mobile technologies and mobility with the intention to unearth the factors, which hinder effective leveraging and integration of useful technologies such as ICTs in education.

Both qualitative and quantitative forms of gathering data were utilised appropriately throughout the project, with the principal aim of gaining a holistic understanding of the outcome of the implementation processes in relation to the research questions and objective. The analysis and synthesis of the entire project of incorporating m-learning into the educational framework of CUC depicted the correlation among the human elements, technology and pedagogic theories which threw more light on the research problem.

A detailed account of the findings from the CUC m-learning phenomenon is comprehensively presented in this chapter as follows: Section 7.2 begins the discussion with an overview of the key findings of the whole project. This is followed with section 7.3, which analyses the exploration of an initial trial preceding subsequent implementation of the system using action research approach. Section 7.4 presents the results and analysis of the second implementation after the 1st experiment. Sub section 7.4.1 gives an analysis of the unfolded phenomenon of teaching and learning with portable mobile computing devices anywhere any time. It discusses the account of teachers and students especially on how they embraced the whole new concept of m-learning. Sub section 7.4.2 continues with the analysis of users' concerns as was found from the users as they used the system. This is followed with the conceptualisation of the

S.T.U.M.P model in sub section 7.4.3. This section elaborates on the previous section's analysis by providing an in-depth discussion on the various factors and their implication on the incorporation of m-learning in tertiary education. Furthermore it discusses how the model was used to prepare the way for the third implementation. Sub section 7.4.5 concludes section 7.4 with an analysis of the general learning outcome of the implementation. It discusses and specifies learning according to the principles of action research for termination or reiteration of the implementation.

Section 7.5 gives an account on the results and analysis of the third implementation of the project. It builds on the outcome of the second implementation and synthesises it with the findings from the third implementation to provide a better understanding of the phenomenon. Sub section 7.5.1 follows with an analysis of mobile computing and communication technology in education delivery. Sub section 7.5.3 follows with an analysis of the need and usefulness of conceptual framework for guiding the incorporation of m-learning into tertiary education. The affordances of mobile technology and its implication on education delivery and the mobility in the delivery of education are respectively analysed in sub section 7.5.5 and 7.5.6. Sub section 7.6.6 gives an analysis of the final learning outcome of the implementation.

7.2 Overview of Key Findings

Although the leveraging of mobile computing devices and communication technology through the m-learning platform at CUC is still ongoing and perhaps has entered the next stage of implementation, the phenomenon as it has unfolded so far from the implementation has a remarkable result worth analysing and discussing within the confinement of this thesis. The designing of the whole research project within action research framework made the study longitudinal and contextual in a real world situation. The data obtained from the study was an outcome of the natural construction of meaning by the users of the m-learning system in their day to day academic activities and how they could take advantage of the educational opportunities of mobile computers and communication technologies to advance ubiquitous delivery of tertiary education. In spite of the idiographic characteristics of the study, the findings from the m-learning project are not necessarily peculiar to CUC as a tertiary education institution in Ghana. The results as discussed and presented in this report is a triangulation of methods and data – qualitative and quantitative.

The project had a dichotomised interest, one was to help in practically solving the problem of CUC on how to effectively leverage and integrate mobile computing and communication technologies into their educational framework and the other was to interpret the outcome of the study from a scientific perspective to contribute academically to the research community. These two legitimate paradigms of interest as were anticipated at the end of the project served as a guide in the collection and analysis of the data in the spirit of action research. Eventually, the outcome of the project after two years of using mobile computing devices and communication technology for teaching and learning at CUC produced some results at the end of each of the implementation cycle which cumulatively reflected both the problem solving interest and the research interest that were synthesised to gain practical and scientific understanding.

The project committee's final evaluation of the entire project stated that it has practically and empirically monitored and gathered data from the project participants from the very beginning of the project to the end and have come to the conclusion that the whole phenomenon of CUC introducing its teachers and students to an innovative way of teaching and learning in this era of digitisation is a welcomed idea. The report indicated that though the project was the first of its kind in a university in Ghana, the outcome was relatively satisfactory with each level of the implementation iteration being an improvement over the other, which implies that if the project continues, greater improvement will be attained as depicted in figure 7.1. The improvement level as presented in the graph was not quantifiably measured, but it was noticeable throughout the implementation. For example in the initial experiment, a few participants were selected and most of the teachers as compared to students could not use the system as expected. In the 2nd cycle of the implementation, the entire school population was configured onto the m-learning system. Though not all had a full experience with the system as shown in figure 7.2, the teachers' usage of the system saw some improvement (see figure 7.3). In the 3rd cycle, most of the problem encountered previously were appreciably resolved which led to more usage of the system. It is also necessary to emphasise that the level of success of the project was not so much as it was anticipated, nevertheless the outcome was significant.

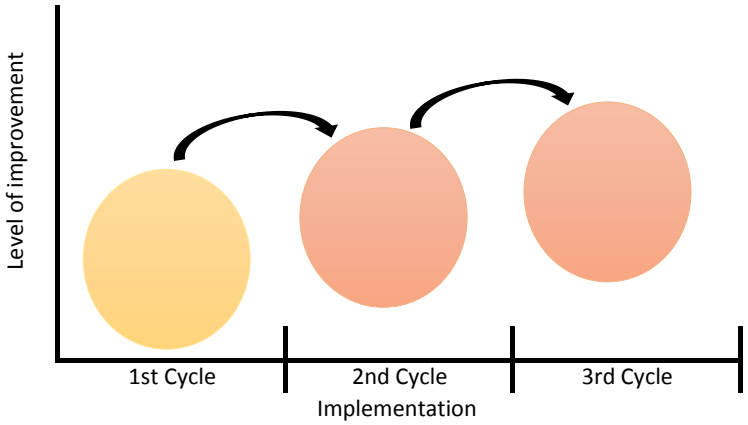


Figure 7. 1 graphical presentation of the improvement level of the project

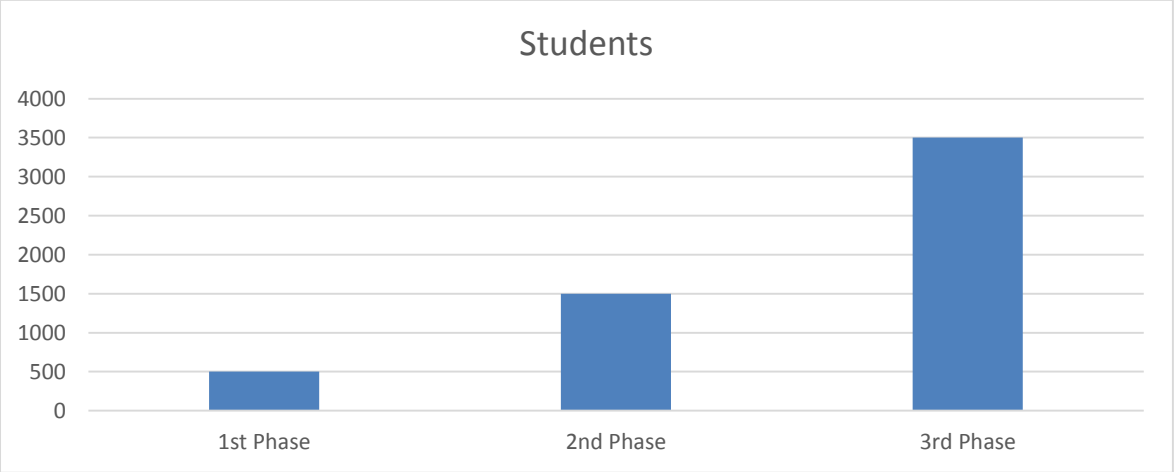


Figure 7. 2 students' participation

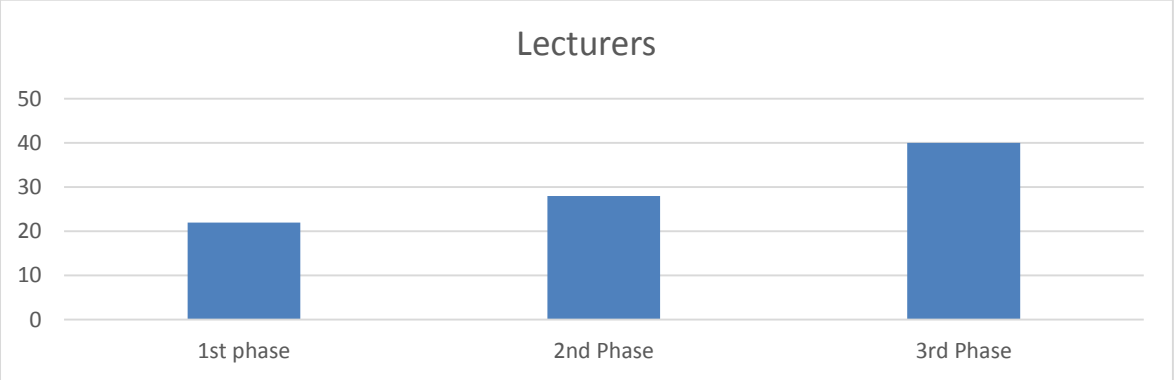


Figure 7. 3 lecturers' participation

The introduction of a conceptual framework for effective incorporation of the m-learning platform into CUC's educational system from the beginning of the second implementation, had a positive impact on the overall outcome of the project. It helped in developing a better

understanding and appreciation of the pedagogic usefulness of mobile computing devices and communication technologies in facilitating tertiary education delivery in this dispensation of high student mobility and connectedness. Notwithstanding this, there were some significant challenges, which were discovered through observations, interviews, focus groups discussion and workshops. These were users' concerns relating to the effective use of their mobile computing devices for teaching and learning from anywhere at any time. The concerns as expressed by the users were their insufficient skills, interest and knowledge of how to manipulate and use their mobile devices productively for teaching and learning, time demand and ability to provide system, service and information quality to ensure user satisfaction, addressing users' social cultural dynamics, attitude and perception towards the technology, providing sufficient motivation and ensuring that the system is suitable for teaching and learning. These issues were eventually found to be the core factors together with the conceptual framework as the pillars for ensuring successful implementation and incorporation of m-learning in tertiary education. The statistical analysis of the quantitative data obtained from the users in relation to the STUMP factors showed that the STUMP constructs have significant impact on implementation, use and overall impact or outcome of the m-learning technology as shown in figure 7.4. The results indicate that a good STUMP level of users reflects in a good cooperation between users and the technology implementer(s). It also translates into use and eventually successful implementation.

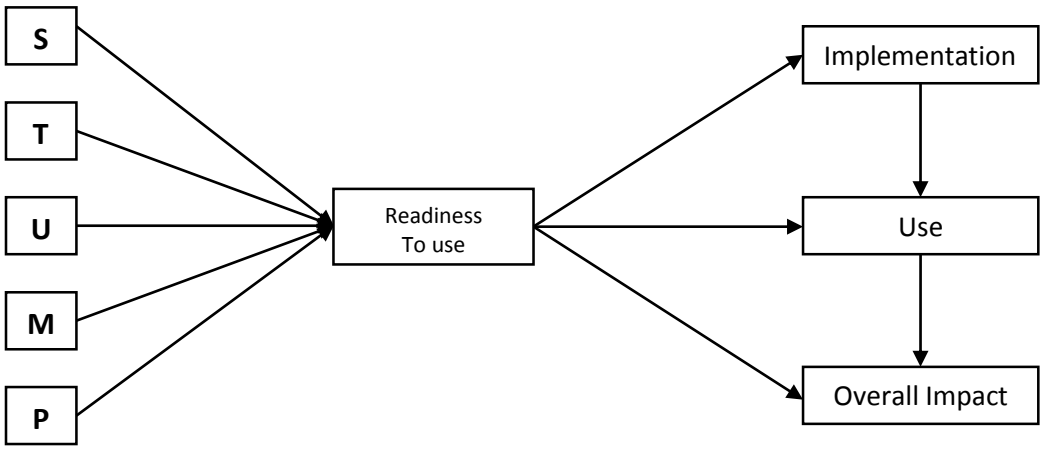


Figure 7. 4 the effect of STUMP on implementation, use and overall impact

For the purpose of quantitative analysis and discussions, data was obtained from approximately 1,478 students, 37 lecturers and 5 administrative staff representing 92%, 67% and 100% respectively from the sample. The inter-item correlation of STUMP, RU, IMP, USE and OI

were all significant. The analysis shows that the readiness of the users (RU) to use their mobile devices for teaching and learning as determined by STUMP is significant to implementation (IMP), use (USE) and overall impact (OI) of the m-learning technology. Correlation analysis were done for all the users for STUMP – RU and IMP, USE, OI – RU as shown in figures 7.5 – 7.9 and tables 7.1 - 7.4 The correlation figures actually represent the level at which the users were comfortable with each of the stump factors in relation to the use of the system. It was found that the students had higher STUMP-RU correlation as compared to the lecturers.

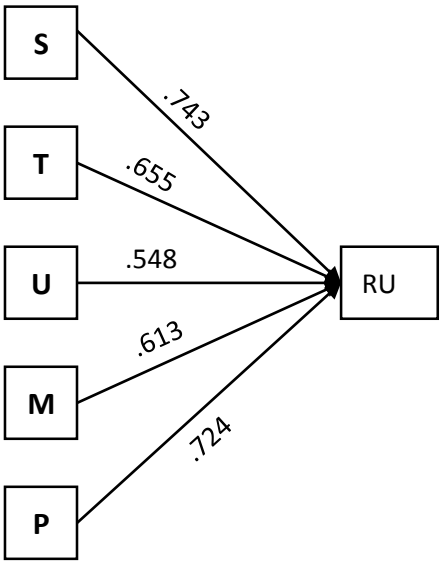


Figure 7. 5 correlation significance between STUMP and RU

Statistics software SPSS 19.0 was used to conduct descriptive statistics of the participants' level of readiness to use the m-learning system as presented in figure 7.5 and tables 7.1 – 7.3. Out of the five factors, S and P have highest mean values with low standard deviations which is an indication that the users have relatively uniformed and positive assessment of the skill, interest & knowledge to use the system and its pedagogic relevance to teaching and learning. Meanwhile T and U also have relatively high mean values with moderate standard deviations as compared to M, which has the lowest mean with the highest standard deviation, which implies that there is high variation among the users in terms of motivation to use the m-learning system. However, essential to all the factors is that the means of mean of all the factors, which determines RU has high mean value and very low standard deviation. This indicates that the users have relatively uniformed STUMP concerns, which reflect in their readiness to use the m-learning system.

The correlation analysis presented in table 7.2 and figure 7.5 show that all the five STUMP constructs correlated significantly with each other at 0.01 (2-tailed) and most importantly they all have high correlations with RU at 0.01 level (2-tailed) with a Cronbach's Alpha of 0.759.

Table 7. 1 Descriptive Statistics of STUMP & RU

	N	Range	Minimum	Maximum	Sum	Mean	Std. Deviation
S	1520	3.00	2.00	5.00	6787.00	4.4651	.86485
T	1520	4.00	1.00	5.00	6318.00	4.1566	1.12624
U	1520	4.00	1.00	5.00	6583.00	4.3309	1.02070
M	1520	4.00	1.00	5.00	5527.00	3.6362	1.33466
P	1520	3.00	2.00	5.00	6774.00	4.4566	.85064
RU	1520	3.40	1.60	5.00	6397.80	4.2091	.67468
Valid N (listwise)	1520						

Table 7. 2 Correlation table of STUMP & RU

		S	T	U	M	P	RU
S	Pearson Correlation	1	.392**	.330**	.255**	.613**	**.743****
	Sig. (2-tailed)		.000	.000	.000	.000	.000
	N	1520	1520	1520	1520	1520	1520
T	Pearson Correlation	.392**	1	.169**	.186**	.380**	**.655****
	Sig. (2-tailed)	.000		.000	.000	.000	.000
	N	1520	1520	1520	1520	1520	1520
U	Pearson Correlation	.330**	.169**	1	.083**	.285**	**.548****
	Sig. (2-tailed)	.000	.000		.001	.000	.000
	N	1520	1520	1520	1520	1520	1520
M	Pearson Correlation	.255**	.186**	.083**	1	.257**	**.613****
	Sig. (2-tailed)	.000	.000	.001		.000	.000
	N	1520	1520	1520	1520	1520	1520
P	Pearson Correlation	.613**	.380**	.285**	.257**	1	**.724****
	Sig. (2-tailed)	.000	.000	.000	.000		.000
	N	1520	1520	1520	1520	1520	1520
RU	Pearson Correlation	**.743****	**.655****	**.548****	**.613****	**.724****	1
	Sig. (2-tailed)	.000	.000	.000	.000	.000	
	N	1520	1520	1520	1520	1520	1520

**. Correlation is significant at the 0.01 level (2-tailed).

Table 7. 3 Reliability Statistics of STUMP & RU

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.759	.810	6

The success of the 'implementation', 'use' and 'overall impact' of the m-learning technology was to a large extent dependent on the level of preparedness or readiness of the users. Thus, RU affects the implementation and the users' behaviour toward the technology, which finally reflects on the overall outcome of implementation and use of the technology. The correlation analysis between IMP, USE, OI and RU shows that RU predicts IMP, USE & OI. The analysis also shows that there is predictive relationship between the overall impact, use and implementation, which indicated that IMP could affect USE and OI.

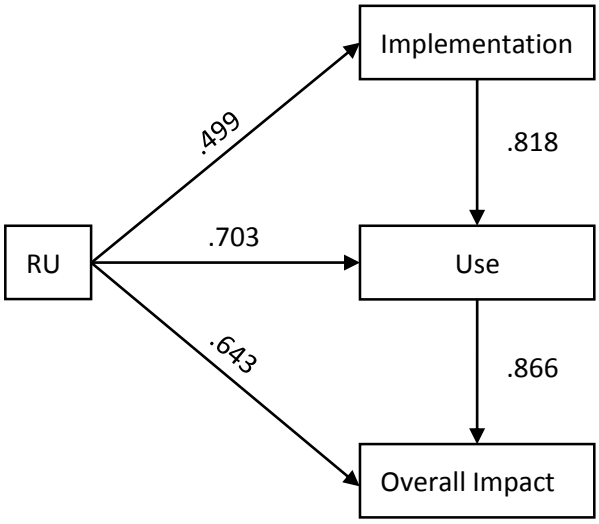


Figure 7. 6 correlation between RU and IMP, USE & OI

After the assessment of the RU level of the students, lecturers and administrative staff, the result was used as the basis for the third round of the implementation. The entire implementation process, how the system was used and its overall impact on teaching and learning at CUC was assessed and related to the initial RU results. The descriptive statistics presented in table 7.4 shows that RU, IMP, USE and OI have high mean values with relatively low standard deviations less than 1 that is an indication that the users have somewhat informed perception on IMP, USE and OI.

The item correlation presented in table 7.5 shows that RU correlate positively to IMP, USE and OI with significant value at 0.01 and Cronbach's Alpha of 0.866. The table also shows that IMP correlate positively to USE, whereas USE also correlate positively to OI. The correlation relationship among RU, IMP, USE and OI indicate that the readiness level of the users has influence on their behaviour toward the implementation, use and eventually overall impact of the m-learning system on the individual users and the organisation at large.

Table 7. 4 Descriptive Statistics of RU and IMP, USE & OI

	N	Range	Minimum	Maximum	Sum	Mean	Std. Deviation
RU	1520	3.40	1.60	5.00	6397.80	4.2091	.67468
IMP	1515	2.33	2.67	5.00	6719.33	4.4352	.49014
USE	1503	2.00	3.00	5.00	6750.67	4.4915	.43820
OI	1502	1.83	3.17	5.00	6763.50	4.5030	.31896
Valid N (listwise)	1502						

Table 7. 5 Correlation table of RU, IMP, USE & OI

		RU	IMP	USE	OI
RU	Pearson Correlation	1	.499**	.703**	.643**
	Sig. (2-tailed)		.000	.000	.000
	N	1520	1515	1503	1502
IMP	Pearson Correlation	.499**	1	.818**	.698**
	Sig. (2-tailed)	.000		.000	.000
	N	1515	1515	1503	1502
USE	Pearson Correlation	.703**	.818**	1	.866**
	Sig. (2-tailed)	.000	.000		.000
	N	1503	1503	1503	1502
OI	Pearson Correlation	.643**	.698**	.866**	1
	Sig. (2-tailed)	.000	.000	.000	
	N	1502	1502	1502	1502

Table 7. 6 Reliability Statistics of RU, IMP, USE & OI

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.866	.904	4

Table 7.7 is a merged table of mean of all the means of the users' responses for all the variables. It is a presentation of the means of the raw data from all the respondents. Its shows the relationship between the STUMP factors and RU, IMP, USE & OI. The table shows that the readiness level of the students was 4.2398 out of a maximum score of 5.0 whereas that of the lecturers and administrative staff were 3.1081 and 3.4000 respectively. Table 7.8 is an extraction from table 7.7, which shows the participants mean scores for each of the STUMP constructs. The major interest in table 7.8 is the RU values. These values are what represent the preparedness or readiness of the various users of the system. It is vital in predicting how the users will behave toward the technology. The analysis shows that the RU level of the users essentially affect their behaviour toward IMP, USE and OI as presented in table 7.9.

Table 7. 7 STUMP Matrix table – 1

	S	T	U	M	P	RU	IMP	USE	OI
Students	4.5020	4.1881	4.3593	3.6637	4.4838	**4.2398**	4.4652	4.5192	4.6103
Teachers	3.0270	3.0541	3.3243	2.6486	3.4865	**3.1081**	3.4017	3.5132	3.7342
Admin.	4.2000	3.0000	3.4000	2.8000	3.6000	**3.4000**	3.6667	3.8333	3.9667

Table 7. 8 STUMP Matrix table – 2

	S	T	U	M	P	RU
Students	4.5020	4.1881	4.3593	3.6637	4.4838	**4.2398**
Teachers	3.0270	3.0541	3.3243	2.6486	3.4865	**3.1081**
Admin.	4.2000	3.0000	3.4000	2.8000	3.6000	**3.4000**

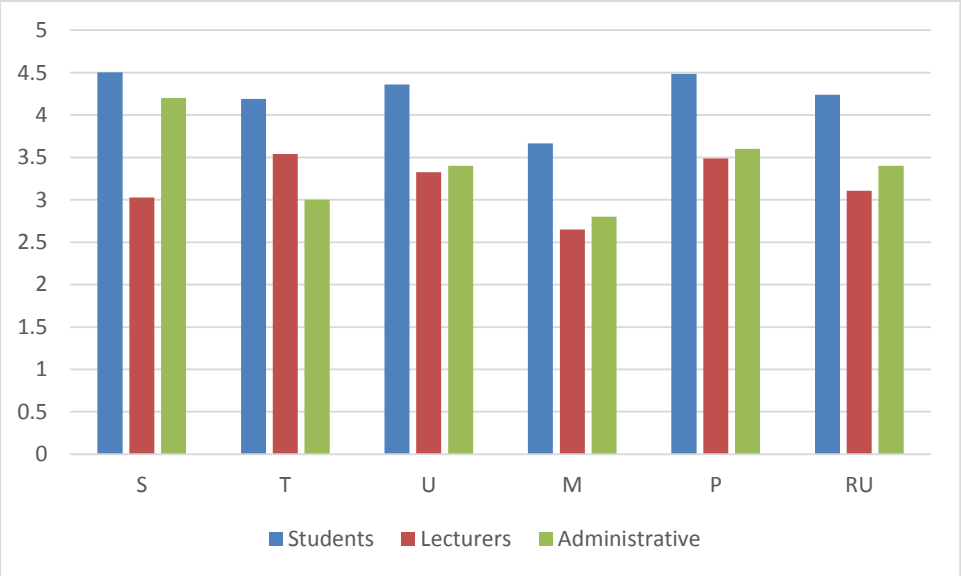


Figure 7. 7 graphic representation of table 7.8

Table 7. 9 RU, IMP, USE & OI table

	RU	IMP	USE	OI
Students	4.2398	4.4652	4.5192	4.6103
Teachers	3.1081	3.4017	3.5132	3.7342
Admin.	3.4000	3.6667	3.8333	3.9667

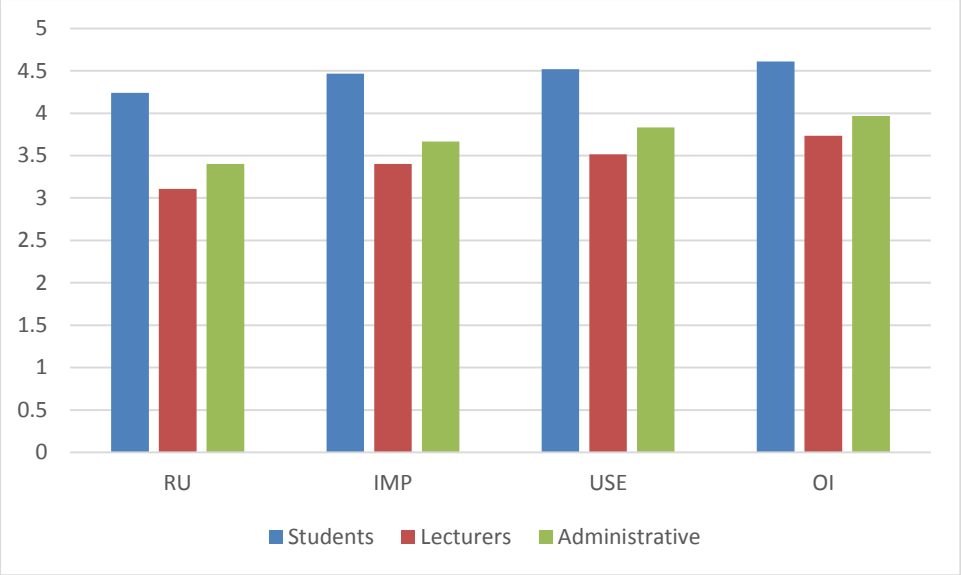


Figure 7. 8 graphic representation of table 7.9

Table 7.10 – 7.12 are representations of the aggregate values of the means of means of all the users put together under each construct of STUMP, RU, IMP, USE and OI. From table 7.12, the 'ALL USERS' value of RU is the presentation of the aggregate readiness level of all the users – students, lecturers and administrative staff. The RU value of 3.5826 with reference to the readiness scales explained in chapter 5 shows that the users were only '*fairly ready'* for the m-learning technology. The IMP value of 3.84453 is an indication that the implementation of the m-learning technology at CUC was 'fairly good'. How the students, lecturers and administrative staff use their mobile devices for teaching and learning was also *'fairly good'* with a values of 3.9552 whereas the overall impact of the implementation of the m-learning technology on the users and whole CUC community was *'good'* with a values of 4.1037.

Table 7. 10 Mean of means of STUMP table – 1

	S	**T**	**U**	**M**	**P**	**RU**	**IMP**	**USE**	**OI**
Students	4.5020	4.1881	4.3593	3.6637	4.4838	**4.2398**	4.4652	4.5192	4.6103
Teachers	3.0270	3.0541	3.3243	2.6486	3.4865	**3.1081**	3.4017	3.5132	3.7342
Admin.	4.2000	3.0000	3.4000	2.8000	3.6000	**3.4000**	3.6667	3.8333	3.9667
All Users	**3.9097**	**3.4140**	**3.6945**	**3.0375**	**3.8567**	**3.5826**	**3.84453**	**3.9552**	**4.1037**

Table 7. 11 Mean of means of STUMP table – 2

	S	T	U	M	P	RU
Students	4.5020	4.1881	4.3593	3.6637	4.4838	**4.2398**
Teachers	3.0270	3.0541	3.3243	2.6486	3.4865	**3.1081**
Admin.	4.2000	3.0000	3.4000	2.8000	3.6000	**3.4000**
All Users	**3.9097**	**3.4140**	**3.6945**	**3.0375**	**3.8567**	**3.5826**

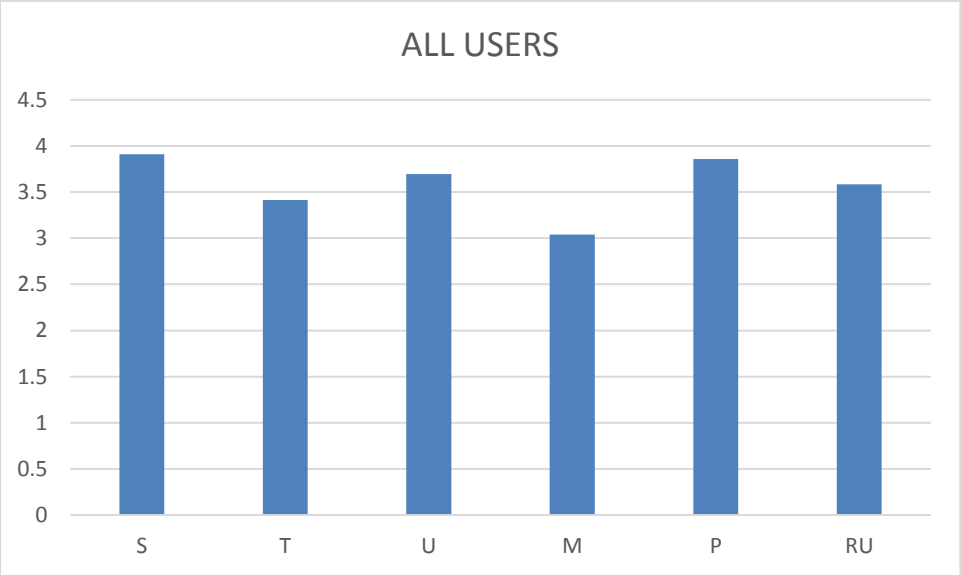


Figure 7. 9 graphical representation of table 7.11

Table 7. 12 Means of means of STUMP table – 3

	RU	IMP	USE	OI
Students	4.2398	4.4652	4.5192	4.6103
Teachers	3.1081	3.4017	3.5132	3.7342
Admin.	3.4000	3.6667	3.8333	3.9667
All Users	**3.5826**	**3.84453**	**3.9552**	**4.1037**

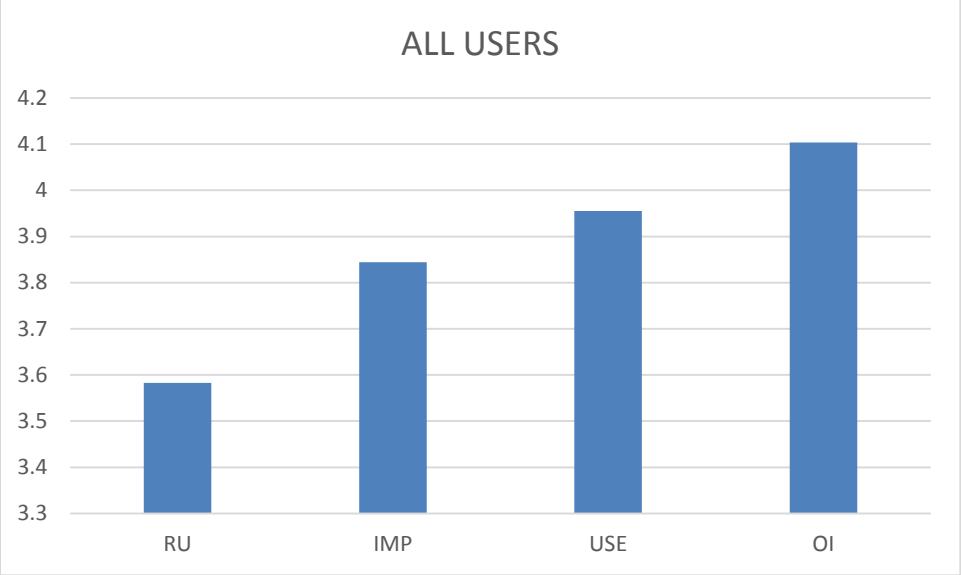


Figure 7. 10 graphical representation of table 7.12

7.3 Result and analysis of the 1st implementation

The m-learning initial trial was a preliminary study to explore the potential use of mobile computing devices and communication technologies in enhancing teaching and learning at CUC. It was observed that only the students were somehow enthusiastic about it. The lecturers on the other hand were not too keen on using the technology. This made it quite difficult in getting sufficient number of lecturers for the trail of the m-learning platform; consequently delaying the take-off date. Eventually, information on 22 lecturers with about 500 students were configured onto the database of the system for the project to start. Although the university initiated the idea of leveraging mobile computing and communication to complement the traditional face-to-face, it did not involve itself much in the pilot. The university only appointed one person from the academic board as a coordinator for the project to liaise with the software company, which was providing the school with the m-learning system. This affected the project in many ways including planning, training, participation and eventually the outcome, which was later found out from meetings with management that they were of the perception that since the needed funding has been provided for the system, the rest was left to the software company to deliver and for the lecturers and students also to use, but unfortunately in this case there was more to it than was expected. It was later after the initial pilot had ended that management in series of meetings with the various stakeholders came to the realisation that for the university to effectively leverage and incorporate m-learning into the school as part of its delivery methods, there was the need for a framework, which will guide the whole implementation process of using mobile devices for teaching and learning.

On the issue of using the m-learning system, students did not really have much to do because they apparently were on the receiving end. That is, they only go onto the system when they receive SMS alert indicating that a new content has been uploaded or a friend opens a discussion on the forum section of the m-leaning platform, which then engages other colleagues to join and share ideas together. This meant that even though the students were users of the system, their actual usage depended on how the lecturers used the system. The student as it was gathered from them, showed that they were highly interested in using such a system for learning anywhere any time but could only do that based on how the lecturers utilise the system for teaching. On the other hand, it was observed that as much as most of the students were comfortable in using their mobile devices for learning, there were others who were not but for peer pressure, had to quickly adapt to the new learning style some way somehow. The remaining students who were not part of the initial pilot were itching to have the m-learning experience, seeing how their colleagues were interacting among themselves and their lecturers on the platform; answering questions, getting feedbacks and receiving lecture summaries. One thing, which almost became a deterrent to the students, was the cost of accessing data on the mobile devices using 3G internet service.

On the contrary, only a handful of the lecturers were initially enthusiastic about the idea of m-learning. It was observed that those who were quite interested were those who were either well exposed in terms of using educational technologies for education delivery or had seen other people using such technologies for teaching and learning locally or overseas and are desirous in experiencing it. Apart from these ones, the rest of them were initially very hostile to the whole concept of using mobile devices for teaching and learning, but a lot of effort had to go into it to gain their minimum interest to sustain the experiment. Most of the time, they turned down invitations from the project coordinator to orient and train them. This obstructed the smooth flow of the project. Because of this, the Software Company had to dispatch a lot of its staff to help most of the lecturers in authoring content almost throughout the entire duration of the initial pilot. After interviewing some of them, it was observed that their lackadaisical attitude towards the project had some organisational, social cultural, technical and ethical connotations, which needed to be addressed if CUC really wanted to roll out a full implementation of the m-learning project after series of piloting.

From the organisational perspective, the lecturers expressed dissatisfaction in the way and manner management and academic board approached the introduction of the technology. According to them in a focus group discussion, they pointed out that their views on the introduction of the m-learning system were not given much attention. Whiles they were sceptical about the system, management was in a haste to force it on them although the lecturers admitted that management's decision was partly influenced by agitation from students on using such technologies to facilitate teaching and learning anywhere any time. The lecturers perceived the m-learning system as coming to take bread from their mouth, because in CUC and most of the universities in Ghana, lecturers sell hand-outs to students to earn extra income so for them to wake up only to be told to now put everything on the m-learning platform for students to access freely was not any good news to them at all.

The social and cultural background of the lecturers played a role in their acceptance and use of the system. Some were innovators, early adopters, early majority, late majority and laggards. These characteristics of the lecturers had its fair share on the project. Out of the 22 lecturers who participated in the initial pilot, only 1 exhibited some characteristics of innovator who could use the system without any assistance, 2 showed some early adoption characteristics and were able to use the system with little guidance, 4 were early majority who could only use the system with adequate assistance, 10 were late majority who could not use the system without any assistance and 6 were laggards who were not much interested in using the system as shown in figure 7.11. Another aspect to this was that most of them had been teaching for several years without any technology, so the sudden introduction of m-learning was seen as being complex system to them. A survey conducted showed that most of them had not used power point before.

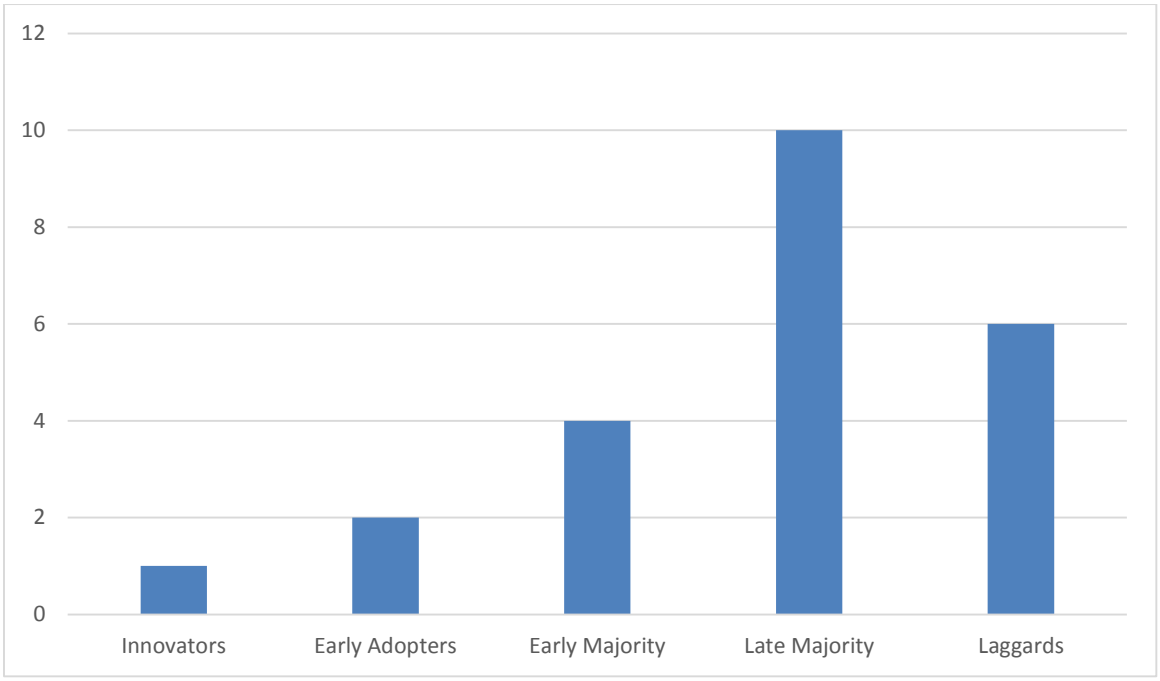


Figure 7. 11 Teachers usage behaviour of the m-learning system

Some of the lecturers showed much concern on the ethics of using mobile devices for teaching and learning anywhere at any time. They saw the mobile device as being a casual device, which does not fit into the formal educational framework of a university. Some of them said that the mobile devices, particularly smart phones and tablet PC were disruptive in nature and could not be used for the intended purpose of teaching and learning. In addition, the use of such devices by students for academics could lead to uncontrollable examination malpractice and reduce academic performance. One of the lecturers in an interview said that she personally saw two students playing game on their smart phone in class pretending to be learning.

Technically, the system had some challenges, which affected the interest in using it. It was observed by both students and lecturers that the software was difficult to use. The service quality was not bad but the system quality was poor. Students had difficulties in locating login screen while it was much difficult for the lecturers to use the authoring tools of the software to create content. This resulted in wasting so much time to create or access content on the platform. Beside this, internet connectivity was too slow because there was not enough 3G coverage. Most of the lecturers were not having smart phones and tablet PC as compared to the students.

In conclusion it was observed that the interest of some of the lecturers to use the system had improved. All the participants attested that using mobile devices for teaching and learning was

good but for the m-learning system to work for CUC; a new software, which is easy to use must be introduced and also the 3G coverage must be improved. The concerns of the lecturers need to be given serious attention before any attempt is made to rollout a full implementation of the system for the whole school.

7.4 Result and analysis of the 2nd implementation

Moving on to the next stage of the implementation was largely dependent on the outcome of the previous one. The results and analysis of the initial pilot served as the foundation for the second cycle of the implementation. This was to ensure that flaws, which were identified in the first cycle had been corrected to enable the second implementation to yield a better result over the former. The implementation eventually took place as scheduled. The outcome was positive but with some challenges to be resolved. Before going in for the implementation, efforts were made to tackle all the negative issues that cropped up in the initial experiment. For example, a new easy to use software was developed and adopted for the project, the organisational, social cultural, ethical and technical issues were also resolved, but at the end of the implementation it was realised that there was still more to be done if educators really want to enjoy the educational benefits of mobile technology. The second implementation was a different experience altogether because this time around the participants were more, unlike the initial pilot which was conducted for a selected few.

The 2010 / 2011 academic year started with a new culture of teaching and learning. Prior to the beginning of the semester, students and lecturers had received SMS on their login details and how to access course outline. During the vacation, some of the lecturers who made themselves available were taken through training on how to use the system to create and publish content. Unfortunately and to the surprise of the project team, very few lecturers and administration staff showed up for, the training sessions, which were organised to provide them with the necessary skills to be able use the system, in spite of management directive. Some of the attendance records can be found in appendix D. Most of the participants were not serious with the training program, and this affected their understanding of the whole concept. It destructed the smooth flow of the training, making it difficult for the resource persons. This abysmal cooperation from the staff had a negative impact on the implementation.

On the other hand, there were no training organised for the students during the vacation, but their orientation and training sessions were scheduled and came off during the early few weeks of the semester. The SRC played an important role in ensuring that students' turn out to any of the orientation and training sessions were massive. Training the students on how to use the system and what to do with it was not much difficult, but there were quite a good number of the students who needed special attention because they were not good at using ICTs. Those who for various reasons could not show up for any of the sessions were encouraged by the SRC to learn from their colleagues, which worked out perfectly.

The whole school started experiencing the new paradigm of teaching and learning some few weeks into the semester with its pros and cons. The system helped lecturers in handling especially large classes of student in a much simpler way. For example, a lecturer could start a lesson on the m-learning platform hours before the actual class starts in the classroom. He or she gives a topic to the students for them to discuss and send their feedback before the class begins. This way, the lecturer was able to gain a better appreciation of the level of understanding of the students before meeting them in class. It saved a lot of time in teaching in class. Assessing the students with multiple choice and short answer questions were very easy and fast. The moment the students finish the exams, the system automatically generates their results, which was instantly made available to them and the lecturer. This rapid feedback was a great motivation to the students in many ways, which encouraged them to be up and doing especially with the m-learning platform. Less confident and shy students were able to utilise the system to express themselves during the pre and post classroom lecture discussions on the m-learning platform. It saved lecturers a great deal in having to spend so much time to mark hundreds of scripts most of the time. The extended use of the system allowed parents, guardians and sponsors to request for login permission, which enabled them to have access to a students' performance as it is without alteration.

Despite all these, the implementation did not yield the desired results as was highly anticipated. There were numerous user concerns, which were a sort of canker to the whole phenomenon of leveraging and incorporating mobile technology into tertiary education to facilitate teaching and learning. These issues include but not limited to computer self-efficacy, perceived ease of use, perceived usefulness, motivation, and job fit, relative advantage, affect, social cultural factors. All these concerns by the users were categorised and grouped as follows:

- ***7.4.1 Skill, Interest and Knowledge – (S)***

  The first set of factors which were among the key elements of ensuring effective and efficient use of mobile technology in tertiary education were the user's knowledge in the technology he or she is being introduced to, his or her interest in using such technology and the availability of the basic skill that is required to use the technology. Evidence of these factors was conspicuously noticed among the users through observations, interviews, focus group and workshops. The various users – lecturers, students, and administers had different peculiar degrees of skill, interest and knowledge that was needed to enable them make meaningful use of the technology to achieve the intended goal. Data gathered showed that absence of good measure of these factors among users affected them in using the technology successfully. For example, lack of skill was an inconvenience to some of them, lack of interest caused some of them to distance themselves from the technology and for lack of knowledge, most of them could not appreciate that the technology is capable of promoting education delivery.

  The lecturers in this case were more susceptible. Most of them did not have the skill, interest and knowledge within the scope of the technology they were being introduced to. The first recording of the effect of these factors was observed during the training sessions, which was organised for the lecturers. Most of them did not show up for the training because they had little or no interest in using the technology for anything be it teaching or learning. Some had reasons while others did not. To some, they just did not fancy the use of such technologies as mobile devices in education. Others were not interested because of previous bad experience with similar or other technologies. Such experiences had demoralised them and exterminated their interest in coming anywhere close to using technology again. In trying to find out more, it was again observed that most of the lecturers were not enthused about the introduction of the technology because they were not aware of the technology and could not comprehend how it could be utilised to facilitate teaching and learning. They had no idea about the evolution of mobile technologies and their potential in transforming the way we teach and learn. It was obvious from the data, which were collected that most of the lecturers at CUC did not know that mobile technologies could be modelled to support tertiary education. So for lack of interest and knowledge, most of them turned down the invitation to be trained on how to use the system.

Another impediment was basic prerequisite ICT skill. It was observed that apart from the information technology staff and some few others, the rest of the lecturers were not too good in ICT. For instance, some of them were not good in using a computer for the following, to use Microsoft Office to create a document or prepare a power point presentation, to browse the internet on a desktop computer or mobile device and use it for sending emails and attachments. This made most of the lecturers feel uncomfortable using the new technology, which they were made to understand that the basic requirement for learning how to use the m-learning system was ICT skill in Microsoft Office and how to use the internet. Lack of these skills had a negative effect on effectively leveraging and incorporating mobile computing and communication technologies at CUC. The lack of skill was synonymous to lack of confidence, which deterred the lecturers from using the system. Some few students and administrative staff also had similar problem with skill, interest and knowledge just like the lecturers.

However, managements' concern with skill, interest and knowledge was on how they perceived the introduction of the system to be welcomed by the lecturers and students based on their skill, interest and knowledge in the area of using mobile technologies for teaching and learning. In assessing this, the administration office tried to find out whether using the new system will require high level of ICT skills or it is an easy to use system, which does not require much ICT skill. Managements' interest and knowledge in the technology was a major driving force for the introduction of the technology at CUC, but this did not reflect the actual use of the system by the lecturers and students.

- ***7.4.2 Time and Technical Issues – (T)***

  Next to the skill, interest and knowledge was the second group of factors, which is time and technical issues. The amount of time needed by a user to perform an activity using the m-learning platform and also the system, service and information quality were very important to the users. In a way, these factors augmented their interest and motivation. It was observed that unnecessary waste of time in using the system due to cumbersome procedures and some few hiccups in the quality of the system, service and information had some negative impact on the implementation. Although administrative staff acknowledged the relevance of these factors, they did not have any significant issues regarding them, but the lecturers and students did.

Most of the students expressed their dissatisfaction on how sometimes it took them so much time to access content from the m-learning platform. This discouraged some of them from using the platform. At times, the system run slowly or encountered connection problems. For example, on some occasions while a class was using the system for a class quiz, some of the students experienced system failure in the middle of the quiz. In another instance, the system was just very slow in responding. This created apathy among some of the students. This was not different from the lecturers as most of them reported unpalatable experience with the system. Some of their complaints were that the system's responsiveness was not good and at times, it displays content in different format other than the one anticipated. All these time and technical issues were attributed to the following as it was learned from the project:

— 7.4.2.1 System quality:

The lecturers' and students' concerns in this regard were typically on the performance and usability features. Accessing and navigating the m-learning platform was burdensome especially to most of them who were not skilful in ICT. It had a lot of unnecessary navigation routes which could have been avoided to make it simple for the users and they could not bookmark visited pages for quick reference. Learning how to use the system was moderately difficult and demanded substantial amount of training for a user to confidently use the system without assistance. The user interface of the system was not easy to use. It was not human friendly. The human computer interaction (HCI) did not engage the users' interest. Tools were not easily accessible. Using the system for even a simple quiz involved a lot of clicks from one page to the other. This made it difficult for most of the lecturers to author and publish content onto the platform without assistance from the technical team. The system did not have good response time and could not be customised to integrate into the university's existing system.

— 7.4.2.2 Information quality:

The users' satisfaction was partly reliant on the quality of information that was produced by the system. That is the usefulness of the system's information output to the user. Some few weaknesses in this respect were found to have affected the outcome of the m-learning project at CUC. The system on some occasions could not generate content output in the correct format for the users. For example, test and pictures were

wrongfully displayed to the disappointment of the users. Most often, the system was not very reliable in providing the users with the necessary information when they needed it most. At times, output information from the system was not adequate enough for the users to understand and make meaningful conclusions out of it.

— 7.4.2.3 Service quality:

This relates to the quality of technical support, which the users got from the technical team of the project. This included training, assurance, reliability, responsiveness, and empathy, interpersonal and intrinsic qualities. Although some of the users especially the lecturers did not participate in the original training program, it was expected that the technical team would have provided a follow up training to mop up any issue relating to users' ability to use the system, but this was not forthcoming. The users were not made to have the assurance of receiving reliable and prompt technical assistance when they were in need. Thus the technical support staffs were not swift in responding to challenges reported by the users. This took the edge off some of the users in having a good m-learning experience. As much as the users were ready to accept help to enable them use the system, it was observed that most of the technical personnel had poor interpersonal relations and could not empathise with the users.

- ***7.4.3 User's Social Cognitive Composition – (U)***

To a large extent, using the m-learning application system for teaching and learning was influenced by the demography and social cultural background of the users. Key among these factors were gender, age, beliefs, ethics, social status and exposure, attitude, perception, geographic considerations, individual and organisational culture. The introduction of CUC's lecturers and students to the use of mobile computing and communication technologies for seamless technology mediated teaching and learning was a whole new culture to them. Thus it was received with individual and group assumptions in using technology especially portable mobile computers for educational activities. It was new to majority of the users. Few of them had heard of such technologies in education but had not used it before. Only a handful of them had had the opportunity of taking advantage of the abilities of their mobile device for the purpose of learning.

Observations made as the phenomenon of using mobile devices for teaching and learning unfolded at CUC were that most of the males were technologically inclined than the female and they were fast on using the new technology than their female counterparts. For every 5 males who were interviewed, 4 of them were very good in using their mobile devices as compared to 3 out of 5 for the females. The young age group were also better on the technology than the older ones. Users' diverse beliefs, attitude and perception affected them in different ways in using the technology. For example some believed that using mobile devices all over campus and everywhere in the name of teaching and learning was ethically unacceptable to them because they came from a background where they were not used to using such technologies in this way. Some also could not phantom how students could interact with lecturers and their colleagues 24/7. They perceived that using the technology this way could be intrusive and disruptive. It was noticed that some of the users had bad attitude towards the use of technology because they were not well exposed to using them or they had had some unfavourable experience, which had created a complex in them. There was this perception among some of the users that using m-learning platform was not academically respected by many people in the community, work place and the country at large.

- ***7.4.4 Motivation – (M)***

  It was observed from the users that lack of motivation from management demoralised most of them from using the new technology. In the case of CUC, the situation was not much different from other universities in Ghana and other developing countries, the users were expecting various forms of incentives from management to propel them to use the m-learning system. These included availability of technology infrastructure, device and relevant tools, management commitment, enabling environment, policy, involvement of all the stakeholders, and good system with excellent technical support. In addition to this, the teaching staff had a peculiar incentive demand which was monetary, to cater for the additional effort to author content and interaction with students on the m-learning platform. The study shows that to ensure successful implementation, all these intrinsic and extrinsic issues must be addressed.

  The users expressed their concerns that for them to be encouraged to use the system, management must be prepared to show total commitment to the cause of using the

technology at all times by making sure that an enabling environment is created with the needed technological infrastructure available to facilitate the implementation of the technology. For example, internet connectivity, server and availability of 3G coverage.

Policies, which encourage and enforces the use of the technology with incentives must be drafted as part of efforts to motivate the users in effectively using the technology. It was essential also to seek the opinion of all the stakeholders to promote corporation and ensure inclusion and equity. Having a good system backed with excellent technical support could not be left out either.

On the issue of having the required device for the m-learning, most students complained bitterly because there was no uniformity in the devices being used. Some were having more sophisticated devices than others, which gave them advantage over their colleagues. Figure 7.9 is a graphical presentation of some of the devices that were used by the students. About 61 percent of the students used less complex smartphones *(ie: smartphone with not larger than a 4 inch screen, without touch screen, with less memory and application support etc)*, 27 percent used ordinary mobile phones with colour screen whiles 12 percent used highly sophisticated smartphones or tablets. Management were expected to arrange with device manufacturers to supply uniform standardised tablet PCs for the students at a moderate cost. On the other hand, the lecturers were of the view that management as part of motivating them must provide them with all the kinds of devices they will need to help them use the system effectively at anytime from anywhere. Most importantly, the user's satisfaction in using the system itself, served as a huge motivation to them.

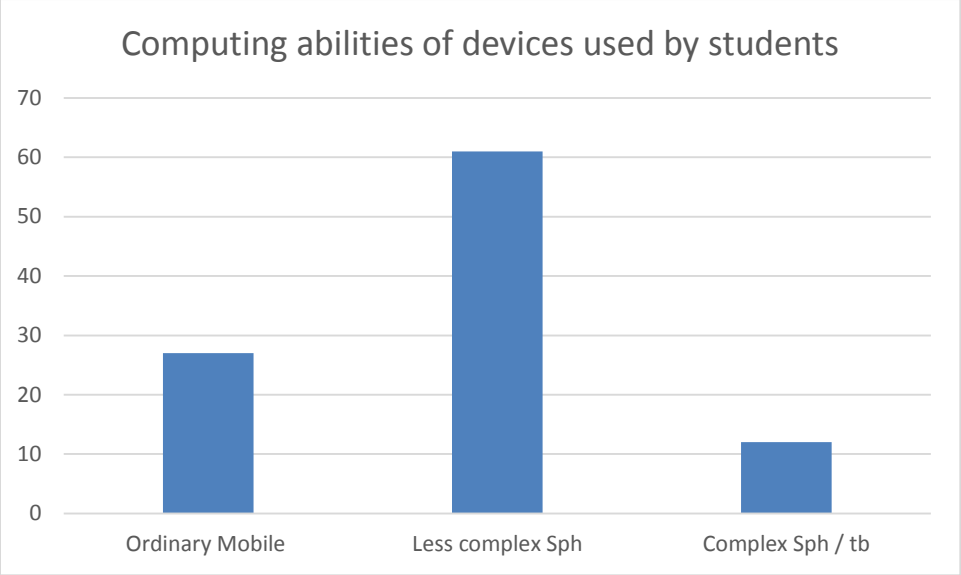


Figure 7. 12 computing abilities of devices used by students

- ***7.4.5 Pedagogic Relevance – (P)***

  The users' major concern was on how the technology fit their task. That is the appropriateness of the technology to their work. They were particular about the relevance of using mobile computing and communication technology for teaching and learning. They were interested in identifying the usefulness of the m-learning technology in tertiary education delivery than just using it. It was observed that the only way the users were going to use and re-use the m-learning technology was if they realise that the technology is suitable for their academic activities as anticipated. That is, there was the need for thorough assessment of the technology to ensure that it was pedagogically suitable to be used for teaching and learning.

7.5 The Emergence of the STUMP model

Contextual analysis of the user's concerns enumerated in sub section 7.4.1 – 7.4.5 gave strong indications that they are the essential factors for achieving effective leveraging and incorporation of mobile computing and communication technologies into tertiary education. The deductions of these factors were obtained through user observations, individual interviews, focus groups and workshops, which were undertaken during the implementation process. All the three main different user groups – Students, Lecturers and Administration had these factors as their major concerns for ensuring the success of the technology at CUC. The users constructed and interpreted their own meanings each day as they experience the m-learning in their academic life. The inference of the user's concerns as relevant to the success of m-learning implementation was based on ethnographic, phenomenological and hermeneutic views of

investigating into human activities as they occur in the real-world to construct meaning. In view of this, a development of a model, which can be used to assess the readiness of the users was added to the original objective of the research to consequently the STUMP model was conceptualised.

The purpose of the model is to assess the users' preparedness to use the m-learning technology. To do this, STUMP matrix analyser is designed for calculating and assessing the users' readiness to use the technology as shown in figure 7.10a & b. Questionnaires were designed to capture the concerns of the users as it pertains to each of the STUMP factors, which were evaluated and used for assessing the users' readiness. The calculation was done separately for each of the factors by computing the mean of means of all the responses to determine the values for each STUMP factor. The total values for each of the user groups in all the five STUMP factors were calculated to determine the readiness level for the various users. The outcome gave indications based on the STUMP scale that there is the need for rigorous effort to step up users' readiness to use the technology before the third implementation commences.

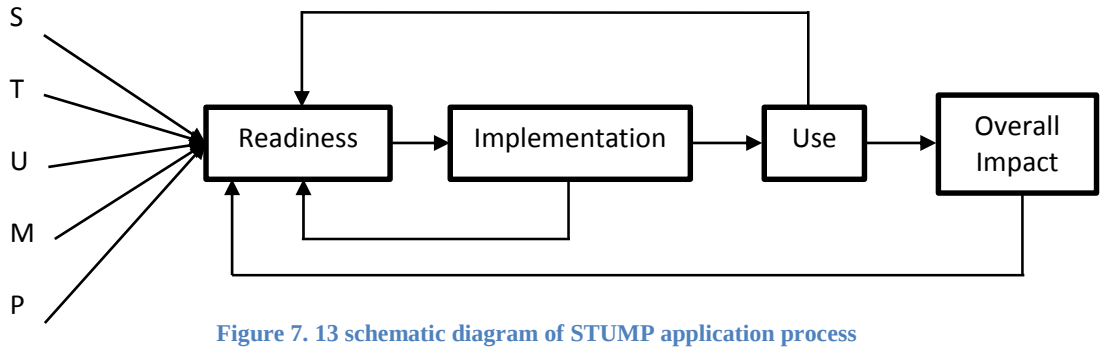


Figure 7. 13 schematic diagram of STUMP application process

7.6 Using the STUMP

The STUMP was used to assess the readiness of the users to use the system before it was implemented. After the implementation, their usage of the system was again assessed to find out the correlation between STUMP and use of the system as shown in figure 7.10b. The result of STUMP must provide enough evidence of readiness to warrant the implementation. The iteration must continue until a desirable STUMP result is attained before proceeding to implement the technology. In the case of CUC, STUMP was run once.

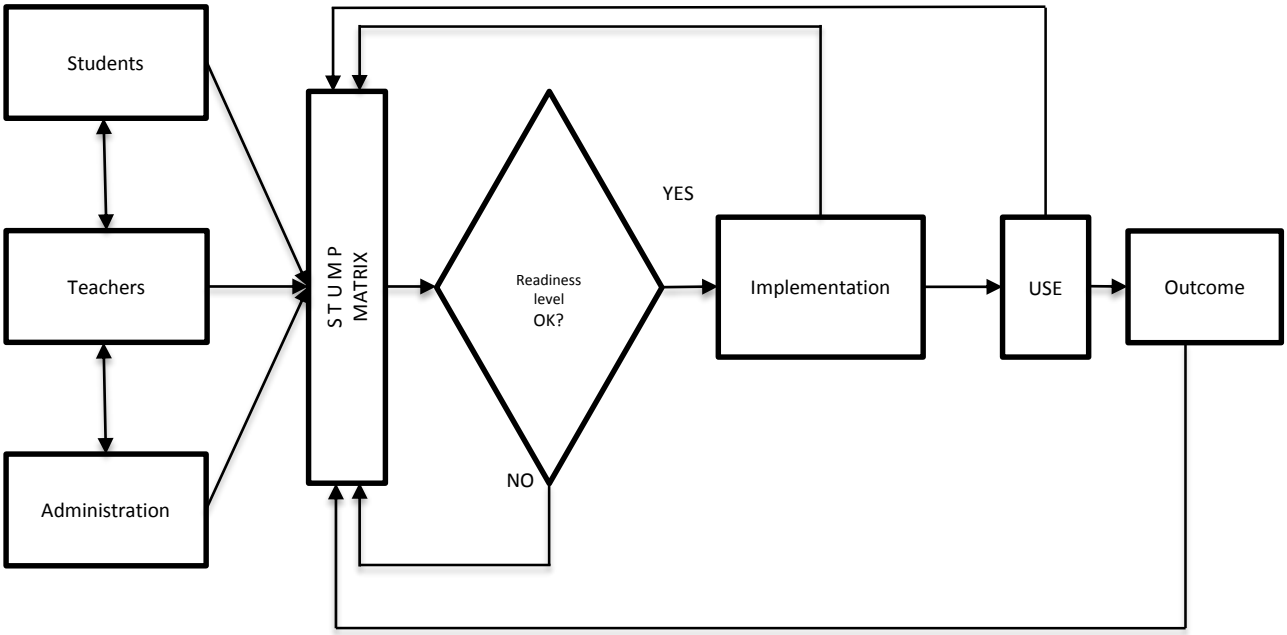


Figure 7. 14 elaborated diagram of the STUMP application process

7.7 Learning Outcome - One

The result and analysis of the second implementation gave an indication of improvement over the initial experiment. The improvement is not necessarily on the success of the implementation but on the general learning from the outcome. It must be admitted that there was a vast difference between the initial experiment and the first implementation. This was not surprising considering the huge difference in population size of the users from about 500 in the experiment to 10,000 in the second implementation. The efforts made to resolve some of the issues from the outcome of the experiment helped tremendously in drastically reducing avoidable problems that could have created obstructions in the second implementation. Nonetheless, the empirical findings from the evaluation of the project showed that, there were still more issues to be tackled in favour of ensuring successful implementation. In spite of all these, there were improvements compared to the experiment. Though it appears to be little, it is significant as far as using this new technology of mobile computing for teaching and learning is concerned. This implementation preceded the initial experiment and it was the first time the entire school population was introduced to the m-learning technology. It was phenomenal to the users in experiencing for the first time using their mobile computing devices powered by mobile communication technology for teaching and learning anywhere anytime. Majority of the students were thrilled and enthused about the whole concept of making use of technology to

facilitate higher education delivery. It narrowed the gap between students and lecturers and content. This fostered collaboration and participation in academic activities. Students became more serious in responding to SMS alerts from the m-learning platform asking them to do some activities. The observation was that, because activities posted on the m-learning platform were time bound, it forced the students to adhere to it and acted accordingly as instructed. Because the m-learning platform was used to complement the traditional classroom face-to-face, it avoided anonymity and truancy among students, since a lecturer could initiate a topic on the m-learning platform and continue the discussion in the classroom or vice versa. In this way, students could not absent themselves from going to class or afford not to use the m-learning system because if they did, they would lose track of what is happening in the courses they were pursuing.

Lecturers were quite sceptical about the new concept of teaching and learning with mobile computing and communication technologies except few who were keen on using technology to facilitate their work processes. However, it was learnt from them that they would be more willing to appreciate and use the technology if their concerns on the m-learning were holistically addressed. They felt that they were not adequately informed and involved in the adoption of the new technology for teaching and learning. According to them, they were going to use the system with the students and administration, so the collective input from all the parties involved had to be treated as critical to the success of the project. Notwithstanding all these, they applauded the initiative of leveraging technology to advance tertiary education delivery, but they were quick to add that it had to be done cautiously.

Some concerns from the users were observed as hindrances to the effective leveraging and incorporation of mobile technology into tertiary education. These concerns were grouped into five categories namely: Skill, interest and knowledge; time and technical issues; user's demographics and social cultural background; motivation and pedagogic relevance of the technology for teaching and learning as mentioned earlier. These factors were put together to conceptualise the STUMP model which was used as the instrument for assessing the readiness level of the users before commencing the second implementation. The STUMP model was conceptualised to ensure that there was consensus from all the users before the implementation. This was to guarantee some level of success in the subsequent implementation of the technology.

The empirical interpretation of the outcome of the implementation showed that there was the need to start another cycle of the implementation. This was to be done after exhaustive efforts have been made to resolve all the factors, which were drawbacks to the success of the second implementation. A lesson was learnt from the outcome of the implementation that first, the users' concerns were paramount to the success of the implementation and second, the introduction of the technology into the university's educational framework had to be done gradually and thirdly, sufficient time had to be allocated for the implementation to allow all the users enough time to integrate the technology into their work processes. In all, it came to light at the evaluation that in the midst of all the constructive and undesirable experiences which the users went through in their bid to use the m-learning technology, they were quick to accept that mobile computing and communication technology has the potential to facilitate teaching and learning if the appropriate framework is put in place to streamline how to integrate it into schools.

Finally, at the completion of the second iteration of the implementation, answers were obtained for the first two research questions which are (1) what are the factors which affect the effective incorporation of m-learning in tertiary education? And (2) in which ways do these factors affect the implementation and integration of m-learning?

7.8 Result and analysis of 3rd implementation

After going through the evaluation, analysing the results and specifying learning outcome of the second implementation, the project committee and the stakeholders became well informed on what will make the m-learning system work at CUC. The aching issue was on how to create a congenial environment by clearing all the stumps, which were identified as hindrances to the success of the previous implementation so as to clear the way for the third implementation. Thus, going onto the next stage of the project was basically rooted in the findings of the previous implementation, implying that the outcome of the previous cycles of the implementation was key to the planning and designing of the third iteration of the project. The third stage of the project was a strategic one. Because the entire school had already experienced the technology and the outcome had shown where the challenges were, there was no need to restart the whole process from the scratch; rather, the prudent step was to go straight to the problematic issues and find ways of resolving them.

Using the STUMP model as the instrument for assessing the readiness level of the users before starting the third implementation was very useful. However result of the STUMP analysis indicated the lecturers and the administrative staff were fairly ready as compared to the students who were fully ready, but the mean of means of all the three groups of users showed a fairly readiness level of 3.5826. This meant that the implementation could go on, but rigorous effort would be needed to ensure successful implementation. The good thing about the STUMP analysis was that it gave the project committee a good picture of the users' preparedness to use the technology.

The outcome at the end of the day was impressive. It gave an indication of an improvement over the second implementation, but not as was expected. However, it was a significant improvement when compared to the previous implementation. The usage level of the m-learning application system increased among the users. Most students adapted their academic schedules to fit the new way of using mobile technology in making teaching and learning interesting and flexible them. Some even went to the extent of purchasing new sophisticated smart phones, tablet PCs and laptops mainly for the purpose of m-learning.

This time, the lecturers' commitment to use the m-learning platform improved significantly. It initially reflected in the training sessions and later in the actual use of the system as presented in figures 7.15, which depicts the percentage of teachers who could use the m-learning tools to author content in the second and third implementation. Most of them attended the training programs, which was organised to teach them how to use the system in a more effective manner. A reasonable number of them were able to author their own content and publish it onto the m-learning platform without assistance. Consequently, most of the lecturers for the first time started to use the technology for teaching. In an interview with some of them, they attested that there had been quite a significant improvement in the whole concept of using mobile technology and communication technology for teaching and learning at CUC. They attributed this to the fact that their concerns had been heard and that some attempts had been made in resolving them though more is still expected to be done. They were of the view that if STUMP is taken serious, then the project will definitely be successful over time.

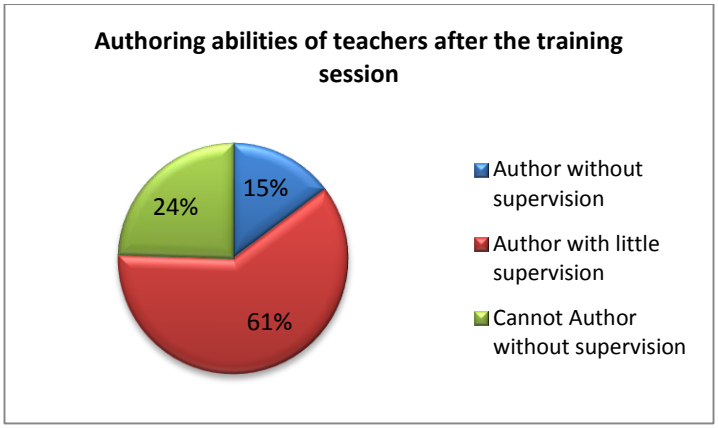


Figure 7. 15 Lecturer's ability to use the system

In the end, it was observed from the result and analysis of the use of the system that the users had a better experience this time around than the former implementation. At least they could see that their concerns were seriously taken into consideration before taking them through the third implementation. There was an improvement in the understanding among the lecturers, students and administration on the use of the m-learning technology at CUC. Overall, the science department did very well in using the m-learning platform as compared to the other departments.

7.8.1 Technology Mediated Blended Teaching and Learning

The conception of m-learning at CUC was motivated by blended learning. That is blending existing method of teaching and learning with mobile technology. The intention was to create another medium for teaching and learning to complement the traditional classroom face-to-face. This is what the whole m-learning pilot project was intended to achieve at CUC. To create a technology enabled environment where lecturers and students have seamless alternative means of performing their academic activities. The initial experiment and the second implementation could not give any tangible evidence of this blended learning status. It was in the third implementation that users came to the realisation that the m-learning system in essence is a complementary platform to the face-to-face with potential of extending teaching and learning beyond the boundaries of the classroom. The introduction of the m-learning technology to support the traditional teaching method was very challenging in the initial stages, but as the project continued, its benefits gradually diffused among the users.

7.8.1.1 In and Out of the Classroom

The social presence characteristics of the m-learning platform enabled the users to attain a "virtual omnipresence" status that is, it made them feel they were present everywhere at any time although they were physically not. For example, one lecturer from the economics department said "with this new system whether I am physically present in the classroom or not, teaching can still take place and my student cannot either give flimsy excuses for absenting themselves from class. Now we have physical and virtual classroom". This lecturer used the system in the second implementation but could not grasp the concept well until he gained enough experience in the third implementation. Another lecturer used both the physical and virtual classroom to conduct examinations for her students. She first published 50 multiple choice questions for the students to answer and submit within 60 minutes on the m-learning before coming to class. 20 minutes after, she met the students in the lecture room and gave them 3 essay questions to answer 2 out of them in class. In an interview with her, she said "Blending the class activities with the m-learning platform is fantastic. It makes it easy to handle large numbers of students much easier". Some of her students also added that blending the traditional face-to-face with m-learning has given them an awesome learning experience using their mobile devices from anywhere at any time.

The backbone technology infrastructure of the m-learning which is mobile telecommunication made it possible for teaching and learning to occur anywhere any time using the m-learning platform as the mediating tool. Although the third implementation was not without challenges, it was at this time that most of the users started integrating the system into their academic life as part of their teaching and learning media. Using the mobile technology in this way for teaching and learning was advantageous, because already the users' daily life activities were in one way or the other mediated by mobile communication technologies.

7.8.2 Technology Enabled Blended Activities

The m-learning platform offered some tools which facilitated the blended learning activities of the users which includes the following:

7.8.2.1 M-learning authoring tools

These are the embedded tools with the m-learning system which enabled the lecturers to create and publish content for the students to access from anywhere at any time. It offered them an opportunity to teach from anywhere without geographic constraints.

7.8.2.2 SMS alert

This tool was used to keep students updated on academic activities that needed immediate responses as follows. Students were receiving SMS informing them on topics to be treated in the next class, they received SMS alerting them on change of class, class cancellation and other activities, they receive SMS updating them on their academic progress, they were being informed on examinations, quizzes, assignments, discussion and feedbacks with SMS alert. This helped so much in keeping the administration, faculty and students in close contact at all times which hitherto was not possible.

7.8.2.3 Emails

The email was used in similar way as the SMS, but it was purposely used for sending large documents as attachments to users. It was used for discussing personal academic issues with faculty and peers.

7.8.2.4 Multimedia

Multimedia tools added new perspective to the blended learning experience by offering the lecturers and students the chance to create and access audio and video contents with their mobile devices.

7.8.2.5 Blog

Students were able to engage in discussions on different topics electronically with their peers and faculty members.

7.8.2.6 Internet and other social network

The m-learning system had an external link to the internet and other social network platforms, which allowed the students especially to interact with experts within their area of study.

7.9 Mobile Technology and the activity of Learning

Using the m-learning platform for teaching and learning activities was based on activity theory. This was one of the ways of making sense of the m-learning concept. The mobile computing devices of the users served as the physical technology mediating tools connected to the m-learning application system for teaching and learning. This approach of using the mobile technology clearly brought out the educational relevance of using mobile computers and communication technologies for academic activities. The intention was to enable the students to use their mobile devices to perform learning activities and relay the feedback to the teacher. In this m-learning project, the teacher assumed two overlapping roles; in the face-to-face interaction, the teacher was a tool for mediating the students' learning activities. On the m-learning environment, the teacher became a user and a mediating tool at the same time. This interplay facilitated blended education delivery at CUC. It helped in making the best out of the m-learning technology.

The application of the activity theory was based on the task model for mobile learning by Taylor and Sharples. The model uses six factors to construct a scenario of performing a learning activity or task at any instance. The factors as they were discussed in chapter 4 are (1) Tool (2) Subject (3) Object (4) Control (5) Context (6) Communication. The m-learning activities as it was implemented at CUC were designed to reflect the characteristics of these factors as shown in figure 7.12.

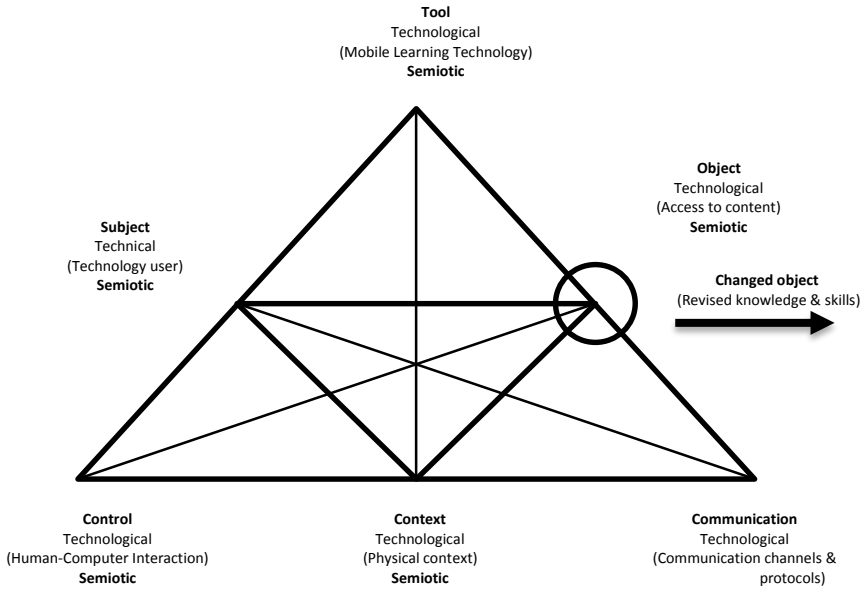


Figure 7. 16 Task model for mobile learning adopted from (Taylor et al. 2006; Sharples et al 2007b)

7.9.1 Tool

This is a general term, which refers to any material, medium, content, artefact, instrument and device, which can be used to mediate learning activity. This can be in the form of ICTs, books, resource persons etc. In this project the focus of the tool was on mobile technology and how it could be used to achieve cognitive objective. As shown in table 7.13 the pedagogic role of the tool varied depending on the intended learning objective. On scale 1 it was used for delivery short note and lecture summaries. On scale 2 it was used for conducting multiple choice quizzes and examinations. On scale 3 it was for learning activities which required the students to perform some task or search for some information from external source and reported on it. Scale 4, the students received content on their mobile devices which instructed them to collect some data and analyse it and scale 5 provided the students with activities which allowed them to construct their own learning content.

Table 7. 13 how the m-learning tools were utilised
Source: adopted from Frohberg & Schwabe (2009)

Factor	**issue**	**Scale**				
		1	**2**	**3**	**4**	**5**
Tools (Wherewith?)	Pedagogic role of tools	Content delivery	Interaction for motivation & control	Guided reflection	Reflective data collection	Content construction

7.9.2 Subject

The students were the subjects in the learning process. The goal was to model the content delivery to meet the learning needs of the various subjects based on their knowledge level. The simplest way, which was adopted was to scale them according to levels or grades (eg. first year students, second year students etc). Only scale 1 to 4 were used in the case of CUC. Based on table 7.14 scale 1 to 4 were assigned to the students from level 100 or first year to level 400 or fourth year in that order.

Table 7. 14 Categorisation of users
Source: adopted from Frohberg & Schwabe (2009)

Factor	**issue**	**Scale**				
		1	**2**	**3**	**4**	**5**
Subject (Who?)	Previous Knowledge	Novice	Little previous knowledge	Good previous knowledge	Much previous knowledge	Expert

7.9.3 Object (ive)

The purpose of using the m-learning platform was basically for learning. The content were designed to provide students with knowledge and skills based on table 7.15. Scale 1 was quite successful on the m-learning platform as compared to the other scales.

Table 7. 15 application of the m-learning platform to different levels of learning
Source: adopted from Frohberg & Schwabe (2009)

Factor	issue	Scale				
		1	2	3	4	5
Object(ive) (What?)	Level	Know	Comprehend	Apply	Analyze	Synthesize & evaluate

7.9.4 Control

To achieve meaningful use of the m-learning platform, there was the need to specify how the users should conduct themselves as they use the system. Responsibilities were assigned to the users as shown in table 7.16 varying from scale 2 to 4. It was observed that there must be flexibility in teacher control to allow for more student control. This way the students were able to personalise their learning to meet their needs.

Table 7. 16 rules
Source: adopted from Frohberg & Schwabe (2009)

Factor	issue	Scale				
		1	2	3	4	5
Control (How?)	Responsibility for learning process and goal	Full teacher control	Mainly teacher control	Scaffold	Mainly learner control	Full learner control

7.9.5 Context

The learning of the students occurred in different context. Using Frohberg's classification of context as shown in figure 7.17, we were able to observe the various context that the students found themselves mostly as they used their mobile devices for learning activities.

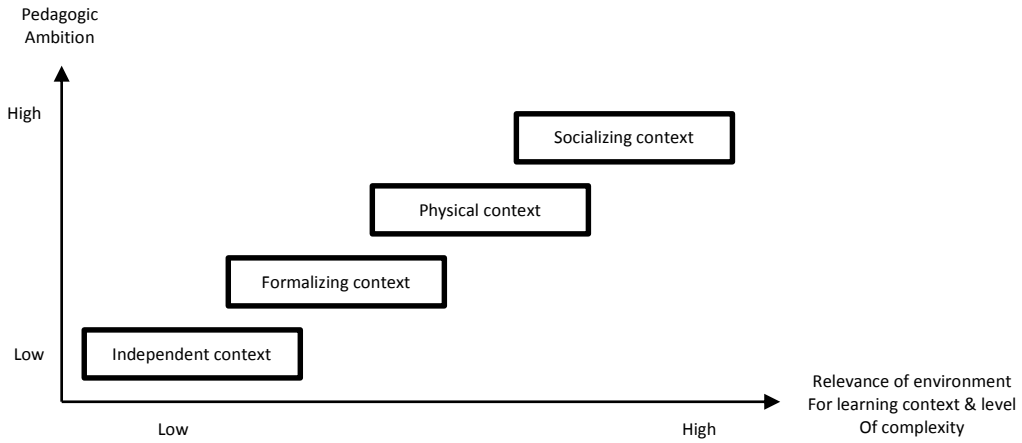


Figure 7. 17 different mobile learning context adopted from Frohberg & Schwabe (2009)

7.9.6 Communication

Learning is a process, which is not an absolute individual affair. It has some social elements and it involves interaction and communication with other people who may directly or indirectly share knowledge with each other. This could be classmates, teachers, participants in a course etc. Good communication among these persons deepens knowledge acquisition. Using table 7.17 we were able to observe the various communication forms among the students. The pedagogic activities on the system allowed different communications among the users. For example, group work or assignment compelled students to participate and collaborate with group members.

Table 7. 17 different forms of communication among users
Source: adopted from Frohberg & Schwabe (2009)

Factor	issue	Scale				
		1	2	3	4	5
Communication (With whom?)	Social setting	Isolated learners	Lose couples	Tight couples	Communication within group	Cooperation

7.10 Mobility in Teaching and Learning

The m-learning project was not a mere form of electronic learning, it was mobile. The teachers and students experienced teaching and learning in their daily mobile life as they moved from one place to the other - spatially, temporary, contextually or fluidly. It granted them the possibility to break away from teaching and learning activities that occurs in the confinement of the classroom to take advantage of mobile network communication for ubiquitous teaching and learning. Using their mobile devices enabled them to gain access to educational resources

at the precise moment via mobile wireless network. Their m-learning experience created an integrated academic environment, which enabled teaching and learning to occur on campus, at home or anywhere into a corporate shared, flexible pervasive educational environment. This helped them immensely in planning and utilising their individual mobility.

The mobility affordances of the m-learning technology in spatial, temporal and contextual changed the way students and teachers interacted in this project. The mobility characteristics of mobile computing and communication technologies in university education has opened new doors for teaching and learning because the technology is able to transform the interactions between the objects of learning, teachers and students to facilitate teaching and learning. The moment a learning objective is established, teachers and students can teach and learn respectively from anywhere at any time blending and utilising the availability and appropriateness of the m-learning technology and the traditional classroom face-to-face to enhance tertiary education delivery. At CUC, the pedagogic model of the courses were framed such that teachers were trained to distinguish areas of their courses into those which must be handled in the classroom, those which could be treated with the m-learning technology and those which could be performed in both instances. It provided a better way of making good use of audio, visual and kinetic techniques of learning. This versatility in varying the pedagogic delivery method, eliminated the boredom of stereotype teaching and learning. The following response from some of the teachers and students attested to this.

7.10.1 Student:

"We are about 280 in the economics 1 class and most of the time the class is destructed by late comers and noise which sometimes makes it difficult for me and some of my friends to keep track of what the lecturer is saying, but thanks to the m-learning system. This time we are able to have multimedia access of our classes on the m-learning platform which we can access from anywhere at our own convenience. This is very useful to me especially, because now after class I can log on to my m-learning account and listen to a recorded version of the class which helps me to take my time to make my own notes".

7.10.2 Student:

"I start getting bored after about 30 minutes into lectures. This makes it quite difficult for me to grasp anything in the class. But with the m-learning platform I am to interact

with colleagues and even my lecturer to get a better understanding of what I did not understand in class".

7.10.3 Student:

"I am not a good note taker. I find it very difficult to combine listening and note taking in class. This has been affecting my academic performance, but with the introduction of the m-learning technology, I am able to have access to short lecture notes and lecture summaries. The multimedia facility of the system also makes it possible for me to listen in to recorded lectures over and over again. This has helped me to keep track and learn at my own pace without lagging behind my colleagues".

7.10.4 Teacher:

***"**I teach economics, accounting and management from level 100 to 400 with 2,014 total number of students and I struggle to interact with them and keep track of their personal learning challenges, but the concept of m-learning has made it easy for me to interact with all of them from anywhere at any time on different occasions. For example, I open a discussion on the m-learning platform and I am able to monitor the discussion from all the students as they post their responses. Some of the students also leave messages in my message box and so forth. This has improved student – teacher interaction tremendously".*

7.10.5 Teacher:

"I had the same large class size issue as my colleague, but my main concern is when it comes to examination and assessment. It is strenuous marking thousands of scripts and grading them, but with the m-learning system, I am able to conduct multiple choice examinations and quizzes and don't have to border about marking and grading because the system does everything for me. The results and grades are spontaneously generated by the system as soon as the students finish the examination. This saves me a lot of time".

The main thrust of the responses gathered from the users were grasped in these three elements of mobility as espoused by Kynaslahti as being convenient, expedient and immediate.

7.11 Convenience

The users' interest in using the m-learning system was partly motivated by the ability for them to be able to use their mobile devices to perform educational activities between times and the portability of the mobile device to carry on one's self. The opportunity for them to make good use of their waiting moments in long queues waiting for transport, on a vehicle or train and at the front desk waiting for their turn. The teachers and students at CUC on different occasions had to utilise the use of their mobile devices for m-learning in some of the above mentioned scenarios to make their waiting moments useful. For example, in Ghana, people spend so much time waiting in queues for transport and after, spend several minutes in heavy traffic to get to their destination. A lecturer reported her experience as follows:

7.11.1 Teacher:

"Today on my way to school there was an accident on the motorway which resulted in a heavy traffic. My husband was driving so for almost two hours that we spent in the traffic, I was able to engage my students in a discussion on taxation using my tablet PC connected to the m-learning platform".

7.12 Expediency

The teachers and students are highly mobile moving in and out of different places as they perform their academic and social activities. For example, as it is shown in figure 7.14 both the teacher and the student moves in and out of the following places: Home, office, classroom, hostel, and friend's home including other social places such as the parks, eateries, parties, theatres etc. From the expediency perspective, it was observed from the users that the portability of the mobile device and the convenience to connect to the m-learning platform and use it from anywhere via mobile broadband internet increased their desire in using the system. The blue colour lines in figure 7.14 represent mobile communication interactions, the yellow is for fix phone communication, the black is for internet activities whiles the red and green represent movement on vehicle and by foot respectively.

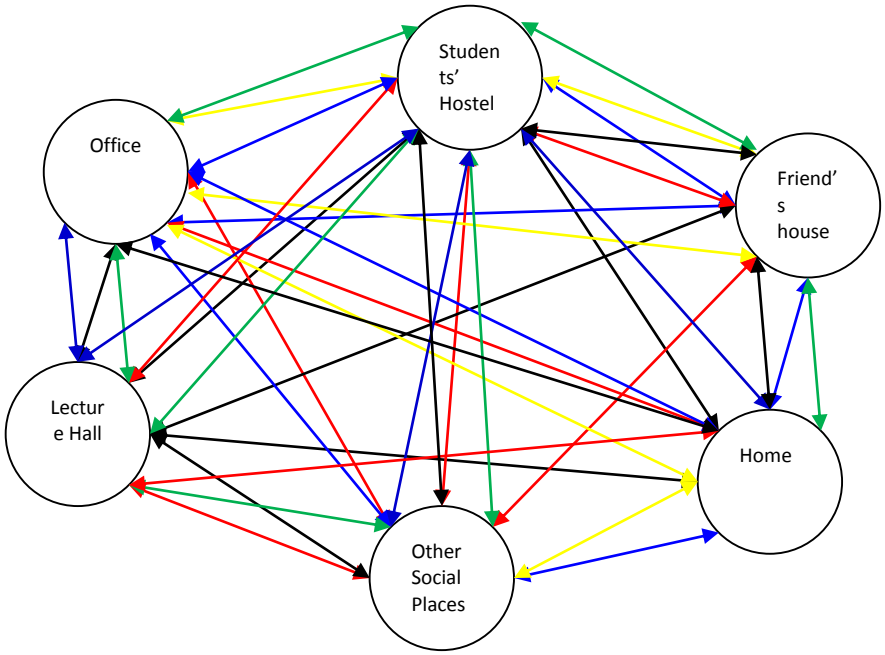


Figure 7. 18 mapping the mobility of teachers and students

7.13 Immediacy

Using their mobile device for responding and receiving immediate feedback was much appreciated by the users. For example a lecturer is able to conduct examination for about 2000 students with the m-learning platform and immediately they finish their results and grades are ready. The lecturer is relieved of the delay in script marking and the students are happy to receive immediate feedback from their performance.

7.14 Result and Analysis of the "USE" of the system

At the end of the third implementation, questionnaire was used to gather feedback from the users on their experience of m-learning. This helped in assessing the effect of STUMP on the implementation. STUMP was used to measure the users' level of readiness and to predict the potential success of the implementation. Different set of questionnaires were designed to assess the outcome of the project and the usefulness of STUMP as the users used the m-learning technology. Finding out the readiness level of the users in relation to the "stump" factors was a prerequisite for the commencement of the second round of the implementation. This implies that the outcome of the third implementation of the project was to a large extent dependant on the STUMP result. It was observed from the project that the outcome of the use of the system was directly linked to the results of STUMP.

7.14.1 S – *(Skill, interest and knowledge)*

The result and analysis of the use of the system showed that the level of users' skill, interest and knowledge for using the m-learning technology as was predicted by STUMP, had a positive impact on the users as they used the system. The impact was directly proportional to the users' level of skill, interest and knowledge as stated by STUMP. This meant that a higher level of users' skill, interest and knowledge will correspond to a higher user experience and a better outcome. It was noticed that the different group of users had different level of skill, interest and knowledge. This resulted in the various group of users having different user experience and different results with reference to their readiness level recorded in STUMP.

7.14.2 T – *(Time and Technical issues)*

The improvement in the users' dissatisfaction on time and technical issues of the m-learning technology after the STUMP analysis yielded some benefits, though there were indications of more room for improvement. The result of the users' perception on time and technical issues as it was extracted from the STUMP analysis was quite good. This gave a corresponding result as the users used the system. They made the observation that using the m-learning system could save them some time in their academic activities, but its possibility depends on fixing some of the technical related issues. They also felt that more time should be allowed for the experimentation of the m-learning project to get it well integrated into the academic of the students and teachers at CUC.

7.14.3 U – *(Users' Cognitive Composition)*

The outcome after the implementation showed that acceptance and diffusion of the concept of using mobile devices for teaching and learning at CUC was partly due to a better understanding of the demographic, social cultural, ethics, attitude, belief, behaviour and perception issues of the users toward ICTs. Prior to the application of STUMP, efforts were made to resolve the users' concerns on the above listed issues. They were taken through orientations, which eventually yielded some good result in STUMP which reflected in the outcome. It was observed that the interest of the females and the older students in using the technology had increased. The users had a positive attitude, behaviour and perception to use the technology.

7.14.4 M – *(Motivation)*

Attempts made after the first implementation to meet the motivation concerns of the users was useful in elevating the users' intention to use the technology. Although the users expressed their concerns on the need for more to be done to motivate them, they did not hesitate in admitting that they had received some level of motivation, which kindled them to use the m-learning technology. For example, one lecturer said that he took keen interest to use the m-learning system when he received a free 3G and Wi-Fi enabled tablet PC from the software company, which was helping the university to implement the m-learning technology. Some of the lecturers and students were also motivated to use the system because they were quite satisfied with the technical support of the system. Their level of motivation for using the technology in the third implementation was a complete reflection of the prediction of STUMP.

7.14.5 P – *(Pedagogic Relevance)*

The success of the third implementation over the previous ones was largely attributed to the users' better appreciation of the pedagogic relevance of the m-learning technology to teaching and learning. Before rolling the third implementation into action, the various user groups were oriented at separate meetings on the usefulness of using mobile computing and communication technologies in tertiary education to enhance teaching and learning. The understanding they gained from the orientation opened them up to the use of the m-learning platform. The users' appreciation of the m-learning technology in third cycle of the implementation was satisfactorily. This of cause was a reflection of the result of STUMP analysis. For example, a lecturer in an interview said that the m-learning technology was very good for teaching and learning if one is able to utilise it well.

7.15 Learning Outcome – Two

The outcome of the first and second cycles of the implementation were quite positive, but with some challenges which needed urgent redress to facilitate better results in the subsequent implementation. It gave so much insight into the project on *what to do*, *how to do it* and *why it is necessary to do it*. Going into the third cycle of the implementation was mainly based on the outcome of the preceding ones. Preparations for the implementation was to ensure that the challenges of the earlier implementations were surmounted to pave way for the third implementation. This was done with the intention that the overall objective of the project of effectively leveraging and incorporating mobile technology into tertiary education was realised in the third implementation. It is against this background that the outcome of the last cycle of

the implementation was evaluated. Eventually the result and analysis of the implementation gave an improved outcome of the project as compared to the previous implementation.

It was learnt from the evaluation of the implementation that the factors which were identified in the first implementation and which were framed into the acronym "STUMP" were truly critical to the success of leveraging and integrating mobile technology into tertiary education. These factors emerged from the concerns of the users during the second cycle of the implementation as being the impedances to the successful implementation of m-learning at CUC. Before commencing the third implementation, the project committee made sure that users were adequately oriented and trained to acquire the necessary skill with an appreciable interest and knowledge to use the m-learning system. Issues relating to system quality, service quality and information quality were taken care off including various time demands for using the system. They were also provided with some few incentives, which satisfactorily motivated them to use the technology. These efforts by the project committee undoubtedly yielded the desired results equivalent to the amount of efforts injected in to resolve the users' concerns and the preparations made prior to the commencement of the implementation.

The usage of the system during the third phase of the implementation was better. More lecturers were interested to use the technology this time than before. Students' complaint on the system also reduced considerably, but there were still more to be done to make the implementation of the m-learning technology successful. It was observed that adequate time was needed for the implementation to allow all the users to gradually incorporate the technology into their academic activities. From the initial experiment to the end of the third implementation was two years, however the outcome of each of the stage of the implementation gave steady but moderate improvement, which indicated that more time may be needed to get the project to mature.

As the users interacted among themselves and used their mobile devices for teaching and learning, it was observed that the most suitable mobile device for m-learning was the tablet. This was gathered from the daily observation of the users as they engage in m-learning activities, interviews and STUMP analysis. It revealed that the characteristics of the tablet which positions it between smart phones and the laptop is strategic and makes it the most preferred mobile device to be used for teaching and learning activities anywhere anytime as shown in figure 7.15a & b. This tablet issue was identified from the STUMP analysis as being

both technical and motivational. Technically the tablet was perceived by the users as the appropriate portable computing device which is endowed with the strength of all the other portable ICTs put together. Based on this the project committee in their evaluation report stated that if the m-learning project will continue and become very successful, then the university must find means to provide the teachers and students with tablets. This they reiterated that, it will serve as motivation and at the same time technically appropriate for the project. Finally, it was recommended that though the project from all the stages has exhibited great signs of being very useful for the advancement of tertiary education, there is the need to strengthen efforts to remove all the "stumps" which are hindrances to the successful implementation of the m-learning technology.

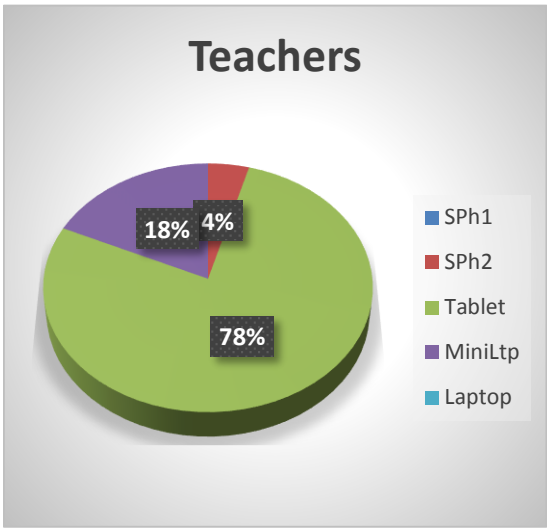


Figure 7. 19 preferred device by teachers

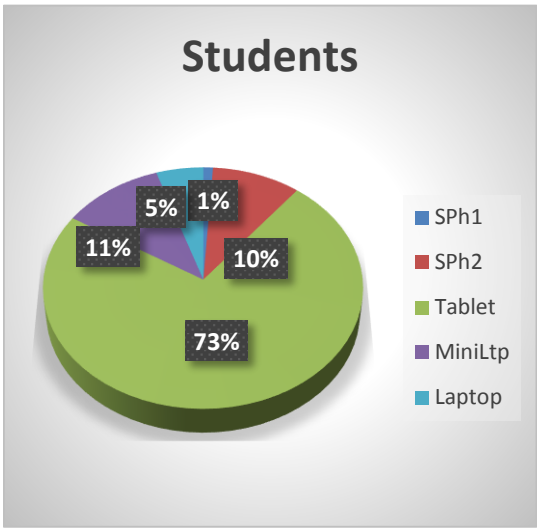


Figure 7. 20 preferred device by students

SPh1 – Smart Phone with screen size of less than 3 inch.

SPh2 – Smart Phone with screen size of 3 inch or more

MiniLtp – Mini laptop (include notebook)

7.16 Conclusion

The results and analysis of the empirical study on m-learning presented in this chapter was to bring to the fore how mobile computing devices and communication technologies could be effectively leveraged and incorporated into teaching and learning in tertiary institutions. The cyclical characteristics of the study created a loop where the outcome of each cycle served as the point of reference for the next cycle of the project. This was a catalyst for strengthening the empirical evidence of the study. The experimentation of the m-learning technology at CUC

went through three stages – initial experimentation, second and third implementation over a period of two and half years. The initial pilot gave an exploratory result, which ignited the preparation for the second implementation, which was the first time the whole school population was introduced to the m-learning technology. The outcome was phenomenal which unveiled scenarios as the users tried to make meaning of their mobility and the affordance of portable ICTs in their daily life as they teach or learn. It observed the following: (i) skill, interest and knowledge of the users in the area of the technology (ii) time and technical issues (iii) users' demographics, social-cultural background, ethics and beliefs (iv) motivation and (v) pedagogic relevance of the technology for teaching and learning were essential factors for ensuring successful implementation of m-learning . This led to the conceptualisation of the STUMP model, which is used to assess the readiness level of the users in terms of the factors and predicts the success or failure of an implementation.

The findings of the empirical study met the objective of the thesis by providing relevant answers to the questions, which were asked. Although the outcome of the project was satisfactory it was not as successful as it was anticipated, but the steady improvement from the beginning to the end of the third implementation shows that greater success will be achieved if it continues to the next stage of implementation. The project committee made strong recommendations that attaining the desired level of success of the m-learning project was directly linked to the amount of time allocated for the implementation. Although there is high proliferation of the mobile technology, the concept of taking advantage of its portability and ubiquity for education delivery is quite new in academia and will need ample time for integration. The length and breadth of the outcome is if management is able to clear all the "stump", then the concept of leveraging and incorporating mobile computing and communication technology into the educational framework of tertiary education is likely to be successful.

CHAPTER EIGHT

CONCLUSION

8.1 Overview

This chapter concludes the discussions detailed in this thesis. The study investigated how mobile computing and communication technologies could be leveraged and effectively incorporated into tertiary education to facilitate teaching and learning. The overall outcome of this dissertation is based on thorough and inexhaustible investigation of using wirelessly connected mobile devices for teaching and learning in a natural setting of teachers and students as they perform their academic routines. The approach of the thesis was to use the implementation of m-learning in CUC as a case study in a real-life situation to study how the use of mobile devices as tools for mediating teaching and learning will work for teachers and students in tertiary education. This was pursued with two distinct but unseparated interest; the research interest and practical problem solving interest. From this background, action research strategy of inquiry was adopted to explore the m-learning phenomenon in CUC as the users engaged in m-learning activities. This was to uncover constrains which impede effective integration of m-learning in tertiary education and model a framework for it.

I conclude the whole discussion of this dissertation by summarising the outcome of the study in the remaining sections of this chapter as follows: In *section 8.2*, I present a recap of all the preceding chapters of this thesis. This is followed by *section 8.3* with an outline of my scientific contributions made out of this study. *Section 8.4* explains the implications of the findings. A discussion on the limitations and opportunities for further research is presented in *section 8.5* and *8.6*. My final concluding remarks is found in *section 8.7*.

8.2 Compendium of thesis

The very first chapter of this dissertation provides a general preamble to the entire study. The chapter outlines an overview of the structure of the study by presenting and explaining the problem(s), which the research project seeks to find it answers. This problem is the issue confronting most educators and technology implementers; and it is not being able to successfully implement and integrate ICTs in schools to facilitate education delivery. The chapter addressed the concerns of this study regarding this problem especially with tertiary education institutions. This led to the formulation of the main question of the study – "*How*

can Tertiary educational Institutions leverage on mobile computing technology such as m-learning platform to effectively incorporate it into teaching and learning?" which ignited this empirical study and the research objective. The chapter gives an epitome of the empirical study and concludes with an outline of the rest of the thesis.

Chapter two, is with the heading "state of the art" which sought to delve into relevant literature and case studies within the area of teaching and learning, educational technology, e-learning, m-learning and mobility as well as mobile computing and communication technologies, to establish the basis for understanding and appreciating the problem within the context of tertiary education, which is the point of departure for this research.

The chapter began with a discussion on educational technology, the role of technology in education and a general overview of the composition of the system of tertiary education to gain in-depth knowledge of the application of technology for teaching and learning in tertiary education institutions. This was followed with the exposition of mobility of human's and the use of ICTs emphasizing on teachers and students as they wander while carrying out their academic activities. This led to the discussion of e-learning and m-learning which focused on understanding these learning technologies, their constituents and their impact on teaching and learning, highlighting on the phenomenon of anywhere anytime and the drawbacks of m-learning. Attention was paid to m-learning projects in Africa and its emerging business perspective. Finally the chapter presented a thorough discussion on mobile computing and communication technologies and how their evolution have impacted on education delivery in general.

The methodology for the empirical study is presented in chapter three. The chapter explains how the research was conducted. First, an overview of the entire research philosophy was presented which outlined the epistemology, ontology, theoretical perspective and justification of the research approach. The discussion touched on the two major philosophical assumptions of conducting scientific inquiry and how they interpret knowledge. It explained how the study aligned itself to pragmatism's world view of knowing as the philosophical underpinning for the research design. Next to this was the method, which details all the steps, strategies and instruments used in arriving at the scientific conclusion of the research. The chapter explains the basis for selecting action research as the strategy of inquiry for the study as being suitable because it gives room for both quantitative and qualitative data collection in a natural setting

of the participants, as their activities unfolds a new phenomenon. The chapter concluded by explaining techniques which was used by the researcher (me) to analyse and interpret the various forms of data which was gathered from the participants.

The theoretical framework for the study was encapsulated in chapter four, which provides a philosophical understanding of linking education and technology. The chapter begins with an overview of the three main paradigms of learning theories *(behaviourism, cognitivism and constructivism)* and explains their fundamental principles of assumptions. This is followed with the discussion of learning objectives and pedagogical models which touched on the various teaching and learning styles and pedagogical models including their technological inclinations. The chapter further present a conceptual framework, which was developed to guide effective leveraging and integration of technology in tertiary education. This is followed with a pedagogic method, which was adopted for this study. It explains how the technology was applied in teaching and learning within the context of tertiary education and concludes with the basis of the theoretical framework.

Chapter five presents a discussion of the STUMP model. The chapter starts with an introduction of the background of the model. This was followed with an exposition of the purpose of the model, which is to assess and measure the readiness level of users to use the m-learning technology so as to ensure effective incorporation of the technology into the school's educational framework. The analog of the STUMP model was also presented to give an elaborated explanation on the basis for developing the model. This was supported with a theoretical background consisting of eleven theories. These theories were found to have elements which were identified to be constant with the results of the study relating to the users' behaviour towards the usage of the technology. This resulted in the conceptualisation of these five factors – (1) SKILL, AFFECT, & KNOWLEDGE (2) TECHNICAL ISSUES & TIME (3) USER'S SOCIAL COGNITIVE COMPOSITION (4) MOTIVATION (5) PEDAGOGIC RELEVANCE of the technology as the STUMP model constructs. The chapter further explained the effect of each of the factors on the users' behaviour towards the technology and threw more light on how data was obtained for the formulation and development of the model.

In chapter six, a full account on how the m-learning pilot project at CUC was planned and implemented was presented. The chapter began with a brief background of the project, followed with detailed outline of how the project was operationalized. The account as recorded

by the chapter reports that the whole implementation process of the m-learning technology at CUC was divided into phases. The first phase was an initial experiment that was conducted to prepare the ground with a cross section of the teachers, students and administration staff totalling 527 participants consisting of 500 students, 22 teachers and 5 administration staff. The outcome of the experiment gave insight into how the second stage of the pilot should be approached. In the second stage, the entire school population of CUC were included in the project, thus the first time the whole school experienced m-learning. The chapter explains how the project implementation committee outlined an action plan for the implementation, guided by a conceptual framework. The account of the report revealed that the users had some unsettled concerns that affected their usage of the system. Following the results of the second phase, the third phase commenced. At this stage, the implementation committee became fully aware of the potential factors, which could affect the success or failure of the teachers and students using their mobile devices for teaching and learning respectively.

The results and analysis of the outcome of the m-learning pilot project implementation at CUC was presented in chapter seven. The chapter opens the discussion with an overview of the key findings of the entire study. This is followed with a detailed presentation of the findings and analysis of the empirical study. This was done by discussing and analysing the results of each of the phases of the project since the whole implementation process was cyclical and each cycle outcome served as the basis for the next iteration of the project. The longitudinal nature of the study offered the opportunity to explore how the users experienced the m-learning phenomenon. The initial experiment of the project with a section of the school was used to introduce the technology to the school. This achieved its purpose by catching the attention of most of the teachers and students who were not selected to participate in the experiment. The second phase of the project as recorded in the chapter was preceded by a thorough homework done by the implementation committee as a result of the outcome of the initial experiment, to ensure that the second phase yields a better result than the first one. It emerged from the second phase of the implementation that five main categories of factors were the general concerns of the users, which sought to jeopardise the successful incorporation of m-learning into tertiary education because they affected the users' behaviour towards the use of the technology. The chapter further recounted how the factors were identified as the critical success factors for the effective integration of m-learning in tertiary education. The STUMP framework was developed out of this and used for assessing the preparedness of the users for the third phase

of the implementation and its outcome. The chapter discussed the steady progressive improvement of the outcome of the implementation throughout the stages of the project.

8.3 Research Contributions

The empirical work, which I have presented so far in this dissertation, has several dimensions of scientific contribution to information technology and educational research. However, for meeting the requirement of originality and novelty, which is necessary for this kind of research, I will only confide myself to present aspects of the outcome of the study, which I found to be original, novel and most importantly significant to the research community. In doing this, I admit without hesitation that the level of originality and novelty of my contribution is built on existing research knowledge in the research area of this study. Knowledge of other people's theories and models equipped me to conceptualise a new model from which is solidly grounded on empirical data that is supported by empirically tested and proven theories and models. My research contribution emanated from new knowledge, which was espoused out of the findings of this empirical study. I hereby present a summary of my contributions as follows:

- An allusion of a conceptual model, which hypothesizes the effect of the relationship between people and their constructed perception of using a given technology as individuals or in an organisation. The model postulates that within the context of education institution, the behaviour of people towards the use of technology is influenced by mix of factors. This consequently determines the success or failure of the usage of the technology. The model provides an instrument for assessing and measuring users' perception and behaviour to use the technology and predicts the actual use of the technology.

- An exposition of the paradox interplay between pedagogy and technology used for teaching and learning based on a conceptual framework, which serves as a template for educators and technology implementer in schools to follow. The framework explicates how the choice of a technology must be appropriate for meeting the intended learning objective, teaching & learning philosophy and consequently pedagogic approach.

- Mapping the mobility of teachers and students and how the affordances of mobile computing and communication technologies facilitates these mobility in the delivery of tertiary education. The mapping illustrates the complexities of the mobility of teachers and students as they wander in pursuit of their academic goals.

- An elucidation of best practices in leveraging and effectively incorporating mobile ICTs into tertiary education as mediating tools for the advancement of teaching and learning.

8.4 Implications of contribution

For educators, technology implementers, and educational technologist, the theorising of the findings of this empirical study can be used as a blueprint for ensuring effective leveraging and successful implementation of appropriate mobile ICTs in schools to meet teaching and learning needs of teachers and students.

For mobile learning software developers, the results of the empirical study clearly reveals relevant criticisms which are useful for designing mobile learning system which have good human computer interaction among other things and is capable of meeting their task needs.

In addition, for the research fraternity, the findings from this thesis increases understanding by adding to a host of existing theories and models with new knowledge.

8.5 Limitations

Now, I wish to acknowledge that the study has some limitations, which are worth mentioning. These limitations are considered from the methodological perspective, time and practical constraints, which to some extent contributed to the outcome of the study. The research was philosophically grounded on pragmatist worldview with action research as the strategy of inquiry, which used both quantitative and qualitative techniques of data collection to arrive at the empirical findings of the study.

Although action research is perceived as a research method which offers researchers with the opportunity to gather first-hand data from participants in their natural setting of life with mixed method of data collection techniques, it has its own peculiar challenges including criticisms

from people who do not accept action research as a solid scientific method, which can be used for conducting empirical study, others also perceive action research to be nothing different from consultancy because of its practical nature and the involvement of the researcher among others. This study appreciates some of these concerns and will like to make known the extent to which these limitations impacted on the entire study.

The m-learning case study, which was adopted for this research was a real world pilot project of integrating mobile technology into teaching and learning in a university in Ghana. The implementers were concerned with solving a practical problem by blending traditional classroom method of teaching and learning with m-learning to facilitate tertiary education delivery whereas the research interest was to find out how mobile technology could be leveraged and effectively incorporated into the educational framework of the school based on empirical evidence. These two dimensions reflected a typical dual action research, which seeks to solve practical problem while constructing theoretical meaning of the phenomenon, but this dual purpose occasionally created conflict between the implementers and myself (the action researcher) which sometimes affected the empirical process, however this did not create much problems because most often we were able to understand each other after series of meetings.

The idiographic characteristics of action research and for that matter this study as compared to other methods restricts the study to a particular context with a particular set of people. This implies that the reliability for the study to produce the same results in a different context with different participants is minimal. Thus, the generalisation of the research findings is limited, but notwithstanding this, if the prevailing conditions are the same, then the likelihood of obtaining the same results is highly reliable. In spite of this, the idiographic nature of this study within the context of social science research provided an opportunity for in-depth and thorough research, which led to comprehensive understanding and description of the phenomenon as it unfolded. The concentration of the study at CUC was mainly on how the students and teachers utilised their mobile devices for teaching and learning activities with less emphasis on the administrative staff. The study did not investigate the effect of using mobile computing and communication technology in education on teaching and learning outcome.

Practically, observing the teachers were quite difficult than the students. It was easier mingling with the students to observing their m-learning experience, but in the case of the teachers, it was not because I either had to go to them in their offices or sit in their lecture which was

inconvenient most of the time. I thus monitored the teachers' use of the m-learning platform indirectly from how frequently they published content on the platform for students. Ethically and for private reasons, none of the participants was eager to allow me to record him or her although they had been assured of the confidentiality of the data, but they openly and unsparingly shared their thought and experiences in using the m-learning technology with me.

Although the research was longitudinal in nature, I was trapped by the time limitation of the PhD research to terminate the study at a point and reported on results, which were available to me, but the project was one which needed enough time to be able to draw holistic conclusions after several test of the conceptual model. Again within the time constraints of this research, the study could not be replicated in other schools to verify the reliability of the findings. And finally there was not enough funding to sustain the project to the end. These limitations I have enumerated concerning this study only show that there are a lot of issues concerning the use of mobile computing and communication technology for teaching and learning which needs further research in this area to unearth other unresolved issues through empirical study.

8.6 Future Research

Further research can be conducted as a follow up on this study or in other areas of mobile computing and communication technology in education, which were not touched by this study. This area could be investigated to broaden research knowledge and inform practice in the application of mobile ICTs in education. This study focused on finding out how tertiary education institutions can leverage mobile technology and effectively incorporate it into teaching and learning to facilitate education delivery. This of course is a small aspect of the enormous research problems confronting educators and technologist as they attempt to introduce mobile ICTs in schools for the purpose of teaching and learning.

This study can be extended to investigate and measure the impact of m-learning on teaching and learning outcome to establish a correlation between the dependence of educational performance and the use of mobile technology. Such a study will focus and throw more light on the pedagogic usefulness of the technology and how it enhances teaching and learning. Or instead of action research, another researcher can approach this study with design based research or experiment to compare the findings.

Most importantly, the constructs of the STUMP model, which were espoused out of the findings of this study can be hypothesized and used for further research to find out more about teachers' and students' behaviour towards mobile technology to test the reliability of the constructs in different context. The discourse on mobile ICTs in education especially m-learning is still in its infancy stage and thus requires more research.

8.7 Concluding Remarks

In an attempt to help to contribute a panacea to the overarching problem of most educational practitioners in not being able to effectively incorporate the use of ICTs into their educational framework, I took it upon myself in this dissertation to investigate how to leverage and effectively incorporate mobile computing and communication technologies through the use of m-learning platform in tertiary education, to accomplish teaching and learning practices anywhere, anytime. The study systematically followed through the research design with an express aim of obtaining empirical answers for the research questions, which is the pinnacle of the whole research process. The theme of the thesis was '*Leveraging Mobile Computing and Communication Technologies in Education: "Incorporation of mobile learning into Tertiary Education'* and the objective was to conduct a study to find out how educational practitioners can be able to harness the educational affordances of mobile computing and communication technologies and integrate it into tertiary education to support traditional classroom style of teaching and learning.

In spite of the few limitations and suggestions presented for further research on this study, which tantamount to the fact that there are unresolved issues. That need to be addressed, I strongly believe that the contributions made by this study to the research community of mobile ICT and education is enormous and of significance to emerging literature concerned with the exposition of mobile technology and its usage for educational purposes. The findings from the empirical study provided answers to the research questions on *why* the users behaved in a certain manner toward the technology, *what* influenced their behaviour and *how* it could be resolved. The findings revealed some relevant determinants, which were identified as concerns, which influenced the users' behaviour towards the use of the technology. This led to the conceptualisation of the STUMP model, which summarizes all the determinants under an umbrella of five main general constructs. STUMP is a predict model which is used for predicting potential success or failure of implementing a technology. First of all, it is used for assessing and measuring the readiness level of users to use the technology and second, to

evaluate their actual use of the technology. The model postulates that the STUMP level of the users directly influence their usage of the technology. Consequently, it is a requirement according to the framework to have a good "stump" clarity level before going ahead with implementation.

This study acknowledges the great work done by other researchers in this area. However, I will not hesitate to admit that there is still more to be done to advance the use of mobile computing for teaching or learning and to that effect, the end of this research marks the beginning of further research in the area of mobile ICT for education delivery.

REFERENCES

(Ghana), N. C. for T. E. (1999). *National Council for Tertiary Education (NCTE) handbook*. NCTE.

A Science Odyssey: People and Discoveries: Ivan Pavlov. (n.d.). Retrieved February 20, 2013, from http://www.pbs.org/wgbh/aso/databank/entries/bhpavl.html

AAU/ICT Report. (n.d.). Retrieved February 17, 2013, from http://rc.aau.org/files/english/documents/aau-ictreport-p31.htm

Afshari, M., Bakar, K. A., Luan, W. S., Samah, B. A., & Fooi, F. S. (2009). Factors affecting teachers' use of information and communication technology. *International Journal of Instruction*, *2*(1), 77–104. Retrieved from http://www.davidhaw.net/wp-content/uploads/2011/08/afshari.pdf

Ajzen, I. (1989). Attitude structure and behavior. *Attitude structure and function*, 241–274. Retrieved fromhttp://www.google.com/books?hl=en&lr=&id=DPXes4FwtngC&oi=fnd&pg=PA241&dq=%27Ajzen,I%27+1985&ots=VoiEUhXuWI&sig=UFiEv-kN4PfIGx0gWYjRRSPo_Xq

Ajzen, I. (1991). The theory of planned behavior. *Organizational behavior and human decision processes*, *50*(2), 179–211. Retrieved from http://www.cas.hse.ru/data/816/479/1225/Oct%2019%20Cited%20%231%20Manage%20THE%20THEORY%20OF%20PLANNED%20BEHAVIOR.pdf

Ajzen, I., & Fishbein, M. (1977). Attitude-behavior relations: A theoretical analysis and review of empirical research. *Psychological Bulletin; Psychological Bulletin*, *84*(5), 888. Retrieved from http://psycnet.apa.org/journals/bul/84/5/888/

Ajzen, I., & Madden, T. J. (1986). Prediction of goal-directed behavior: Attitudes, intentions, and perceived behavioral control. *Journal of experimental social psychology*, *22*(5), 453–474. Retrieved from http://www.sciencedirect.com/science/article/pii/0022103186900454

Akpotu, N. E., & Akpochafo, W. P. (2009). An analysis of factors influencing the upsurge of private universities in Nigeria. *Journal of Social Sciences, KAMLA-RAJ ENTERPRISES*, *18*(1), 21–27. Retrieved from http://www.krepublishers.com/02-Journals/JSS/JSS-18-0-000-09-Web/JSS-18-1-000-2009-Abst-PDF/JSS-18-1-021-09-499-Akpotu-N-E/JSS-18-1-021-09-499-Akpotu-N-E-Tt.pdf

Alexander, B. (2006). Web 2.0: A new wave of innovation for teaching and learning? *Educause review*, *41*(2), 32. Retrieved from http://www.educause.edu/ero/article/web-20-new-wave-innovation-teaching-and-learning

Ally, M. (2009). *Mobile Learning: Transforming the Delivery of Education and Training*. Athabasca University Press.

Anderson, L. W., Krathwohl, D. R., & Bloom, B. S. (2005). *A taxonomy for learning, teaching, and assessing*. Longman. Retrieved from http://www.lavoisier.fr/livre/notice.asp?id=OSOWR2AR6O2OWZ

Annan, N. K., Ofori-Dwumfuo, G. O., & Falch, M. (2012). Mobile Learning Platform: a case study of introducing m-learning in Tertiary Education. *Global Science and Technology Forum*, *2*(1), 23. Retrieved from

http://www.academia.edu/1577293/Mobile_Learning_Platform_a_case_study_of_introducing_m-learning_in_Tertiary_Education

Archambault, L., & Crippen, K. (2009). Examining TPACK among K-12 online distance educators in the United States. *Contemporary Issues in Technology and Teacher Education*, *9*(1), 71–88. Retrieved from http://www.editlib.org/p/29332/

Atkinson, P. (1997). *The clinical experience: the construction and reconstruction of medical reality*. Ashgate.

Audi, R. (2010). *Epistemology: A Contemporary Introduction to the Theory of Knowledge*. Routledge.

Ausubel, D. P. (2000). *The acquisition and retention of knowledge: A cognitive view*. Springer.

Avison, D. E., Lau, F., Myers, M. D., & Nielsen, P. A. (1999). Action research. *Communications of the ACM*, *42*(1), 94–97. Retrieved from http://dl.acm.org/citation.cfm?id=291479

B. F. Skinner. (n.d.). Retrieved February 20, 2013, from http://webspace.ship.edu/cgboer/skinner.html

Babbie, E. R. (2010). *The Practice of Social Research*. Cengage Learning.

Babbie, E. R. (2012). *The practice of social research*. Wadsworth Publishing Company. Retrieved from http://www.google.com/books?hl=en&lr=&id=k-aza3qSULoC&oi=fnd&pg=PR6&dq=related:bcFmBBBj59UJ:scholar.google.com/&ots=V2Eu5tFoZg&sig=B30scWvQBDf6B9zKPS6O3FH8c7M

Bacon, M. (2012). *Pragmatism*. Polity.

Bakvis, H., & Cameron, D. M. (2000). Post-secondary education and the SUFA. *POLICY OPTIONS-MONTREAL-*, *21*(4), 46–47.

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory.* Prentice-Hall, Inc. Retrieved from http://psycnet.apa.org/psycinfo/1985-98423-000

Bandura, A. (2001). Social cognitive theory: An agentic perspective. *Annual review of psychology*, *52*(1), 1–26. Retrieved from http://www.annualreviews.org/doi/pdf/10.1146/annurev.psych.52.1.1

Barab, S. A., & Kirshner, D. (2001). Guest editors' introduction: Rethinking methodology in the learning sciences. *The Journal of the Learning Sciences*, *10*(1-2), 5–15. Retrieved from http://www.tandfonline.com/doi/abs/10.1207/S15327809JLS10-1-2_2

Bargellini, M. L., & Bordoni, L. (2001). The role of the library in a new learning scenario. *Electronic Library, The*, *19*(3), 153–157. Retrieved from http://www.emeraldinsight.com/journals.htm?articleid=861925&show=abstract

Barnes, S. B. (2010). User Friendly: A Short History of the Graphical User Interface. *Sacred Heart University Review*, *16*(1), 4. Retrieved from http://digitalcommons.sacredheart.edu/shureview/vol16/iss1/4/

Baskerville, R. L. (1999). Investigating information systems with action research. *Communications of the AIS*, *2*(3es), 4. Retrieved from http://dl.acm.org/citation.cfm?id=374476

Beaubrun, R., & Pierre, S. (2001). Technological developments and socio-economic issues of wireless mobile communications. *Telematics and Informatics*, *18*(2), 143–158. Retrieved from http://www.sciencedirect.com/science/article/pii/S0736585300000265

Bednar, A. K., Cunningham, D., Duffy, T. M., & Perry, J. D. (1992). Theory into practice: How do we link. *Constructivism and the technology of instruction: A conversation*, 17–34. Retrieved from http://www.google.com/books?hl=en&lr=&id=7Uv8NHvKK44C&oi=fnd&pg=PA17-IA2&dq=Theory+into+Practice:+How+do+we+link&ots=XOgA_yUgqI&sig=Spq5HJh7o4_aVDxT0Pm7EbsGFCE

Behaviorism Theory Overview. (n.d.). Retrieved February 20, 2013, from http://www.lifecircles-inc.com/Learningtheories/behaviorism/behaviorism.htmlthe behaviourist orientation to learning @ the informal education homepage. (n.d.). Retrieved February 20, 2013, from http://www.infed.org/biblio/learning-behavourist.htm

Benke, G. (2008). Where Is Enron? Changing Perceptions of Geographic Relationships in the Deregulation of California‘s Energy Market. Retrieved from https://35.9.18.4/~business/bhcweb/publications/BEHonline/2008/benke.pdf

Benzie, D. (1995). IFIP Working group 3.5: using computers to support young learners. In *World Conference on Computers in Education VI: WCCE* (Vol. 95, pp. 35–42).

Berlo, D. K. (1960). *The process of communication: An introduction to theory and practice*. Holt, Rinehart and Winston New York. Retrieved from http://orton.catie.ac.cr/cgi-bin/wxis.exe/?IsisScript=LIBROSCO.xis&method=post&formato=2&cantidad=1&expresion=mfn=009479

Bijker, W. E., Hughes, T. P., & Trevor, J. (1984). *Pinch, eds. 1987. The social construction of technological systems: New directions in the sociology and history of technology*. Cambridge, MA: MIT Press.

Blaikie, N. (2009). *Designing social research*. Polity. Retrieved from http://www.google.com/books?hl=en&lr=&id=AcQ7mBUIkGEC&oi=fnd&pg=PR7&dq=%22Blaikie+N%22+2010&ots=orRgn3GKWW&sig=pauXnQwFOAgiD_DQmMXB7vXVVik

Blaug, M. (1985). Where are we now in the economics of education? *Economics of Education Review*, *4*(1), 17–28. doi:10.1016/0272-7757(85)90034-2

Blaxter, L., Hughes, C., & Tight, M. (2006). *How to Research*. McGraw-Hill International.

Bouton, M. E., & Bolles, R. C. (1979). Contextual control of the extinction of conditioned fear. *Learning and Motivation*, *10*(4), 445–466. Retrieved from http://www.sciencedirect.com/science/article/pii/0023969079900572

Boyle, T. (1997). *Design for multimedia learning*. Prentice-Hall, Inc. Retrieved from http://dl.acm.org/citation.cfm?id=249037

Brick, J. (2009). *Academic culture: A student's guide to studying at university*. Macmillan Education AU.

Brown, A. L. (1994). The advancement of learning. *Educational researcher*, 4–12. Retrieved from http://www.jstor.org/stable/10.2307/1176856

Brown, J. S., Collins, A., & Duguid, P. (1989). Situated cognition and the culture of learning. *Educational researcher*, *18*(1), 32–42. Retrieved from http://edr.sagepub.com/content/18/1/32.short

Bruner, J. S. (1966). *Toward a theory of instruction* (Vol. 59). Belknap Press. Retrieved from http://www.google.com/books?hl=en&lr=&id=F_d96D9FmbUC&oi=fnd&pg=PA1&dq=Toward+a+Theory+of+Instruction&ots=ySTR2eF5zJ&sig=0SPaMQO_5_omCSjiTDLTbhH4xCQ

Bruner, Jerome S., & Bruner, J. S. (1986). *Actual minds, possible worlds*. Harvard University Press. Retrieved from http://www.google.com/books?hl=en&lr=&id=YNuBf6W2rt0C&oi=fnd&pg=PR7&dq=Actual+Minds,+Possible+Worlds,&ots=352yWBDoCO&sig=zCMDQ5m7PmGwS21OFyr1BRH-xWw

Bryant, T. (2006). Social software in academia. *Educause Quarterly*, *29*(2), 61. Retrieved from http://net.educause.edu/ir/library/pdf/EQM0627.pdf

Bryman, A. (2008). *Social Research Methods* (3rd ed.). Oxford University Press.

Carleson, N. R., Buskist, W., Enzle, M. E., & Heth, C. D. (2005). *Psychology: The Science of Behaviour*. Pearson Education Canada Inc, Needham Heights, MA,.

Cerf, V. (1993). How the internet came to be.

Chan, T. W., Roschelle, J., SHERRY, H., Kinshuk, Sharples, M., Brown, T., … Norris, C. (2006). One-to-one technology-enhanced learning: An opportunity for global research collaboration. *Research and Practice in Technology Enhanced Learning*, *1*(01), 3–29. Retrieved from http://www.worldscientific.com/doi/abs/10.1142/S1793206806000032

Chance, P. (1999). Thorndike's Puzzle Boxes And The Origins Of The Experimental Analysis Of Behavior. *Journal of the Experimental Analysis of Behavior*, *72*(3), 433. Retrieved from http://www.ncbi.nlm.nih.gov/pmc/articles/pmc1284753/

Checkland, P. (1991). From framework through experience to learning: the essential nature of action research. *Information systems research: Contemporary approaches and emergent traditions*, 397–403.

Chikh, A., & Berkani, L. (2010). Communities of practice of e-learning, an innovative learning space for e-learning actors. *Procedia-Social and Behavioral Sciences*, *2*(2), 5022–5027. Retrieved from http://www.sciencedirect.com/science/article/pii/S1877042810008542

Clarke, D. J. (2002). E-learning: Big bang or steady evolution. *Learning Technologies*, 1–2.

Classics in the History of Psychology -- Pavlov (1927). (n.d.). Retrieved February 20, 2013, from http://psychclassics.yorku.ca/Pavlov/

Clements, D. H. (1987). Longitudinal study of the effects of Logo programming on cognitive abilities and achievement. *Journal of Educational Computing Research*, *3*(1), 73–94. Retrieved from http://baywood.metapress.com/index/RCNV2HYF60CMK7K7.pdf

Cobcroft, R. S., Towers, S. J., Smith, J. E., & Bruns, A. (2006). Mobile learning in review: Opportunities and challenges for learners, teachers, and institutions. Retrieved from http://eprints.qut.edu.au/5399

Coghlan, D. (2011). Action research: Exploring perspectives on a philosophy of practical knowing. *The Academy of Management Annals*, *5*(1), 53–87. Retrieved from http://www.tandfonline.com/doi/abs/10.1080/19416520.2011.571520

Compeau, D. R., & Higgins, C. A. (1995a). Computer self-efficacy: Development of a measure and initial test. *MIS quarterly*, 189–211. Retrieved from http://www.jstor.org/stable/10.2307/249688

Compeau, D. R., & Higgins, C. A. (1995b). Application of social cognitive theory to training for computer skills. *Information Systems Research*, *6*(2), 118–143. Retrieved from http://isr.journal.informs.org/content/6/2/118.short

Cook, T. D., Campbell, D. T., & Day, A. (1979). *Quasi-experimentation: Design & analysis issues for field settings*. Houghton Mifflin Boston. Retrieved from http://dickyh.staff.ugm.ac.id/wp/wp-content/uploads/2009/ringkasan%20buku%20quasi-experimentakhir.pdf

Coughlan, P., & Coghlan, D. (2002). Action research for operations management. *International journal of operations & production management*, *22*(2), 220–240. Retrieved from http://www.emeraldinsight.com/journals.htm?articleid=849392&show=abstract

Crescente, M. L., & Lee, D. (2011). Critical issues of m-learning: design models, adoption processes, and future trends. *Journal of the Chinese Institute of Industrial Engineers*, *28*(2), 111–123. Retrieved from http://www.tandfonline.com/doi/abs/10.1080/10170669.2010.548856

Creswell, J. W. (2008). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. SAGE Publications.

Creswell, J. W., & Clark, V. L. P. (2010). *Designing and Conducting Mixed Methods Research*. SAGE.

Crotty, M. (1998). *The foundations of social research: Meaning and perspective in the research process*. Sage Publications Limited. Retrieved from http://www.google.com/books?hl=en&lr=&id=Op_SDKrf1ZQC&oi=fnd&pg=IA1&dq=the+foundations+of+social+research:+meaning+and+perspective+in+the+research+process&ots=RrIwZ7uZC0&sig=bZrzzeedPjqP6D9O1Zod_zoBKSo

Cuban, L. (1986). *Teachers and machines: The classroom use of technology since 1920*. Teachers College Pr.

Cuban, L., & Cuban, L. (2003). *Oversold and underused: Computers in the classroom*. Harvard University Press. Retrieved from http://www.google.com/books?hl=en&lr=&id=sdSutyVQfzYC&oi=fnd&pg=PP6&dq=Oversold+and+Underused:+Computers+in+the+classroom&ots=VEWftvcyUW&sig=gHUrzR7LrVDMOM6gcHMIwCs6e4c

Dabbagh, N., & Bannan-Ritland, B. (2005). *Online learning: Concepts, strategies, and application*. Prentice Hall.

Dahlman, E. (2008). *3G evolution: HSPA and LTE for mobile broadband*. Academic Press. Retrieved from http://www.google.com/books?hl=en&lr=&id=cmMgp4j23D0C&oi=fnd&pg=PP2&dq=evolution+of+mobile+communication&ots=KCff3TooZ4&sig=AYYRbHfGwGMo-wLGri3c3DDkKmY

Davis, F. D. (1985). *A technology acceptance model for empirically testing new end-user information systems: Theory and results*. Massachusetts Institute of Technology, Sloan School of Management. Retrieved from http://en.scientificcommons.org/7894517

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS quarterly*, 319–340. Retrieved from http://www.jstor.org/stable/10.2307/249008

Davis, F. D. (1993). User acceptance of information technology: system characteristics, user perceptions and behavioral impacts. Retrieved from http://deepblue.lib.umich.edu/handle/2027.42/30954

Davis, F. D., Bagozzi, R. P., & Warshaw, P. R. (1989). User acceptance of computer technology: a comparison of two theoretical models. *Management science*, *35*(8), 982–1003. Retrieved from http://mansci.journal.informs.org/content/35/8/982.short

Davis, F. D., Bagozzi, R. P., & Warshaw, P. R. (1992). Extrinsic and intrinsic motivation to use computers in the workplace1. *Journal of applied social psychology*, *22*(14), 1111–1132. Retrieved from http://onlinelibrary.wiley.com/doi/10.1111/j.1559-1816.1992.tb00945.x/abstract

Deci, E. L. (1975). *Intrinsic motivation.* Plenum Press. Retrieved from http://doi.apa.org/psycinfo/1976-11500-000

Deci, E. L., & Ryan, R. M. (1985). *Intrinsic motivation and self-determination in human behavior*. Springer. Retrieved from http://www.google.com/books?hl=en&lr=&id=p96Wmn-ER4QC&oi=fnd&pg=PA1&dq=the+empirical+exploration+of+intrinsic+motivation&ots=3cJVs7s772&sig=HBNFSYXQlxmKwVNb9YLaTSudl7Y

Deci, E. L., & Ryan, R. M. (1991). A motivational approach to self: Integration in personality. In *Nebraska symposium on motivation* (Vol. 38, pp. 237–288). Retrieved from http://exordio.qfb.umich.mx/archivos%20PDF%20de%20trabajo%20UMSNH/Aphilosofia/2007/autoestima/motivacion.pdf

Deci, Edward L., & Ryan, R. M. (2004). *Handbook of Self-Determination Research*. University Rochester Press.

Dede, C. (1996). The evolution of distance education: Emerging technologies and distributed learning. *American Journal of Distance Education*, *10*(2), 4–36. Retrieved from http://www.tandfonline.com/doi/abs/10.1080/08923649609526919

Dede, C. (2005). Planning for neomillennial learning styles: Implications for investments in technology and faculty. *Educating the net generation*, *15*. Retrieved from http://cfcc.edu/SACS/QEP/documents/PlanningforNeomillenniallearningstylesDede2004.pdf

Dede, C. (2008). Theoretical perspectives influencing the use of information technology in teaching and learning. *International handbook of information technology in primary and secondary education*, 43–62. Retrieved from http://www.springerlink.com/index/K146X4155U14240L.pdf

Dede, C., Whitehouse, P., & Brown-L'Bahy, T. (2002). Designing and studying learning experiences that use multiple interactive media to bridge distance and time. *Current perspectives on applied information technologies*, *1*, 1–30. Retrieved from http://www.google.com/books?hl=en&lr=&id=ZAbM3CuY9DcC&oi=fnd&pg=PA1&dq=Designing+and+studying+learning+experiences+that+use+multiple+interactive+media+to+bridge+distance+and+time&ots=W5zh7MqbnR&sig=eRW6i2sA8bgWkuqyneZzjJU3v9E

Delone, W. H., & McLean, E. R. (2002). Information systems success revisited. In *System Sciences, 2002. HICSS. Proceedings of the 35th Annual Hawaii International Conference on* (pp. 2966–2976). Retrieved from http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=994345

DeLone, W. H., & McLean, E. R. (1992). Information systems success: The quest for the dependent variable. *Information systems research*, *3*(1), 60–95. Retrieved from http://infosys.highwire.org/content/3/1/60.short

DeVries, R., & Zan, B. (2003). When children make rules. *Educational Leadership*, *61*(1), 64–67.

Dewey, J. (1895). My Pedagogic Creed (1897). *Ders.: The Early Works*, *5*, 84–95. Retrieved from http://secondary.nrms.wikispaces.net/file/view/Dewey_Pedagogic_Creed_Text.pdf/373484956/Dewey_Pedagogic_Creed_Text.pdf

Dewey, J. (1998). *Experience and education*. Kappa Delta Pi. Retrieved from http://www.google.com/books?hl=en&lr=&id=UE2EusaU53IC&oi=fnd&pg=PR3&dq=Experience+and+Education&ots=EE1S5kMUNi&sig=mVHkY3RAPnyMT78SSXBL8QSOklk

Dewey, J. (2010). *My pedagogic creed*. Retrieved from http://www.google.com/books?hl=en&lr=&id=QDwqACGdf0IC&oi=fnd&pg=PA215&dq=%22My+Pedagogic+Creed%22&ots=9qmf5nlgUh&sig=RqYv7JYSsmvsGS_HeBH0f1CFRbQ

Dews, P. B. (1955). Studies on behavior. I. Differential sensitivity to pentobarbital of pecking performance in pigeons depending on the schedule of reward. *Journal of Pharmacology and Experimental Therapeutics*, *113*(4), 393–401. Retrieved from http://jpet.aspetjournals.org/content/113/4/393.short

Dey, A. K., Abowd, G. D., & Wood, A. (1998). CyberDesk: A framework for providing self-integrating context-aware services. *Knowledge-Based Systems*, *11*(1), 3–13. Retrieved from http://www.sciencedirect.com/science/article/pii/S0950705198000537

Dias, L. B., & Atkinson, S. (2001). Technology integration: Best practices-where do teachers stand. *International electronic journal for leadership in learning*, *5*(10), 1–13.

Dockstader, J. (1999). Teachers of the 21st Century Know the What, Why, and How of Technology Integration. *The Journal*, *26*(6), 73–74. Retrieved from http://www.eric.ed.gov/ERICWebPortal/recordDetail?accno=EJ584319

Ebert, A., & Gershon, N. D. (2012). Interview with Alan Kay. *KI-Künstliche Intelligenz*, 1–3. Retrieved from http://www.springerlink.com/index/58232413415QW9R6.pdf

Educational technology. (2013, February 18). In *Wikipedia, the free encyclopedia*. Retrieved from http://en.wikipedia.org/w/index.php?title=Educational_technology&oldid=535847950

Ely, D. (2008). Frameworks of educational technology*. *British Journal of Educational Technology*, *39*(2), 244–250. Retrieved from http://onlinelibrary.wiley.com/doi/10.1111/j.1467-8535.2008.00810.x/full

Ely, D. P. (1990). Conditions That Facilitate the Implementation of Educational Technology Innovations. *Journal of Research on Computing in Education*, *23*(2), 298–305. Retrieved from http://www.eric.ed.gov/ERICWebPortal/detail?accno=EJ421756

Engelbrecht, E. (2003). A look at e-learning models: investigating their value for developing an e-learning strategy. Retrieved from http://uir.unisa.ac.za/handle/10500/4992

Engeström, Y. (1993). Developmental studies of work as a testbench of activity theory: The case of primary care medical practice. *Understanding practice: Perspectives on activity and context*, 64–103. Retrieved from http://www.google.com/books?hl=en&lr=&id=iR_YTUIHoMgC&oi=fnd&pg=PA64&dq=%27Developmental+studies+of+work+as+a+test+bench+of+activity+theory:+the+case+of+primary+care+medical+practice%27&ots=fvnWGPFhsa&sig=T343jWs8Bsk7h85-Y38QTHXHrMg

Enni-Cole, D. (2004). Emerging Theories of Learning and Preservice Teachers. In *Association for educational communication and technology conference on emerging technologies and theories for teaching and learning*. Presented at the AECT Professional Development Conference, Denton, Texas. Retrieved from http://www.aect.org/pdf/AECT_UNT_Proceedings_2004.pdf

Essegbey, G. O., & Frempong, G. K. (2011). Creating space for innovation—The case of mobile telephony in MSEs in Ghana. *Technovation*, *31*(12), 679–688. Retrieved from http://www.sciencedirect.com/science/article/pii/S0166497211001222

Fay, M., Uteng, T. P., & Cresswell, T. (2008). "Mobile belonging": Exploring transnational feminist theory and online connectivity. *Gendered Mobilities*, 65–82. Retrieved from http://www.google.com/books?hl=en&lr=&id=nWkFCbw40C4C&oi=fnd&pg=PA65&dq=mobility+and+Virtual+Omnipresence+Status&ots=qHi_ir1juf&sig=UWHHoJRDZ0i_PkjYN4_PyEbQAO4

Fetaji, B., & Fetaji, M. (2011). Analyses and review of M-learning feasibility, trends, advantages and drawbacks in the past decade (2000-2010). In *Proceedings of the 5th European Conference on European Computing Conference (ECC 2011), World Scientific and Engineering Academy and Society (WSEAS), Stevens Point, Wisconsin, USA* (pp. 474–479). Retrieved from http://www.wseas.us/e-library/conferences/2011/Paris/ECC/ECC-76.pdf

Fishbein, M., & Ajzen, I. (1975). *Belief, attitude, intention and behavior: An introduction to theory and research*. Retrieved from http://trid.trb.org/view.aspx?id=1150648

Forest, J. J., & Kinser, K. (2002). *Higher Education in the United States: AL*. Abc-clio. Retrieved from http://www.google.com/books?hl=en&lr=&id=sFFX9OIkF2IC&oi=fnd&pg=PR10&dq=Experiential+Education,+Higher+Education+in+the+the+United+States:+An+Encyclopedia+Santa+Barbara,+California:+ABC-CLIO,+2002&ots=AFaF6pfSOF&sig=7iQu4NnLzXX40Z57Bs6O7ISDRRQ

Forum Solutions - Online Conferencing Solution, Teleconferencing Applications For Education, Religion, Governance, Politics, Business, Media, Others. (n.d.). Retrieved February 16, 2013, from http://forum.com.gh/solutions.aspx

Fox, L., & Fox, C. L. (1999). *Foundations: A Manual for the Beginning Student of Epistemology*. University Press of America.

Frohberg, D. (2006). Mobile Learning is Coming of Age: What we have and what we still miss. In *Proceedings of DeLFI* (pp. 327–338). Retrieved from http://www.comp.leeds.ac.uk/umuas/reading-group/MLearn_Framework.pdf

Frohberg, D., Göth, C., & Schwabe, G. (2009). Mobile learning projects–a critical analysis of the state of the art. *Journal of Computer Assisted Learning*, *25*(4), 307–331. Retrieved from http://onlinelibrary.wiley.com/doi/10.1111/j.1365-2729.2009.00315.x/full

Fuentelsaz, L., Maícas, J. P., & Polo, Y. (2008). The evolution of mobile communications in Europe: The transition from the second to the third generation. *Telecommunications Policy*, *32*(6), 436–449. Retrieved from http://www.sciencedirect.com/science/article/pii/S0308596108000402

Gagne, R. M. (1970). The conditions of learning.. Retrieved from http://psycnet.apa.org/psycinfo/1970-19966-000

Garrison, D. R. (2011). *E-Learning in the 21st Century*. Taylor & Francis.

Garrison, J. (1994). Realism, Deweyan pragmatism, and educational research. *Educational Researcher*, *23*(1), 5–14. Retrieved from http://edr.sagepub.com/content/23/1/5.short

Gay, G., Stefanone, M., Grace-Martin, M., & Hembrooke, H. (2001). The effects of wireless computing in collaborative learning environments. *International Journal of Human-Computer Interaction*, *13*(2), 257–276. Retrieved from http://www.tandfonline.com/doi/abs/10.1207/S15327590IJHC1302_10

Gebauer, J., & Shaw, M. (2002). *A theory of task/technology fit for mobile applications to support organizational processes*. University of Illinois at Urbana-Champaign. Retrieved from http://business.illinois.edu/Working_Papers/papers/02-0124.pdf

Gebauer, J., & Tang, Y. (2008). Applying the theory of task-technology fit to mobile technology: the role of user mobility. *International Journal of Mobile Communications*, *6*(3), 321–344. Retrieved from http://inderscience.metapress.com/index/562010up2714q772.pdf

George, M. (2003). Issues arising from an examination of the Junior Secondary School reform of 1987 in Ghana. *Educational Studies*, *29*(2-3), 141–177. Retrieved from http://www.tandfonline.com/doi/abs/10.1080/03055690303277

Glaser, R. (1965). *Teaching Machines and Programmed Learning: Data and Directions*. Department of audio-visual instruction national education.

Glaser, R. (1976). Components of a psychology of instruction: Toward a science of design. *Review of educational research*, 1–24. Retrieved from http://www.jstor.org/stable/10.2307/1169916

Goddard, W. D., & Melville, S. (2004). *Research Methodology: An Introduction*. Juta and Company Ltd.

Goodhue, D. L., & Thompson, R. L. (1995). Task-technology fit and individual performance. *MIS quarterly*, 213–236. Retrieved from http://www.jstor.org/stable/10.2307/249689

Gookin, D. (2008). *Laptops for dummies*. For Dummies. Retrieved from http://www.google.com/books?hl=en&lr=&id=zlg2jm3T8dgC&oi=fnd&pg=PA1&dq=xerox+dynabook+project&ots=4CuW9OJ0oA&sig=P1ktEejQrLNhnL9s433Kdr2dj3o

Gotschall, M. (2000). E-learning strategies for executive education and corporate training. *Fortune*, *141*(10), S5–S59.

Goulding, C. (2005). Grounded theory, ethnography and phenomenology: A comparative analysis of three qualitative strategies for marketing research. *European Journal of Marketing*, *39*(3/4), 294–308. Retrieved from http://www.emeraldinsight.com/journals.htm?articleid=1463194&show=abstract

Graham, R. C., Burgoyne, N., Cantrell, P., Smith, L., St Clair, L., & Harris, R. (2009). Measuring the TPACK confidence of inservice science teachers. *TechTrends*, *53*(5), 70–79. Retrieved from http://www.springerlink.com/index/0vm166x930163735.pdf

Greene, M. F. (1988). *Leaders for a New Era: Strategies for Higher Education. American Council on Education/Macmillan Series on Higher Education.* ERIC. Retrieved from http://www.eric.ed.gov/ERICWebPortal/recordDetail?accno=ED296625

Greeno, J. G. (1989). A perspective on thinking. *American Psychologist; American Psychologist*, *44*(2), 134. Retrieved from http://psycnet.apa.org/journals/amp/44/2/134/

Greenwood, D. J., & Levin, M. (1998). *Introduction to action research: Social research for social change*. Sage Publications, Incorporated.

Groenewald, T. (2004). A phenomenological research design illustrated. Retrieved from http://uir.unisa.ac.za/handle/10500/2573

Grosshans, W., & General, A. C. (1990). GAO Program Evaluation and Methodology Division. Retrieved from http://www.ojp.usdoj.gov/BJA/evaluation/guide/documents/documentee.html

Guo, S. (2010). From printing to Internet, are we advancing in technological application to language learning? *British Journal of Educational Technology*, *41*(2), E10–E16.

Gupta, B., & Koo, Y. (2010). Applications of mobile learning in higher education: An empirical study. *International Journal of Information and Communication Technology Education (IJICTE)*, *6*(3), 75–87. Retrieved from http://www.igi-global.com/article/applications-mobile-learning-higher-education/45152

Guy, R. (2009). *The evolution of mobile teaching and learning*. Informing Science. Retrieved from http://www.google.com/books?hl=en&lr=&id=Cz5SCEaHNAMC&oi=fnd&pg=PR9&dq=The+Evolution+of+Mobile+Teaching+and+Learning&ots=U327T_l1VB&sig=JboMYBRiPELWqdD1jhx7fNdgiLg

Gyepi-Garbrah, K. (2012). The perception of stakeholders in education on computerized school selection and placement system in Gomoa East and West districts in the Central region. Retrieved from http://ir.ucc.edu.gh/dspace/handle/123456789/1288

Hadzic, M., Wongthongtham, P., Chang, E., & Dillon, T. (2009). *Ontology-Based Multi-Agent Systems*. Springer.

Halonen, T., Romero, J., & Melero, J. (2003). *GSM, GPRS and EDGE performance: evolution towards 3G/UMTS*. Wiley. Retrieved from http://www.google.com/books?hl=en&lr=&id=eTOQGQtrhWkC&oi=fnd&pg=PR17&dq=The+evolution+of+mobile+communications+in+Europe:+The+transition+from+the+second+to+the+third+generation&ots=L1qkMlRJgb&sig=YkpnE9rT5mi_ZYcHk_9MI44t7sI

Hannafin, M. J., Hannafin, K. M., Land, S. M., & Oliver, K. (1997). Grounded practice and the design of constructivist learning environments. *Educational Technology Research and Development*, *45*(3), 101–117. Retrieved from http://www.springerlink.com/index/42LG7L51H5088T4G.pdf

Harden, R. M. (2002). Learning outcomes and instructional objectives: is there a difference? *Medical Teacher*, *24*(2), 151–155. Retrieved from http://informahealthcare.com/doi/abs/10.1080/0142159022020687

Harris, A. (2008). *Distributed school leadership*. Routledge. Retrieved from http://www.rtuni.org/uploads/docs/Distributed%20School%20Leadership%20alma_harris_2008.pdf

Harris, J., Mishra, P., & Koehler, M. (2009). Teachers' technological pedagogical content knowledge and learning activity types: Curriculum-based technology integration reframed. *Journal of Research on Technology in Education*, *41*(4), 393–416. Retrieved from http://mra.onefireplace.org/Resources/Documents/TPCK%20Article.pdf

Hjorth, L. (2005). Locating Mobility: Practices of co-presence and the persistence of the postal metaphor in SMS/MMS mobile phone customization in Melbourne. *Fibreculture Journal*, *6*, web–page. Retrieved from http://www.fibreculture.org/journal/issue6/issue6_hjorth.html

Hlodan, O. (2010). Mobile learning anytime, anywhere. *BioScience*, *60*(9), 682–682. Retrieved from http://www.bioone.org/doi/abs/10.1525/bio.2010.60.9.4

Hothersall, D. (2003). *History of Psychology* (4th ed.). McGraw-Hill Humanities/Social Sciences/Languages.

Hsieh, C. C., Chen, J. W., Luo, D., Lu, C. C., & Huang, Y. L. (2011). Insights from the Technology System Method for the Development Architecture of e-Textbooks. In *ICDS 2011, The Fifth International Conference on Digital Society* (pp. 205–209). Retrieved from http://www.thinkmind.org/index.php?view=article&articleid=icds_2011_8_30_10192

http://ccoe.umdnj.edu/forms/EffectiveUseofLearningObjectives.pdf - Google leiting. (n.d.). Retrieved February 20, 2013, from https://www.google.dk/search?q=http%3A%2F%2Fccoe.umdnj.edu%2Fforms%2FEffectiveUseofLearningObjectives.pdf&ie=utf-8&oe=utf-8&aq=t&rls=org.mozilla:en-US:official&client=firefox-beta

Huang, Y. M., Chiu, P. S., Liu, T. C., & Chen, T. S. (2011). The design and implementation of a meaningful learning-based evaluation method for ubiquitous learning. *Computers & Education*, *57*(4), 2291–2302. Retrieved from http://www.sciencedirect.com/science/article/pii/S0360131511001291

Hung, D. (2001). Theories of learning and computer-mediated instructional technologies. *Educational Media International*, *38*(4), 281–287. Retrieved from http://www.tandfonline.com/doi/abs/10.1080/09523980110105114

Hycner, R. H. (1985). Some guidelines for the phenomenological analysis of interview data. *Human studies*, *8*(3), 279–303. Retrieved from http://www.springerlink.com/index/g8561256g5382770.pdf

Igbaria, M. (1994). An examination of the factors contributing to microcomputer technology acceptance. *Accounting, Management and Information Technologies*, *4*(4), 205–224. Retrieved from http://www.sciencedirect.com/science/article/pii/095980229490023X

Igbaria, M., & Chakrabarti, A. (1990). Computer anxiety and attitudes towards microcomputer use. *Behaviour & Information Technology*, *9*(3), 229–241. Retrieved from http://www.tandfonline.com/doi/abs/10.1080/01449299008924239

Instructional Design Knowledge Base. (n.d.). Retrieved February 20, 2013, from http://classweb.gmu.edu/ndabbagh/Resources/IDKB/index.htm

Isaacs, S. (2012a). Mobile Learning for Teachers In Africa and the Middle East. *United Nations Educational, Scientific and Cultural Organisation (UNESCO)*.

Isaacs, S. (2012b). Turning on Mobile Learning In Africa and Middle East. *United Nations Educational, Scientific and Cultural Organisation (UNESCO)*.

Johnson, D. W., Johnson, R. T., & Smith, K. A. (1998). Cooperative Learning Returns to College What Evidence Is There That It Works? *Change: The Magazine of Higher Learning*, *30*(4), 26–35. Retrieved from http://www.tandfonline.com/doi/abs/10.1080/00091389809602629

Jonassen, D. H. (1991). Objectivism versus constructivism: Do we need a new philosophical paradigm? *Educational technology research and development*, *39*(3), 5–14. Retrieved from http://www.springerlink.com/index/J008V02U57U71827.pdf

Jonassen, D. H. (1997). Instructional design models for well-structured and III-structured problem-solving learning outcomes. *Educational Technology Research and Development*, *45*(1), 65–94. Retrieved from http://www.springerlink.com/index/F45R2470835N0918.pdf

Jonassen, D. H. (2000). Computers as mindtools for schools: Engaging critical thinking. Retrieved from http://www.getcited.org/pub/100427107

Jonassen, D. H., & Carr, C. S. (2000). Mindtools: Affording multiple knowledge representations for learning. *Computers as cognitive tools*, *2*, 165–196.

Jones, J. W. (1989). Personality and epistemology: Cognitive social learning theory as a philosophy of science. *Zygon®*, *24*(1), 23–38. Retrieved from http://onlinelibrary.wiley.com/doi/10.1111/j.1467-9744.1989.tb00974.x/abstract

Jones, S. (1998). *Cybersociety 2.0: Revisiting computer-mediated community and technology* (Vol. 2). Sage Publications, Incorporated. Retrieved from http://www.google.com/books?hl=en&lr=&id=pmMSzuT61DQC&oi=fnd&pg=PR7&dq=Information,+Internet,+and+Community:+Notes+Towards+an+Understanding+of+Community+in+the+Information+Age&ots=2HuTUyCcNQ&sig=qWUwpjo-CTElfOV8U0x9Us1qNIE

Junglas, I., & Watson, R. T. (2006). The u-constructs: four information drives. *Communications of the Association for Information systems*, *17*(1), 26. Retrieved from http://aisel.aisnet.org/cais/vol17/iss1/26/

Kahiigi, E., Ekenberg, L., & Hansson, M. (2007). Exploring the e-Learning State of art. In *Conference on E-Learning, Academic Conferences Limited* (pp. 349–368). Retrieved from http://www.google.com/books?hl=en&lr=&id=spo9X16qn30C&oi=fnd&pg=PA349&dq=Mobile+learning+in+review%3B+Opportunities+and+challenges+for+learners,+teachers+and+institutions.&ots=rtPADUmUFA&sig=vTnbXJFVibdclDdCiARIvy7qzO0

Kajander, A., & Lovric, M. (2005). Transition from secondary to tertiary mathematics: McMaster University experience. *International Journal of Mathematical Education in Science and Technology*, *36*(2-3), 149–160. Retrieved from http://www.tandfonline.com/doi/abs/10.1080/00207340412317040

Kajumbula, R. (2006). The effectiveness of mobile short messaging service (SMS) technologies in the support of selected distance education students of Makerere University, Uganda. Retrieved from http://pcf4.dec.uwi.edu/viewpaper.php?id=98

Kakihara, M., & Sorensen, C. (2002). Mobility: An extended perspective. In *System Sciences, 2002. HICSS. Proceedings of the 35th Annual Hawaii International Conference on* (pp. 1756–1766). Retrieved from http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=994088

Kasi, P. (2009). *Research: What, Why and How?: a Treatise from Researchers to Researchers*. AuthorHouse.

Kay, A., & Goldberg, A. (1977). Personal dynamic media. *Computer*, *10*(3), 31–41. Retrieved from http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=1646405

Kearney, M., & Treagust, D. F. (2001). Constructivism as a referent in the design and development of a computer program using interactive digital video to enhance learning in physics. *Australian*

Journal of Educational Technology, *17*(1), 64–79. Retrieved from http://www.ascilite.org.au/ajet/ajet17/kearney.html?iframe=true&width=95%&height=95%

Keegan, D. (2004). Mobile learning: the next generation of learning. In *The 18th Asian Association of Open Universities Annual Conference, Shanghai*. Retrieved from http://learning.ericsson.net/mlearning2/files/workpackage5/book.doc

Keegan, D. (2005). The incorporation of mobile learning into mainstream education and training. In *World Conference on Mobile Learning, Cape Town*. Retrieved from http://www.mlearn.org/mlearn2005/CD/papers/keegan1.pdf

Kennedy, D., Hyland, Á., & Ryan, N. (2007). *Writing and using learning outcomes: a practical guide*. University College Cork. Retrieved from http://sss.dcu.ie/afi/docs/bologna/writing_and_using_learning_outcomes.pdf

Kennedy, G. E., Judd, T. S., Churchward, A., Gray, K., & Krause, K. (2008). First year students' experiences with technology: Are they really digital natives. *Australasian Journal of Educational Technology*, *24*(1), 108–122. Retrieved from http://www.ascilite.org.au/ajet/ajet24/kennedy.html

Kleinrock, L. (1996). Nomadicity: anytime, anywhere in a disconnected world. *Mobile networks and applications*, *1*(4), 351–357. Retrieved from http://dl.acm.org/citation.cfm?id=274618

Klenke, K. (2008). *Qualitative Research In The Study Of Leadership*. Emerald Group Publishing.

Koehler, M. J., & Mishra, P. (2008). Introducing tpck. *Handbook of technological pedagogical content knowledge (TPCK) for educators*, 3–29.

Kopomaa, T. (2000). *The city in your pocket: birth of the mobile information society*. Gaudeamus.

Kozma, R. (2000). Qualitative studies of innovative pedagogical practices using technology. *SITES M2 design document, IEA*.

Kozma, R. B. (1991). Learning with media. *Review of educational research*, *61*(2), 179–211. Retrieved from http://rer.sagepub.com/content/61/2/179.short

Kukulska-Hulme, A., Traxler, J., & Pettit, J. (2007). Designed and user-generated activity in the mobile age. *Journal of Learning Design*, *2*(1), 52–65. Retrieved from http://oro.open.ac.uk/8080/

Kumar, K., & Reddy, T. R. (2012). Role of Mobile Communication and Technology Services in Educational Libraries. *International Journal of Librarianship and Administration*, *3*(1), 57–68. Retrieved from http://www.ripublication.com/ijla/ijlav3n1_06.pdf

Kumar, R. (2011). *Research Methodology*. APH Publishing.

Kuutti, K. (1996). Activity theory as a potential framework for human-computer interaction research. *Context and consciousness: Activity theory and human-computer interaction*, 17–44. Retrieved from http://www.google.com/books?hl=en&lr=&id=JeqcgPlS2UAC&oi=fnd&pg=PA17&dq=%27Activity+theory+as+a+potential+framework+for+human-computer+interaction+research&ots=eZgaXzvUEy&sig=TcIcIk2seVYMctRyLcN3NA0YqMA

Lazzouni, M., Yousaf, M., Qureshi, R. A., & Nazir, N. A. (1997, August 26). Pen and paper information recording system using an imaging pen. Retrieved from http://www.google.dk/patents?id=bcUdAAAAEBAJ

Learning theory (education). (2013, January 27). In *Wikipedia, the free encyclopedia*. Retrieved from http://en.wikipedia.org/w/index.php?title=Learning_theory_(education)&oldid=533231703

Lee, H. (1999). Time and information technology: monochronicity, polychronicity and temporal symmetry. *European Journal of Information Systems*, *8*(1), 16–26. Retrieved from http://www.ingentaconnect.com/content/pal/0960085x/1999/00000008/00000001/3000318

Lee, H., & Liebenau, J. (2000). Temporal effects of information systems on business processes: focusing on the dimensions of temporality. *Accounting, Management and Information Technologies*, *10*(3), 157–185. Retrieved from http://www.sciencedirect.com/science/article/pii/S0959802200000035

Leiner, B. M., CERF, V. G., Clark, D. D., Kahn, R. E., Kleinrock, L., Lynch, D. C., … Wolff, S. S. (1997). The Past and Future History of the INTERNET. *Communications of the ACM*, *40*(2). Retrieved from http://www.isoc.org/internet-history

Lennon, J., & Maurer, H. A. (2003). Why it is Difficult to Introduce e-Learning into Schools And Some New Solutions. *J. UCS*, *9*(10), 1244. Retrieved from http://www.jucs.org/jucs_9_10/why_it_is_difficult/Lennon_J.pdf

Leontjev, A. N. (1978). Activity. Consciousness. Personality. Retrieved from http://www.citeulike.org/group/980/article/554897

Lilienfeld, S. O., Lynn, S. J., Namy, L. L., & Woolf, N. J. (2009). *Psychology: A Framework for Everyday Thinking*. Allyn & Bacon, Incorporated.

Lim, C. P. (2007). Effective integration of ICT in Singapore schools: pedagogical and policy implications. *Educational Technology Research and Development*, *55*(1), 83–116. Retrieved from http://www.springerlink.com/index/1372161u03650177.pdf

Lofland, J., & Lofland, L. H. (1995). Analyzing social settings. Retrieved from http://library.mpib-berlin.mpg.de/toc/z2007_865.pdf

Lombardi, S. M. (2011). *Internet Activities for a Preschool Technology Education Program Guided by Caregivers*. North Carolina State University.

Looi, C. K., Seow, P., Zhang, B. H., So, H. J., Chen, W., & Wong, L. H. (2010). Leveraging mobile technology for sustainable seamless learning: a research agenda. *British Journal of Educational Technology*, *41*(2), 154–169. Retrieved from http://onlinelibrary.wiley.com/doi/10.1111/j.1467-8535.2008.00912.x/full

Lowenthal, P., & Wilson, B. G. (2010). Labels do matter! A critique of AECT's redefinition of the field. *TechTrends*, *54*(1), 38–46. Retrieved from http://www.springerlink.com/index/a40453437193u101.pdf

Lumsdaine, A. A. (1964). Educational technology, programmed learning, and instructional science. *Theories of learning and instruction: The sixty-third yearbook of the National Society for the Study of Education, Part*, *1*, 16–18.

MacKenzie, D., & Wajcman, J. (1999). *The social shaping of technology*. Open University Press. Retrieved from http://eprints.lse.ac.uk/28638/

Madden, T. J., Ellen, P. S., & Ajzen, I. (1992). A comparison of the theory of planned behavior and the theory of reasoned action. *Personality and social psychology Bulletin*, *18*(1), 3–9. Retrieved from http://psp.sagepub.com/content/18/1/3.short

Mager, R. F. (1962). *Preparing objectives for programmed instruction* (Vol. 26). Fearon San Francisco. Retrieved from http://library.wur.nl/WebQuery/clc/472402

Mangal. (2009). *Essentials Of Educational Technology*. PHI Learning Pvt. Ltd.

Mason, R. O. (1978). Measuring information output: A communication systems approach. *Information & Management*, *1*(4), 219–234. Retrieved from http://www.sciencedirect.com/science/article/pii/0378720678900289

Masters, K. (2005). Low-key m-learning: a realistic introduction of m-learning to developing countries. *Seeing, Understanding, Learning in the Mobile Age, Budapest, Hungary*. Retrieved from http://www.fil.hu/mobil/2005/Masters_final.pdf

Mathiassen, L. (2002). Collaborative practice research. *Information Technology & People*, *15*(4), 321–345. Retrieved from http://www.emeraldinsight.com/journals.htm?articleid=883572&show=abstract

Mathieson, K. (1991). Predicting user intentions: comparing the technology acceptance model with the theory of planned behavior. *Information systems research*, *2*(3), 173–191. Retrieved from http://infosys.highwire.org/content/2/3/173.short

McDonald, J. K., & Gibbons, A. S. (2009). Technology I, II, and III: Criteria for understanding and improving the practice of instructional technology. *Educational Technology Research and Development*, *57*(3), 377–392. Retrieved from http://www.springerlink.com/index/E1463W641W715135.pdf

McKay, J., & Marshall, P. (2001). The dual imperatives of action research. *Information Technology & People*, *14*(1), 46–59. Retrieved from http://www.emeraldinsight.com/journals.htm?articleid=883540&show=abstract

Merriam, S. B., Caffarella, R. S., & Baumgartner, L. M. (2012). *Learning in adulthood: A comprehensive guide*. Jossey-Bass. Retrieved from http://www.google.com/books?hl=en&lr=&id=ffaKVcPVC84C&oi=fnd&pg=PR3&dq=Learning+in+Adulthood&ots=JUpRz7qHPF&sig=62S3J-nNVgz3kgqskwFnCJSsKNY

Mi, C., & Chen, R. (2007). *Naturalized Epistemology and Philosophy of Science*. Rodopi.

Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis: An expanded sourcebook*. Sage Publications, Incorporated. Retrieved from http://www.google.com/books?hl=en&lr=&id=U4lU_-

wJ5QEC&oi=fnd&pg=PR12&dq=related:GfldC4oXVe8J:scholar.google.com/&ots=kCYA4HMWXR&sig=Y5e9kvrUTHpC5uBlS1Q4VoB4P2s

Mioduser, D., Nachmias, R., Oren, A., & Lahav, O. (1999). Web-based learning environments (WBLE): Current implementation and evolving trends. *Journal of Network and Computer Applications*, *22*(4), 233–247. Retrieved from http://www.sciencedirect.com/science/article/pii/S1084804599900930

Mioduser, D., Nachmias, R., Tubin, D., & Forkosh-Baruch, A. (2002). Models of pedagogical implementation of ICT in Israeli schools. *Journal of Computer Assisted Learning*, *18*(4), 405–414. Retrieved from http://onlinelibrary.wiley.com/doi/10.1046/j.0266-4909.2002.00252.doc.x/full

Mishra, P., & Koehler, M. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. *The Teachers College Record*, *108*(6), 1017–1054. Retrieved from http://www.tcrecord.org/Content.asp?ContentID=12516

Mol, A., & Law, J. (1994). Regions, networks and fluids: anaemia and social topology. *Social studies of science*, *24*(4), 641–671. Retrieved from http://sss.sagepub.com/content/24/4/641.short

Mölder, B. (2010). *Mind Ascribed: An Elaboration and Defence of Interpretivism*. John Benjamins Publishing.

Moore, G. C., & Benbasat, I. (1991). Development of an instrument to measure the perceptions of adopting an information technology innovation. *Information systems research*, *2*(3), 192–222. Retrieved from http://isr.journal.informs.org/content/2/3/192.short

Morton, A. (1999). Ethics in Action Research. *Systemic Practice and Action Research*, *12*(2), 219–222. doi:10.1023/A:1022430231458

Muijs, D. (2010). *Doing Quantitative Research in Education with SPSS*. SAGE.

Muntean, A., & Tomai, N. (2010). A Simple Web Platform Solution for M-Learning. *Informatica Economica*, *14*(1), 172–181. Retrieved from http://www.revistaie.ase.ro/content/53/18%20Muntean,%20Tomai.pdf

Murray, D. L. (2004). *Pragmatism*. Kessinger Publishing.

Mustafa, K. (2005). Implications of Learning Theories for Effective Technology Integration and Pre-service Teacher Training: A Critical Literature Review. *Journal of Turkish Science Education*, *2*.

Muyinda, P. B., Mugisa, E., & Lynch, K. (2007). M-Learning: The Educational Use of Mobile Communication Devices. *Strengthening the Role of ICT in Development*, 72. Retrieved from http://www.cit.mak.ac.ug/iccir/downloads/SREC07.pdf#page=186

Myers, D. G. (2004). *Exploring psychology*. Worth Publishers.

NAB. (2013). *National Accredation Board*. Retrieved May 2, 2013, from http://www.nab.gov.gh/

Nardi, B. A. (1996). Activity theory and human-computer interaction. *Context and consciousness: Activity theory and human-computer interaction*, 7–16. Retrieved from

http://www.google.com/books?hl=en&lr=&id=JeqcgPlS2UAC&oi=fnd&pg=PA7&dq=%27Activity+theory+and+human+computer+interaction%27,+In+B.A+Nardi+(Ed),+Context+and+Consciousness:+Activity+Theory+and+Human-Computer+Interaction&ots=eZgaXzuYLw&sig=0QcLlq_zjdjQfV4gM8VP7yG0zEc

Nastasi, B. K. (1990). Social-cognitive interactions, motivation, and cognitive growth in Logo programming and CAI problem-solving environments. *Journal of Educational Psychology*, *82*(1), 150–58. Retrieved from http://www.eric.ed.gov/ERICWebPortal/recordDetail?accno=EJ442305

Nelson, D. L. (1990). Individual adjustment to information-driven technologies: a critical review. *MIS Quarterly*, 79–98. Retrieved from http://www.jstor.org/stable/10.2307/249311

Newman, I., & Benz, C. R. (1998). *Qualitative-Quantitative Research Methodology: Exploring the Interactive Continuum*. SIU Press.

News. (n.d.). Retrieved February 16, 2013, from http://ghana.worlded.org/News.htm

Niess, M. L. (2005). Preparing teachers to teach science and mathematics with technology: Developing a technology pedagogical content knowledge. *Teaching and Teacher Education*, *21*(5), 509–523. Retrieved from http://www.sciencedirect.com/science/article/pii/S0742051X05000387

Nissen, H.-E., Klein, H. K., & Hirschheim, R. (1991). *Information systems research: contemporary approaches and emergent traditions*. Elsevier North-Holland, Inc. Retrieved from http://dl.acm.org/citation.cfm?id=137128

O'Malley, C., Vavoula, G., Glew, J. P., Taylor, J., Sharples, M., Lefrere, P., … Waycott, J. (2005). Guidelines for learning/teaching/tutoring in a mobile environment. Retrieved from http://telearn.archives-ouvertes.fr/hal-00696244/

Oliver, K., & Hannafin, M. J. (2000). Student management of web-based hypermedia resources during open-ended problem solving. *The Journal of Educational Research*, *94*(2), 75–92. Retrieved from http://heldref-publications.metapress.com/index/V52376H8841771LL.pdf

Omwenga, E. I., & Rodrigues, A. (2009). Towards an Education Evaluation Framework: Synchronous and Asynchronous e-Learning Cases. *Journal of the Research Center for Educational Technology*, *2*(1), 46–59. Retrieved from http://www.rcetj.org/index.php/rcetj/article/viewArticle/108

OReilly, T. (2007). What is Web 2.0: Design patterns and business models for the next generation of software. *Communications & strategies*, (1), 17. Retrieved from http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1008839

Papert, S. (1980). *Mindstorms: Children, computers, and powerful ideas*. Basic Books, Inc. Retrieved from http://dl.acm.org/ft_gateway.cfm?id=1095592&type=pdf

Pavlov, I. P. (1927). *Conditioned reflexes: an investigation of the physiological activity of the cerebral cortex. Translated and edited by GV Anrep*. London: Oxford University Press.

Peirce, C. S. (1905). What pragmatism is. *The Monist*, *15*(2), 161–181. Retrieved from http://www.jstor.org/stable/10.2307/27899577

Pellegrino, G. (2011). *The Politics of Proximity: Mobility and Immobility in Practice*. Ashgate Publishing. Retrieved from http://www.google.com/books?hl=en&lr=&id=rel9OHSRo1EC&oi=fnd&pg=PR7&dq=mobility+and+Virtual+Omnipresence+Status&ots=mxhHbOwrKR&sig=h6XtK905h6aZ-hhpwzhRvmWB0ZY

Peng, H., Su, Y.-J., Chou, C., & Tsai, C.-C. (2009). Ubiquitous knowledge construction: Mobile learning re-defined and a conceptual framework. *Innovations in Education and Teaching International*, *46*(2), 171–183. Retrieved from http://www.tandfonline.com/doi/abs/10.1080/14703290902843828

Petter, S., DeLone, W., & McLean, E. (2008). Measuring information systems success: models, dimensions, measures, and interrelationships. *European Journal of Information Systems*, *17*(3), 236–263. Retrieved from http://www.palgrave-journals.com/uidfinder/10.1057/ejis.2008.15

Pfister, J. (2007). *The Metaphysics and the Epistemology of Meaning*. ontos verlag.

Piaget, J. (1952). The origins of intelligence in children. Retrieved from http://psycnet.apa.org/psycinfo/2007-10742-001

Pintrich, P. R. (2002). *Personal Epistemology: The Psychology of Beliefs About Knowledge and Knowing*. Routledge.

Prensky, M. (2001). Digital natives, digital immigrants Part 2: Do they really think differently? *On the horizon*, *9*(6), 1–6. Retrieved from http://www.emeraldinsight.com/journals.htm?articleid=1532747&show=abstract

Quinn, C. (2000). mLearning: mobile, wireless, in-your-pocket learning. *LiNE Zine*, *2006*.

Rabiee, F. (2004). Focus-group interview and data analysis. *Proceedings of the nutrition society*, *63*(4), 655. Retrieved from http://journals.cambridge.org/production/action/cjoGetFulltext?fulltextid=902312

Reeves, T. C., Herrington, J., & Oliver, R. (2005). Design research: A socially responsible approach to instructional technology research in higher education. *Journal of Computing in Higher Education*, *16*(2), 96–115. Retrieved from http://www.springerlink.com/index/xq235710213h0226.pdf

Resnick, L. B. (1987). *Education and learning to think*. National Academies Press. Retrieved from http://www.google.com/books?hl=en&lr=&id=U1nhg32qTE8C&oi=fnd&pg=PA1&dq=Education+and+learning+to+think.&ots=5Gb4YiAdZp&sig=AAQrDkCLar529lvTAhnE1buHBVU

Richey, R. C., Silber, K. H., & Ely, D. P. (2008). Reflections on the 2008 AECT Definitions of the Field. *TechTrends*, *52*(1), 24–25. Retrieved from http://www.springerlink.com/index/88P665MV0P527470.pdf

Riddell, W. C., & Song, X. (2012). The role of education in technology use and adoption: Evidence from the Canadian workplace and employee survey. Retrieved from http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2015193

Rieber, L. P. (1992). Computer-based microworlds: A bridge between constructivism and direct instruction. *Educational Technology Research and Development*, *40*(1), 93–106. Retrieved from http://www.springerlink.com/index/225867182tk44716.pdf

Rivard, S., Poirier, G., Raymond, L., & Bergeron, F. (1997). Development of a measure to assess the quality of user-developed applications. *SIGMIS Database*, *28*(3), 44–58. doi:10.1145/272657.272690

rLG Distributes "Better Ghana" Laptops. (2012). *Daily Guide Newspaper*. Retrieved May 2, 2013, from http://www.dailyguideghana.com/?p=68625

Roschelle, J. (2003). Unlocking the learning value of wireless mobile devices. *Journal of Computer Assisted Learning*, *19*(3), 260–272.

Roschelle, Jeremy, & Pea, R. (2002). A walk on the WILD side: How wireless handhelds may change CSCL. In *Proceedings of the Conference on Computer Support for Collaborative Learning: Foundations for a CSCL Community* (pp. 51–60). Retrieved from http://dl.acm.org/citation.cfm?id=1658624

Russell, G., & Bradley, G. (1997). Teachers' computer anxiety: Implications for professional development. *Education and Information Technologies*, *2*(1), 17–30. Retrieved from http://www.springerlink.com/index/G584031U27856067.pdf

Ryu, H., & Parsons, D. (2009). Innovative Mobile Learning. *Information Science, New York, NY, USA*. Retrieved from http://sutlib2.sut.ac.th/sut_contents/H123452.pdf

Sahakian, W. S. (1976). *Introduction to the Psychology of Learning*. Rand McNally College Publishing Company. Retrieved from http://www.getcited.org/pub/101587728

Santiago, P., Tremblay, K., Basri, E., & Arnal, E. (2008). *Tertiary education for the knowledge society: OECD thematic review of tertiary education: synthesis report*. Organisation for Economic Co-operation and Development, OECD. Retrieved from http://www.voced.edu.au/content/ngv20398

Sarsby, J. (1984). The fieldwork experience. *Ethnographic research: a guide to General conduct*, 87–132.

Sawyerr, A. (2004). Challenges facing African universities: selected issues. *African studies review*, 1–59. Retrieved from http://www.jstor.org/stable/10.2307/1514797

Schank, R. C., & Jona, M. Y. (1991). Empowering the student: New perspectives on the design of teaching systems. *The Journal of the Learning Sciences*, *1*(1), 7–35. Retrieved from http://www.tandfonline.com/doi/abs/10.1207/s15327809jls0101_2

Schmidt, D. A., Baran, E., Thompson, A. D., Mishra, P., Koehler, M. J., & Shin, T. S. (2009). Technological pedagogical content knowledge (TPACK): The development and validation of an assessment instrument for preservice teachers. *Journal of Research on Computing in*

Education, *42*(2), 123. Retrieved from http://learnonline.canberra.edu.au/pluginfile.php/491591/mod_page/content/1/TPACK_UC/pdf/tpack4_preservice2.pdf

Schramm, W. (1997). How communication works. *Mass media & society*, 51–66. Retrieved from http://www.google.com/books?hl=en&lr=&id=i8_wl32zQf8C&oi=fnd&pg=PA51&dq=How+Communication+Works&ots=A898o44-4C&sig=SJ6BzSH_lr6g2lo9aFN2kRPEBN0

Sedera, D., & Gable, G. G. (2004). A factor and structural equation analysis of the enterprise systems success measurement model. Retrieved from http://eprints.qut.edu.au/4733/

Selwyn, N. (1999). Why the computer is not dominating schools: a failure of policy or a failure of practice? *Cambridge Journal of Education*, *29*(1), 77–91. Retrieved from http://www.tandfonline.com/doi/abs/10.1080/0305764990290106

Semple, A. (2000). Learning theories and their influence on the development and use of educational technologies. *Australian Science Teachers Journal*, *46*(3), 21–28. Retrieved from https://www.hadassah.org.il/NR/rdonlyres/E50BA60A-F482-457B-ACCE-EE10A82C5C5A/22862/sempel.pdf

Sevari, K. (2012). the role of mobile phones in education and instruction of classroom materials - Google Search. *Advances in Education*, *1*(1), 19–21. Retrieved from https://www.google.dk/search?q=The+Role+of+Mobile+Phones+in+Education+and+Instruction+of+Classroom+Materials&ie=utf-8&oe=utf-8&aq=t&rls=org.mozilla:en-US:official&client=firefox-beta

Shannon, C. E., Weaver, W., Blahut, R. E., & Hajek, B. (1949). *The mathematical theory of communication* (Vol. 117). University of Illinois press Urbana. Retrieved from http://guohanwei.51.net/code/A%20Mathematical%20Theory%20of%20Communication.pdf

Sharples, M. (2000). The design of personal mobile technologies for lifelong learning. *Computers & Education*, *34*(3), 177–193. Retrieved from http://www.sciencedirect.com/science/article/pii/S0360131599000445

Sheller, M., & Urry, J. (2006). The new mobilities paradigm. *Environment and Planning*, *38*, 207–226. doi:10.1068/a37268

Sheppard, B. H., Hartwick, J., & Warshaw, P. R. (1988). The theory of reasoned action: A meta-analysis of past research with recommendations for modifications and future research. *Journal of Consumer research*, 325–343. Retrieved from http://www.jstor.org/stable/10.2307/2489467

Shield, G. (2000). A critical appraisal of learning technology using information and communication technologies. Retrieved from http://scholar.lib.vt.edu/ejournals/JTS/Winter-Spring-2000/shield.html

Shim, J. P., Varshney, U., Dekleva, S., & Knoerzer, G. (2006). Mobile and wireless networks: services, evolution and issues. *International Journal of Mobile Communications*, *4*(4), 405–417. Retrieved from http://inderscience.metapress.com/index/6GB8PWE5YDK9K1QD.pdf

Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. *Educational researcher*, 4–14. Retrieved from http://www.jstor.org/stable/10.2307/1175860

Silverstone, R., Haddon, L., In Silverstone, R., & Mansell, R. (1996). Design and the domestication of ICTs: technical change and everyday life. *Communicating by Design: The Politics of Information and Communication Technologies. Oxford: Oxford University Press. p44–74*. Retrieved from http://webfirstlive.lse.ac.uk/media@lse/WhosWho/AcademicStaff/LeslieHaddon/DesignandDomestication.pdf

Simon, B., & Taylor, J. (2009). What is the value of course-specific learning goals. *Journal of College Science Teaching*, *39*(2), 52–57. Retrieved from http://www.cwsei.ubc.ca/SEI_research/files/LifeSci/Simon_Taylor_ValueOfCourseSpecificLG.pdf

Sjolander, C. T., & Cox, W. S. (1994). *Beyond Positivism: Critical Reflections on International Relations*. Lynne Rienner Publishers.

Skinner, B. F. (1954). *The science of learning and the art of teaching*. Cambridge, Mass, USA. Retrieved from http://www.google.com/books?hl=en&lr=&id=24XeCuGWTj0C&oi=fnd&pg=PA301&dq=The+Science+of+Learning+and+the+Art+of+Teaching&ots=SrBQR5YMOe&sig=mj-5tWlg5NYoQhv28yitHQvZfP8

Skinner, B. F. (1960). Teaching machines. *The Review of Economics and Statistics*, 189–191. Retrieved from http://www.jstor.org/stable/10.2307/1926170

Smith, J. A. (2007a). Hermeneutics, human sciences and health: linking theory and practice. *International Journal of Qualitative Studies on Health and Well-being*, *2*(1), 3–11. Retrieved from http://informahealthcare.com/doi/abs/10.1080/17482620601016120

Smith, J. A. (2007b). *Qualitative psychology: a practical guide to research methods*. Sage Publications Limited. Retrieved from http://www.google.com/books?hl=en&lr=&id=D5xHYpXVDaAC&oi=fnd&pg=PR5&dq=phenomenology+and+smith+2007&ots=QxSUZwvJWa&sig=kCH4zIMBJfoHnjEKI_VdJPA_MOU

Smith, J. A., Flowers, P., & Larkin, M. (2009). *Interpretative Phenomenological Analysis: Theory, Method and Research*. SAGE.

Smith, S., Booth, K., & Zalewski, M. (1996). *International Theory: Positivism and Beyond*. Cambridge University Press.

Soloway, E., Grant, W., Tinker, R., Roschelle, J., Mills, M., Resnick, M., … Eisenberg, M. (1999). Science in the palms of their hands. *Communications of the ACM*, *42*(8), 21–27. Retrieved from http://llk.media.mit.edu/papers/archive/p21-soloway.pdf

Somekh, B., & Davies, R. (1991). Towards a pedagogy for information technology. *The Curriculum Journal*, *2*(2), 153–170. Retrieved from http://www.tandfonline.com/doi/abs/10.1080/0958517910020205

Somekh, B., & Lewin, C. (2005). *Research Methods in the Social Sciences*. SAGE.

Soulsby, E. (2011). *How to write program objectives/outcomes*. Accessed online at: http://www. assessment. uconn. edu.

Stuart, I., McCutcheon, D., Handfield, R., McLachlin, R., & Samson, D. (2002). Effective case research in operations management: a process perspective. *Journal of Operations Management*, *20*(5), 419–433. Retrieved from http://www.sciencedirect.com/science/article/pii/S0272696302000220

Stultz, S. L. (2008). *The Effectiveness of Computer-assisted Instruction for Teaching Mathematics to Students with Specific Learning Disability*. ProQuest.

Tam, M. (2000). Constructivism, instructional design, and technology: Implications for transforming distance learning. *Educational Technology & Society*, *3*(2), 50–60. Retrieved from http://www.ifets.info/journals/3_2/tam.html

Tarasewich, P. (2003). Designing mobile commerce applications. *Communications of the ACM*, *46*(12), 57–60. Retrieved from http://dl.acm.org/citation.cfm?id=953489

Tashakkori, A., & Teddlie, C. (2002). *Handbook of mixed methods in social & behavioral research*. Sage Publications, Incorporated. Retrieved from http://www.google.com/books?hl=en&lr=&id=F8BFOM8DCKoC&oi=fnd&pg=PR9&dq=Social+research+methods:+qualitative+and+quantitative+approaches&ots=gTgMzAnsRc&sig=QET_ds28jB66J3Bv-9IV41AQDyU

Tashakkori, A., & Teddlie, C. (2008). *Foundations of mixed methods research: Integrating quantitative and qualitative approaches in the social and behavioral sciences*. Sage Publications, Incorporated. Retrieved from http://www.google.com/books?hl=en&lr=&id=XvMAYYvS1rEC&oi=fnd&pg=PT1&dq=the+foundations+of+social+research:+meaning+and+perspective+in+the+research+process&ots=hMxnKM5jUp&sig=aCwuoCpmSMQ5Ei578lazk_LcSuc

Tavangarian, D., Leypold, M. E., Nölting, K., Röser, M., & Voigt, D. (2004). Is e-learning the Solution for Individual Learning. *Electronic Journal of E-learning*, *2*(2), 273–280. Retrieved from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.116.8017&rep=rep1&type=pdf&a=bi&pagenumber=1&w=100

Tawiah, V. N. (2006). *Assessment of linkages between the JSS Pre-Vocational Skills Programme and the SSS Visual Arts Programmes: A Case Study Of Selected Schools in Akwapim South District of Eastern Region, Ghana.* Retrieved from http://dspace.knust.edu.gh:8080/xmlui/handle/123456789/739

Taylor, J., Sharples, M., O'Malley, C., & Vavoula, G. (2006). Towards a task model for mobile learning: a dialectical approach. *International Journal of Learning Technology*, *2*(2), 138–158. Retrieved from http://inderscience.metapress.com/index/34XNW24J6HB12DAH.pdf

Taylor, S., & Todd, P. A. (1995). Understanding information technology usage: A test of competing models. *Information systems research*, *6*(2), 144–176. Retrieved from http://isr.journal.informs.org/content/6/2/144.short

Teaching and Learning Resources / Learning Theories. (n.d.). Retrieved February 20, 2013, from http://teachinglearningresources.pbworks.com/w/page/19919565/Learning%20Theories

Tearle, P. (2003). ICT implementation: What makes the difference? *British Journal of Educational Technology*, *34*(5), 567–583. Retrieved from http://onlinelibrary.wiley.com/doi/10.1046/j.0007-1013.2003.00351.x/full

Tessmer, M., & Richey, R. C. (1997). The role of context in learning and instructional design. *Educational Technology Research and Development*, *45*(2), 85–115. Retrieved from http://www.springerlink.com/index/7LW260N449223814.pdf

Thompson, R. L., Higgins, C. A., & Howell, J. M. (1994). Influence of experience on personal computer utilization: testing a conceptual model. *Journal of Management Information Systems*, 167–187. Retrieved from http://www.jstor.org/stable/10.2307/40398123

Thompson, R. L., Higins, C. A., & Howell, J. M. (1991). CANADA N6A 3K7. *MIS quarterly*, 125. Retrieved from http://ais.bepress.com/cgi/viewcontent.cgi?article=2152&context=misq

Thorndike, E. L. (1932). The fundamentals of learning. Retrieved from http://psycnet.apa.org/psycinfo/2006-04535-000

Thornton, P., & Houser, C. (2004). Using mobile phones in education. In *Wireless and Mobile Technologies in Education, 2004. Proceedings. The 2nd IEEE International Workshop on* (pp. 3–10). Retrieved from http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=1281326

Tinio, V. L. (2003). *ICT in Education*. e-ASEAN Task Force. Retrieved from http://www.saigontre.com/FDFiles/ICT_in_Education.PDF

Todes, D. P. (1997). Pavlov's physiology factory. *Isis*, 205–246. Retrieved from http://www.jstor.org/stable/10.2307/236572

Traxler, J. (2005). Mobile Learning-it's here but what is it? *Interactions*, *9*(1).

Traxler, John. (2007). Defining, Discussing and Evaluating Mobile Learning: The moving finger writes and having writ.... *The International Review of Research in Open and Distance Learning*, *8*(2). Retrieved from http://www.irrodl.org/index.php/irrodl/article/viewArticle/346

Traxler, John. (2009a). Current state of mobile learning1. *Mobile learning*, 9. Retrieved from http://books.google.com/books?hl=en&lr=&id=Itp60WteuJsC&oi=fnd&pg=PA9&dq=mobile+learning+projects+in+africa&ots=5XITH9DOog&sig=LK8IlV9J8tfHqh42KgCpFxqoggc

Traxler, John. (2009b). The evolution of mobile learning. *The evolution of mobile teaching and learning*, 1–14. Retrieved from http://www.google.com/books?hl=en&lr=&id=Cz5SCEaHNAMC&oi=fnd&pg=PA1&dq=The+Evolution+of+Mobile+Learning&ots=U327TXp-TA&sig=gS6fMQAf6OZRdf7jOgs9vPbyjHU

Traxler, John, & Kukulska-Hulme, A. (2005). Evaluating mobile learning: Reflections on current practice. Retrieved from http://oro.open.ac.uk/12819/

Traxler, John, & Leach, J. (2006). Innovative and sustainable mobile learning in Africa. In *Wireless, Mobile and Ubiquitous Technology in Education, 2006. WMUTE'06. Fourth IEEE International*

Workshop on (pp. 98–102). Retrieved from http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=4032531

Triandis, H. C. (1989). The self and social behavior in differing cultural contexts. *Psychological Review; Psychological Review*, *96*(3), 506. Retrieved from http://psycnet.apa.org/journals/rev/96/3/506/

Trochim, W. M. (2000). The Research Method Knowledge Base, 2nd edition. *Atomic Dog Publishing*.

Trombley, B. K., & Lee, D. (2002). Web-based Learning in Corporations: who is using it and why, who is not and why not? *Journal of Educational Media*, *27*(3), 137–146. Retrieved from http://www.tandfonline.com/doi/abs/10.1080/1358165020270305

Uden, L. (2007). Activity theory for designing mobile learning. *International Journal of Mobile Learning and Organisation*, *1*(1), 81–102. Retrieved from http://inderscience.metapress.com/index/EW9VEADD3EUFJHV3.pdf

Urry, J. (2000). *Sociology beyond societies: mobilities for the twenty first century*. Routledge.

Vallerand, R. J. (1997). Toward a hierarchical model of intrinsic and extrinsic motivation. *Advances in experimental social psychology*, *29*, 271–360. Retrieved from http://www.sciencedirect.com/science/article/pii/S0065260108600192

Vallerand, R. J. (2000). Deci and Ryan's self-determination theory: A view from the hierarchical model of intrinsic and extrinsic motivation. *Psychological Inquiry*, *11*(4), 312–318. Retrieved from http://www.jstor.org/stable/10.2307/1449629

Vallerand, R. J., Pelletier, L. G., Blais, M. R., Briere, N. M., Senecal, C., & Vallieres, E. F. (1992). The Academic Motivation Scale: A measure of intrinsic, extrinsic, and amotivation in education. *Educational and psychological measurement*, *52*(4), 1003–1017. Retrieved from http://epm.sagepub.com/content/52/4/1003.short

Van Maanen, J., & Kolb, D. (1982). *The Professional Apprentice: Observations on Fieldwork Roles in Two Organizational Settings.* DTIC Document. Retrieved from http://oai.dtic.mil/oai/oai?verb=getRecord&metadataPrefix=html&identifier=ADA117035

Vavoula, G. N., & Sharples, M. (2002). KLeOS: A personal, mobile, knowledge and learning organisation system. In *Wireless and Mobile Technologies in Education, 2002. Proceedings. IEEE International Workshop on* (pp. 152–156). Retrieved from http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=1039239

Venezky, R. L., & Davis, C. (2002). Quo vademus? The transformation of schooling in a networked world. *Version 8c. OECD Centre for Educational Research and Innovation, Paris.(www. oecd. org/pdf/M00027000/M00027107. pdf)*. Retrieved from http://akgul.bilkent.edu.tr/egitim/vademus-oecd-k12.pdf

Venkatesh, V., & Bala, H. (2008). Technology acceptance model 3 and a research agenda on interventions. *Decision Sciences*, *39*(2), 273–315. Retrieved from http://onlinelibrary.wiley.com/doi/10.1111/j.1540-5915.2008.00192.x/full

Venkatesh, V., & Davis, F. D. (2000). A theoretical extension of the technology acceptance model: Four longitudinal field studies. *Management science*, *46*(2), 186–204. Retrieved from http://mansci.journal.informs.org/content/46/2/186.short

Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003a). User acceptance of information technology: Toward a unified view. *MIS quarterly*, 425–478. Retrieved from http://www.jstor.org/stable/10.2307/30036540

Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003b). User acceptance of information technology: Toward a unified view. *MIS quarterly*, 425–478. Retrieved from http://www.jstor.org/stable/10.2307/30036540

Vodafone Ghana » About eLearning @ Vodafone. (n.d.). Retrieved February 16, 2013, from http://www.vodafone.com.gh/Internet-Cafes/Internet-cafe/eLearning-@-Vodafone-Ghana/About-eLearning-@-Vodafone.aspx

Vygotsky, L. (1978). Mind in society. Retrieved from http://www.citeulike.org/group/1912/article/563607

WAECDIRECT ONLINE - RESULT CHECKER. (n.d.). Retrieved February 16, 2013, from http://www.waecdirect.org/

Walliman, N. (2006). *Social research methods*. Sage Publications Limited. Retrieved from http://www.google.com/books?hl=en&lr=&id=QLnjo5OG6UMC&oi=fnd&pg=PA1&dq=Social+research+methods&ots=KCySyvit6Z&sig=RryTm1ifi9DaUqaBECkCoNe7dTY

White, L. (1940). Technology and Invention in the Middle Ages. *Speculum*, *15*(2), 141–159. doi:10.2307/2849046

Williamson, G. R., & Prosser, S. (2002). Action research: politics, ethics and participation. *Journal of Advanced Nursing*, *40*(5), 587–593. Retrieved from http://onlinelibrary.wiley.com/doi/10.1046/j.1365-2648.2002.02416.x/full

Wilson, J. (2001). Lessons of a virtual timetable: Education. *The Economist*, *17*(4), 27–41.

Woodbridge, R. (2011, March 17). Mobile: The Key to Education Anywhere. *GigaOM*. Retrieved December 27, 2012, from http://gigaom.com/mobile/mobile-the-key-to-education-anywhere/

Wulf, R. (1996). The historical roots of Gestalt therapy theory. *Gestalt Dialogue: Newsletter for the Integrative Gestalt Centre*. Retrieved from http://www.gestalt-annarbor.org/Reading_Room/historical_roots.pdf

Yanow, D. (2003). Interpretive empirical political science: What makes this not a subfield of qualitative methods. *Qualitative Methods*, *1*(2), 9–13. Retrieved from http://class.csueastbay.edu/publicadmin/dyanow/qualmeth.pdf

Yin, R. K. (2002). *Case study research: Design and methods* (Vol. 5). SAGE Publications, Incorporated.

Yin, R. K. (2008). *Case study research: Design and methods* (Vol. 5). Sage Publications, Incorporated.

Yount, W. (2010). *Created to learn: A Christian teacher's introduction to educational psychology*. B&H Academic. Retrieved from http://www.google.com/books?hl=en&lr=&id=34ptvk9g7iYC&oi=fnd&pg=PR9&dq=Created+to+Learn&ots=AOgkhtO45N&sig=OE0zYGpwQYFS7p6FY0OLaCKfe48

Yuen, A. H., Law, N., & Wong, K. C. (2003). ICT implementation and school leadership: Case studies of ICT integration in teaching and learning. *Journal of Educational Administration*, *41*(2), 158–170. Retrieved from http://www.emeraldinsight.com/journals.htm?articleid=839261&show=abstract

Zigurs, I., & Buckland, B. K. (1998). A theory of task/technology fit and group support systems effectiveness. *Mis Quarterly*, 313–334. Retrieved from http://www.jstor.org/stable/10.2307/249668

Zubroff, S. (1988). *In the age of the smart machine*. London: Heinemann.

Zurita, G., & Nussbaum, M. (2007). A conceptual framework based on activity theory for mobile CSCL. *British Journal of Educational Technology*, *38*(2), 211–235. Retrieved from http://onlinelibrary.wiley.com/doi/10.1111/j.1467-8535.2006.00580.x/full

APPENDICES

Appendix A Interview questions

Interview Questions -1

RQ1 What are the challenging issues which obstruct the effective incorporation of m-learning in tertiary education?

1. As a teacher/student, what are some of the difficulties you encounter as you use the m-learning system?
2. Can you enumerate some of the challenges associated with the use of mobile phones, tablet and other portable mobile computing devices for learning?
3. Can you share your personal challenging experience of using the m-learning system with me?

RQ2 In which ways do these challenging issues affect the implementation and integration of m-learning in tertiary education?

1. In your opinion how do these challenges affect the implementation m-learning?
2. What do you think are the consequences of these challenges on the use of m-learning for teaching and learning?
3. What do you think must be done to resolve the problem?
4. Can you share with me how these challenges have affect your use of the m-learning system?

RQ3 To what extent is the blend of mobile learning and face-to-face going to enhance teaching and learning?

1. What is the relevance of m-learning to you as a teacher or student?
2. What is the necessity of m-learning in CUC?
3. What is the impact of m-learning on your academic activities?
4. How has the introduction of m-learning influenced teaching and learning?
5. How will you assess the use of m-learning as a tool for teaching and learning?

RQ4 What are the challenges of using mobile computing in tertiary education for teaching and learning?

1. What are the challenging issues associated with the use of mobile computing devices for the purpose of teaching and learning?
2. How do these challenges affect the use mobile devices for teaching and learning?
3. What is your personal challenging experience with regards to using your mobile device for teaching and learning?

RQ5 How mobile learning systems should be designed and developed in other to meet the pedagogic framework of tertiary education?

1. How do you assess the m-learning system as an educational tool for teaching and learning?
2. In your opinion what do you expect from an m-learning system?
3. Can you enumerate some features and functions that you think an m-learning system should have?

STUMP Interview Questions -2

Skill, Interest & Knowledge

1. Are you a computer literate?
2. Have you been trained to use the m-learning?
3. Do like using your mobile phone/tablet for browsing?
4. Why do you like using your mobile phone or tablet for browsing?
5. Personally do you like the concept of m-learning?
6. What makes you like the m-learning concept?
7. Do you know the educational usefulness of the m-learning system?
8. How useful is the m-learning to teaching and learning?
9. How will assess your skill, interest and knowledge of the m-learning system?

Technical Issues & Time

1. How will you assess the m-learning system quality in terms of efficiency among others?
2. How will you assess the m-learning information quality in term of content and output?
3. How will you assess the m-learning service quality in terms of technical support?
4. What is your opinion on the time factor of the m-learning implementation and use?

User's Social Cognitive Composition

1. Do you have affect for m-learning?
2. What is your attitude toward the use of mobile device for teaching and learning?
3. How do you perceive the idea of m-learning?
4. How does your previous experience of a similar system affect your use of the m-learning system?
5. How does your social and cultural affiliations affect your desire to use the m-learning system?
6. How does the organisational cultural affect the implementation of m-learning?
7. Does the educational cultural in Ghana provide opportunities for the use m-learning?
8. How do people perceive the concept of m-learning?

Motivation

1. What the things that will motivate you to use the m-learning system?
2. How well are you motivated to use the system?
3. How will you assess your motivation level to use the system?

Pedagogic Relevance

1. How appropriate is m-learning for teaching and learning?
2. How adaptable is m-learning to the pedagogic framework of tertiary education?
3. Hoe convenient is it to use mobile computing devices for teaching and learning?
4. How does m-learning influence your teaching or learning task?

Appendix B Survey questionnaire

Survey Questions -1

Skills, Interest and Knowledge

Answer questions S1-3 by selecting from options 1 - 5 ➡		1 Poor	2 Fair	3 Good	4 Very Good	5 Excellent
S1	How will you assess your level of skills to use the system?					
S2	How will you assess your level of interest to use the system?					
S3	How will you rate your understanding of m-learning with regards to teaching and learning?					
S4	How will you rate the ease of use of the system?					

Time and Technical Issues

Answer question T1-4 by selecting from options 1 to 5 ➡		1 Poor	2 Fair	3 Good	4 Very Good	5 Excellent
T1	How will you assess the system quality of the m-learning platform?					
T2	How will you assess the service quality of the m-learning platform?					
T3	How will you assess the information quality of the m-learning platform?					
T4	How will you assess the time factor of the implementation and use of the system					

User's Social Cognitive Perception

Answer question U1-6 by selecting from options 1 to 5 ➡		1 Strongly Disagree	2 Disagree	3 Neither Agree Nor Disagree	4 Agree	5 Strongly Agree
U1	You now have a positive attitude toward the use of the system?					
U2	You have develop affection for the use of m-learning system?					
U3	I now have the self-efficacy to use the system?					
U4	My social cultural background do not affect me in using the system					

U5	Organisational cultural and norms do affect me in using the system?					
U6	The use of the system meets my personal expectation?					

Motivation

Answer question M1-3 by selecting from options 1-5 ➡		1 Poor	2 Fair	3 Good	4 Very Good	5 Excellent
M1	How will you assess the satisfaction of your intrinsic motivation to use the system?					
M2	How will you assess the provision of extrinsic motivation to use the system?					
M3	How will you asses the facilitating conditions to aid in using the system?					

Pedagogy

Answer question P1-4 by selecting from options 1 to 5 ➡		1 Strongly Disagree	2 Disagree	3 Neither Agree Nor Disagree	4 Agree	5 Strongly Agree
P1	Using the system fit my job task					
P2	I perceive the system to be useful for teaching and learning					
P3	Using the system meet my performance expectation					
P4	The usage of the system is compatible to the ethic of teaching and learning					

Survey Questions -2

Skills, Interest and Knowledge

Answer questions S1-9 by selecting from options 1 or 2 ➡		0 NO	1 YES			
S1	Are you a computer literate? (That is have knowledge of MS office, internet).					
S2	Do you like the concept of m-learning?					
S3	Do you use your phone/tablet to browse?					
S4	Do you use your laptop/notebook to browse?					
S5	Do you have training on how to use the system?					
S6	You have received enough training that will enable you to use the m-learning platform confidently.					
S7	You are enthusiastic to use the system.					

S8	You like using your smart phone for browsing, sending SMS, emails, file attachment etc.					
S9	You have knowledge on the usefulness of the system for teaching and learning.					
S10	It is difficult to use the system					
Answer question S10 by selecting from options 1 to 5 ➡		1 A Few Days	2 A Few Weeks	3 Over a Months	4 Full Semester	5 Over a Semester
S11	For how long have you been using m-learning?					
Answer question S11 – 12 by selecting from options 1 to 5 ➡		1 Daily	2 Weekly	3 Monthly	4 Occasionally	5 Never
S12	How often do you use your phone/ tablet for browsing?					
S13	How often do you use your laptop/ notebook for browsing?					

Time and Technical Issues

		1	2	3	4	5
Answer question T1-T8 by selecting from options 1 to 5 ➡		Strongly Disagree	Disagree	Neither Agree Nor Disagree	Agree	Strongly Agree
T1	It takes a lot of time to create and format content on the m-learning platform?					
T2	Uploading and downloading content on the platform takes too much time. (Because it requires a high bandwidth).					
T3	It is difficult to get internet connectivity anytime anywhere on your mobile phone.					
T4	It saves lot of time for teaching and learning.					
T5	It saves lot of time for conducting multiple choice examinations.					
T6	Generally using the m-learning platform for teaching and learning takes too much of my time.					
T7	The m-learning system is reliable.					
T8	Availability of the m-learning system promotes teaching and learning anytime anywhere.					
T9	The system provides simple but comprehensive tools for teaching and learning					
Answer question T9-17 by selecting from options 1 to 5		1 Poor	2 Fair	3 Good	4 Very Good	5 Excellent
T10	How do you evaluate the ease of utilizing the capability of the m-learning platform? ➡					
T11	How will you rate the Human Computer Interaction of the m-learning platform?					
T12	How will you evaluate the ease of understanding of the m-learning platform?					
T13	How will you evaluate the ease of using the system to create content?					
T14	How will you evaluate the navigation interface of the platform?					
T15	How will you evaluate the set of vocabulary, syntax, and grammatical rules used to interact with the m-learning platform?					

T16	How do you evaluate the ability of the m-learning platform to change or adapt to new conditions, demands or circumstances of education?					
T17	How good is the internet service in your school?					
T18	How will you evaluate the technical support responsiveness of the platform?					

User's Social Cognitive Perception

Answer question 21-28 by selecting from options 1 to 5 ➡		1 Strongly Disagree	2 Disagree	3 Neither Agree Nor Disagree	4 Agree	5 Strongly Agree
U1	I like using mobile devices for my work					
U2	I have the self-efficacy to use the system					
U3	I am griped with anxiety to use the system					
U4	I get bored quickly when using my mobile device					
U5	Using the system is intimidating					
U6	I don't know how it is going to be possible to use my mobile device for teaching or learning					
U7	Academically I don't think it is ethical to use mobile device in this way					
U8	I am compelled to use the system because of recognition					
U9	I think teaching can best be done in the classroom					
U10	I think reading from hardcopy document is the most suitable way of learning					
U11	I feel mobile devices are disruptive					
U12	I am not a fun of using technologies such mobile device for my work.					
U13	I love trying new technologies.					
U13	Using the system add to myself esteem among my colleagues in other universities.					

Motivation

Answer question M1-14 by selecting from options 1 or 2 ➡		0 NO	1 YES			
M1	Do you have a smart phone? ***(A phone with a java browser, multimedia, computer keyboard, ability to run application programs, 3G, memory card, etc.)***					
M2	Do you have tablet?					
M3	Do you laptop or notebook?					
M4	Do you have official smart phone given to you by your management?					
M5	Do you have official laptop or notebook given to you by your management?					
M6	Do you have internet access on your smart phone?					
M7	Do you have internet access on your laptop?					
M8	Do you have internet access in your school?					
M9	Do you get internet access on your smart phone anywhere anytime?					

M10	For the purpose of m-learning, does management pay for your mobile broadband?					
M11	Are you given allowances for developing content for the m-learning platform?					
M12	Are any of the mobile telecommunication companies offering special packages to schools for m-learning?					
M13	You use the system because of self-satisfaction you get from it.					
M14	You use the system because you want to satisfy various students learning styles.					
Answer question M15 by selecting from options 1 to 5 ➡		1 Poor	2 Fair	3 Good	4 Very Good	5 Excellent
M15	How will you evaluate management's involvement in encouraging you to use the m-learning platform					

Pedagogy

Answer question P1-7 by selecting from options 1 to 5 ➡		1 Strongly Disagree	2 Disagree	3 Neither Agree Nor Disagree	4 Agree	5 Strongly Agree
P1	M-learning is suitable for teaching and learning?					
P2	All subjects can be delivered on the m-learning platform?					
P3	It helps in teaching and conducting examinations for large numbers of students?					
P4	It is flexible in adapting to different teaching styles?					
P5	It is appropriate to blend face-to-face classroom education with m-learning.					
P6	The platform allows teacher and student interaction anywhere anytime?					
P7	Generally it fits the teaching task					

Use

Answer question U1-3 by selecting from options 1 to 5 ➡		1 Strongly Disagree	2 Disagree	3 Neither Agree Nor Disagree	4 Agree	5 Strongly Agree
US1	You used the system as frequently as possible?					
US2	You will like to continue using the system?					
US3	Using it to manage students' results and other work was excellent?					

Implementation

Answer question IMP1-3 by selecting from options 1 to 5 ➡		1 Strongly Disagree	2 Disagree	3 Neither Agree Nor Disagree	4 Agree	5 Strongly Agree
IMP1	The users were eager to use the system					
IMP2	The users gave the implementing team maximum support					
IMP3	The users knew much about the technology and it perceive usefulness					

Overall Impact

Answer question OI1-12 by selecting from options 1 to 5 ➡		1 Strongly Disagree	2 Disagree	3 Neither Agree Nor Disagree	4 Agree	5 Strongly Agree
OI1	The m-learning system allows me to monitor, track and assess large number of students than before.					
OI2	The m-learning system improves teaching and learning performance.					
OI3	The m-learning system saves lots of time.					
OI4	It offers innovative ways of teaching and learning.					
OI5	It helps me to meet different students learning styles.					
OI6	It helps to remove fear from less brilliant students.					
OI7	It makes students confident in participating.					
OI8	It helps to reduce paper work.					
OI9	It helps students to learn.					
OI10	It helps in meeting deadlines.					
OI11	It makes teaching and learning fun.					
OI12	It makes it easy for the academic registry to monitor students and teachers					

Appendix C Formula for obtaining STUMP values

The mean of means per factor for all the respondents

$$= \frac{\text{Total of all Respondents Mean}}{\text{Total Number of Respondents}} \Longrightarrow \frac{\sum\left(\frac{\sum RV}{NQ}\right)}{NR} = \text{m.M}$$

= Mean of Means

The mean of means per factor for all the respondents

$$= \frac{\text{Total of all Respondents Mean}}{\text{Total Number of Respondents}} \Longrightarrow \frac{\sum\left(\frac{\sum RV}{NQ}\right)}{NR} = \text{m.M}$$

= Mean of Means

RU is obtained by Adding all the mean of means of all the users for each factor

$$\text{RU} = \frac{\text{S} + \text{T} + \text{U} + \text{M} + \text{P}}{5}$$

$$= \frac{\frac{\sum_S\left(\frac{\sum RV}{NQ}\right)}{NR_S} + \frac{\sum_T\left(\frac{\sum RV}{NQ}\right)}{NR_T} + \frac{\sum_U\left(\frac{\sum RV}{NQ}\right)}{NR_U} + \frac{\sum_M\left(\frac{\sum RV}{NQ}\right)}{NR_M} + \frac{\sum_P\left(\frac{\sum RV}{NQ}\right)}{NR_P}}{5}$$

= RU Clarity Level

Appendix D Initial factor extraction

Initial factor Extraction from interview

These factors were extracted from the responses of interviewees

1. Complexity
2. Perceive ease of use
3. Perceive usefulness
4. Self-efficacy
5. Computer anxiety
6. Training
7. System quality
8. Service quality
9. Information quality
10. Relative advantage
11. Extrinsic motivation
12. Intrinsic motivation
13. Facilitating condition
14. Attitude toward behaviour
15. Social factors
16. Image
17. Affect
18. Subjective norm
19. Visibility
20. Compatibility
21. Result demonstrability
22. Task fit
23. Interest
24. Knowledge
25. Time
26. Personal expectancy
27. Performance expectancy

Categorization of the factors under S.T.U.M.P

Skill, Interest & Knowledge

1. Perceived ease of use
2. Skill
3. Interest
4. Knowledge

Technical issues & Time

1. System quality
2. Service quality
3. Information quality
4. Relative advantage
5. Time

User's social cognitive composition

1. Attitude
2. Social Cultural factors
3. Affect
4. Self-efficacy
5. Personal Expectancy

Motivation

1. Extrinsic
2. Intrinsic
3. Facilitating conditions

Pedagogic relevance

1. Task fit
2. Compatibility
3. Perceived usefulness
4. Performance Expectancy

Appendix E Workshop Attendance Sheets

Name	Organisation
Victor Yao Adigbli	AD-CONNECT
Adiel Ntuk	AD-CONNECT
Nana Annan	Aaalborg University
Prince Ankrah	AD-CONNECT
Joseph Larbie	AD-CONNECT
Chris Umunnabuike	AD-CONNECT
Rev. Godson Ahiabor	Central University College
Dr. Benjamin E. Aflakpui	Central University College
Dr. Franklin Asamoa-Baah	Ghana Telecom University College
Dr George Ofori-Dwumfuo	Methodist University College
Dr Jamal-Deen Abdulai	GIMPA
Dr Gamel Okoampa Wiredu	GIMPA
Rev. Emmanuel K. Dadebo	INSET Unit (Teacher Education Division)- Ghana Education Service Hqtrs, Accra
Mr George Akorfu	Wisconsin International University
Mr Moses Azameti	Wisconsin International University
Mrs Maud Elliot Ashong	Wisconsin International University
Mrs Mateko Okantey	Wisconsin International University
Mr Ezer Yeboah Boateng	Phd fellow - AAU
Mr Benjamin Kwoufie	Phd fellow - AAU
Mr Samuel Adu-Gyamfi	Phd fellow - AAU
Ing. Michael Adjin Okwabi	Phd fellow - AAU
Florence Onny	Workshop Coordinator
Mawuli	Workshop Coordinator
Abena Offe	Head of Research GTUC
ELLIOT ATTIPOE	UCC
DANIEL ESSEL	UCC
DANIEL GESU	UCC
JOHN BLEBOO	CIBT
ELIKE HODO	RMTU
KWAKU NUAMAH-GYAMBRAH	KF-POLY
FRANCIS BOTCHAY	KF-POLY
SAMUEL GYAMFI	UEW
COLLINS HAGAN	CIBT
Dr. W.S DZISAH	GIJ
DESMOND LARTEY	MUC
JOSEPH DARISON	GP
D.M.O ADJIN	GTUC
MAXWELL KISSI	NAB

REV. E.K DADEBO	GES
DICKSON MANESSEH	RMTU
ALBERT NAA	KF-POLY
STANLEY OPOKU-YEBOAH	NAFTI
REXFORD ATUNWEY	ZUC
DANIEL AMOO	Ghanaian TIMES
VICENTIA AKWETEY	NAFTI
KAY MOSES	BUS. TIMES
ERIC KWADA	GH. CU
REV.WILLIAM KUDJOR	KUDJOR & ASS
LUKE DERY	ZUC
D. K MENSAH	KAIPTC
ADASE AKUDE	ZUC
GEORGE HNNI	GTUC
MORTEN FALCH	CMI-AAU
FRANCIS ASANTE	GH. CU
HARRY APPIAH	GH. CU
BEN KWOFIE	CMI
HENRY MINTAH	KAIPTC
REGINA DZODZOMANYO	WAEC
ALBERT KOOMSON	BSMS
JAMAL ABAHAI	GIMPA
PHILIP KANKAM	AUCC
EDEM AVEVOR	AUCC
MAWUKO DZA	GRIFFITH
AUGUSTINE OWUSU	KAIPTC
SAMUEL ATTUQUAYEFIO	AUCC
NICHOLAS DAKER	AUCC
DAVID ACHMI	DUR
LYDIA HAGAN	KAIPTC
JOHN APPIAH	WAEC
EDWARD KUDJEY	GTUC
LAWSON MAMAH	GTUC
FRANK BOATENG	GTUC
EMMANUEL FIAGBENU	GIMPA
SWATI BHATT	IPMC
HENRY QUARSHIE	VVU
PROSPER KEKETSYO	ILGS
SAMUEL NORTY	GTUC

Appendix F Correspondence

Letter of consent

GHANA OFFICE
748/10 Oshiapen Street, Awudome Estate,
Off TV Africa. Accra.
P.O.BOX OS 2202, Osu-Accra

Phone: (233) 0302 91 82 32
(233) 0302 22 41 51

NIGERIA OFFICE
Suite C18, Km 18 Lekki Epe Expressway
Opposite Alfa Beach road – Lekki Peninsula,
Lagos State

Phone: (234) 8023564461

www.adconnectmobile.com
adiel@adconnectmobile.com

AD-CONNECT

Date: September 15, 2011

To:

Nana Kofi Annan - PhD Fellow
CMI- Aalborg University Copenhagen
A.C Meyers Vænge 15
DK-2450 Copenhagen SV
Denmark
Email: annan@es.aau.dk

Dear Sir,

LETTER OF CONSENT

On September 12th 2011, our company received a letter from you expressing interest in collaborating with us as a researcher to implement m-learning in Central University College.

This letter is to convey to you that your request has been granted and I am keen to have you on board to share ideas for a successful implementation. I believe that your involvement as a researcher in this project will advance the cause of m-learning for ubiquitous teaching and learning.

AD-CONNECT is of great anticipation that your role in this project as a researcher will be useful in the practical implementation of the m-learning technology.

Looking forward to hear from you.

Yours Faithfully,

adiel ntuk
CEO

Appendix G Summary data sheet of CUC m-learning

1	Total number of students which were on the m-learning system	2011/2012 Academic year:10,000 Students
		2012/2013 Academic year :8,838 Students
2	Actual number of students who had a feel of the m-learning	2011/2012 Academic Year 4,324
		2011/2012 Academic Year 5,324
3	Total number of students which were on the m-learning system	2012/2013 Academic year :8,838 Students
4	Total number of students which were on the m-learning system	8838
5	Total number of courses which were put on the m-learning system	23
6	Total number of department	18
7	Total number of faculties	143
8	Total number teachers at CUC	143
9	Total number of the teachers who were put on the m-learning system	143
10	Total number of level 100 students	1364
11	Total number of level 200 students	1638
12	Total number of level 300 students	3121
13	Total number of level 400 students	2715
14	Which of the departments did very well with the m-learning	SCIENCE
15	Which courses really published content for students frequently	PHARMACY, NURSING, SCIENCE, ECONOMICS,
16	Which courses really used the system for class exams often	PHARMACY, ARCHITECTURE, SCIENCE,
17	How many teachers were able to use the system for their classes effectively	26
18	How many teachers and students had smart phones	5342
19	What type mobile device did most students used for the m-learning	JAVA enabled smart phones

Appendix H PhD Courses Taken

Courses	Place/Organized by	ECTS	General/Project course	Status
Political Economy of ICT	AAU/CMI	5	General	completed
Research Methodology	AAU/CMI	3	General	completed
Thesis Writing and Getting Papers into Journals	AAU/CMI	2	General	Completed
Library Information Management	AAU/CMI	1	General	Completed
Problem Base Learning (PBL) and Engineering Education Research - From Research Questions to Research Methodologies and Publications	AAU	4	General	Completed
Total of General Courses		**15**		
Techno-Economics of Mobile Networks and the Internet	AAU/CMI	3	Technical	Completed
IT and Media Policy and Regulation	AAU-Cph	3	Technical	Completed
Introduction to University Pedagogy	AAU/Cph	2.5	Technical	Completed
Mobility and Mobile Methods	AAU	5	Technical	Completed
Mobile Computing and Communication Technologies	India	5	Technical	Completed
Total of Project Courses		**18.5**		
	Total	**33.5**		

Appendix I Published Paper

Nana Kofi ANNAN, George O. OFORI-DWUMFUO, and Morten FALCH

Mobile Learning Platform: a case study of introducing m-learning in Tertiary Education

***Abstract*—This paper presents a study on a one year m-learning pilot project at Central University College in Ghana. This was done through a user trial, where the m-learning tool AD-CONNECT is introduced in 44 courses with a total of 500 students and 22 lecturers at the College. The paper reports on the first experiences gained by both teachers and students by asking the following questions: What are the perceptions of teachers on m-learning? What are the effects of m-learning on students? What does m-learning contribute to face-to-face teaching and learning? Questionnaires were administered to students and lecturers to gather quantitative data on their views on the use of m-learning, particularly after using the AD-CONNECT M-Learning system. Also, observations and interviews were used to collect data from users which provided us with some qualitative data.**

***Index Terms*—Anywhere anytime, Education, learning, m-learning, teaching**

INTRODUCTION

The Government of Ghana, in its ICT in Education policy of 2008, lays emphasis on educational institutions to be creative and innovative by adopting and adapting new appropriate technologies which are useful in enhancing teaching and learning for better results [*1*]. The world in the past five to ten years has experienced huge research into the use of mobile technology for teaching and learning as a new way of facilitating education in the mobile age [*2*], [*3*], [*4*].This has provided numerous frameworks and findings on how best mobile devices can be utilized in education to match the dynamics of society greatly influenced by diverse innovative technologies [*5*], (O' Malley, C., Vavoula, G., Glew, J., Taylor., Sharples, M., & Lefrere, P., 2003), [*7*].

Africa with its challenges in meeting the education needs of its citizenry has a great opportunity to overcome its educational difficulties by carefully employing the use of mobile devices to support teaching and learning. This will go a long way in promoting sustainable education to large numbers of students anywhere anytime to meet the socio-economic

needs of the people. The students have the technology (mobile
phone) in their hands and therefore educational practitioners have to leverage the use of mobile technology which has become a part of today's student's life to go along with their technology-inherited learning life-styles [*8*], [*9*], (Traxler J. , Learning in a mobile age., 2009). M-learning will serve as a good platform to augment the face-to-face classical way of providing education where teacher and student contact is mainly limited to a fixed location. M-learning overcomes the limitation of static education to a more ubiquitous way of education delivery in social context [*11*], [*12*], [*13*].

Currently some m-learning pilot projects in Africa are making a successful head way after several years of experiments [*14*], [*15*], [*16*]. One of these success stories can be found in Ghana at the Central University College (CUC). Having used the AD-CONNECT M-Learning system on pilot basis for two years, CUC is now ready to

Manuscript received February 29, 2012. Mobile Learning Platform: a case study of introducing m-learning in tertiary education.

N. K. Annan, Centre for Communication, Media and Information Technologies (CMI) Aalborg University, Frederikskaj 12, 3rd floor Sydhavn 17 DK2450 Copenhagen SV Denmark & Wisconsin International University, P.O. Box LG 751, Legon, Accra Ghana (e-mail: annan@cmi.aau.dk).

G. Ofori-Dwumfuo, Methodist University College Ghana, Department of Information Technology, P. O. Box DC 940 Dansoman, Accra Ghana (g_ofori@yahoo.com).

M. Falch, Centre for Communication, Media and Information Technologies (CMI) Aalborg University, Frederikskaj 12, 3rd floor Sydhavn 17 DK2450 Copenhagen SV Denmark (e-mail: falch@cmi.aau.dk).

do full adoption and implementation of m-learning to cover a student population of 10,000 starting from September 2011.

Although m-learning is quite new to the Ghanaian education community, the use of mobile phones for browsing the internet, sending short messages, watching movies, making money transfer, receiving bank statements and balances, listening to music, getting updates on stock markets and commodity prices, farm produce information etc are common. All these serve as a good acquaintance for a large number of people in Ghana especially teachers and students to use mobile phones for teaching and learning.

The purpose of this study was to observe the usage of AD-CONNECT M-learning system and gather feedback from users and also to solicit user opinions on the use of m-learning in tertiary education. The overall research objective of the study is to analyse how the use of m-learning tools can enhance the learning process in a tertiary learning environment. This is done through a user trial, where the m-learning tool AD-CONNECT is introduced in 44 courses at Central University College in Ghana. This paper reports on the first experiences gained by both teachers and students by asking the following questions: What are the perceptions of teachers on m-learning? What are the effects of m-learning on students? What does m-learning contribute to face-to-face teaching and learning?

Background and motivation

In today's modern society, ICT plays an important role in providing quality education in order to fulfill its human resources capacity building for a country so as to meet the demands of the labor market, locally as well as internationally. The Government of Ghana in 2000 enacted a policy that all computers and mobile phones will be imported duty free. This the Government did as a way of promoting the use of ICT in various sectors of the economy. This policy has enabled high import of mobile phones which has resulted in relatively cheap prices- a good sign for m-learning.

Mobile technology offers new cost effective ways of learning, but only limited research has been done on how these can be applied and how they will affect the learning process. Currently the computing power of smart phones has improved tremendously over the past few years such that these phones are capable of processing information as handheld computers. This makes mobile phones perform beyond just being used for making calls. These, among other factors, form the basis which has led to enormous research in m-learning implementation, adoption and diffusion in schools.

WHAT IS M-LEARNING?

Many researchers and educators view mobile learning as a descendant of electronic learning (e-learning). For instance, as cited by Laouris and Eteokleous [*17*], mobile learning is "e-learning that uses mobile devices and wireless transmission". [*7*] Mostakhdemin –Hosseini and Mustajarvi view it as the evolution of e-learning; and ([*18*] describe it as "occupying a sub-space within the e-learning space.

This paper agrees with the definition of m-learning by [*3*] that provides a roster of characteristics, thus:

"The capacity for learning anytime and anywhere through the use of multimedia (text, voice, image, or video) and communication (phone call, voice/text messaging, e-mail, web access). This mode of teaching and learning provides real-time online interaction in a series of short burst learning activities, with features such as voice/video recording for storytelling or even a mobblogging journal."

Starting in the late 1990s Professor Mike Sharples of University of Nottingham directed an active research program to investigate mobile learning [*19*]. In 2000, computer learning consultant Clark Quinn provided one of the first definitions of mobile learning, which he described as: 'learning through mobile computational devices' (Quinn C. , 2000). Shepherd [*21*] says 'M-learning is not just electronic, it's mobile'. One feature of mobile learning is the opportunity to break away from teaching that takes place in a classroom, and to move to another location while communicating via information networks. Another distinctive feature of mobile learning is that it enables learners to enter an information network at the precise moment when necessary by using portable learning devices and wireless networks. The mobile environment integrates studies that take place on campus, at home or outside university facilities into one shared, flexible learning environment.

WHY M-LEARNING?

In today's society, students have access to handheld technologies that are more powerful and better connected than conventional desktop computers. These technologies do not only provide students with access to the internet but also serve as a mechanism for what has become their main mode of electronic communication: e-mail and instant messaging [*22*]. As a result of increased popularity, this phenomenon and demand of mobility have extended to the teaching and learning environment.

Since the start of the new millennium, the development and delivery of mobile learning have grown in visibility and significance as witnessed by the number of research projects and dedicated conferences and seminars [*16*].

Mobile technologies have profoundly impacted the way we learn and communicate in business, education, government, and society. It is a phenomenon that has been acknowledged across the globe and continues to impact various facets of our lives. As witnessed by its popularity, mobile innovation inspires flexibility and accessibility to learning and has the capacity to bridge the digital divide while transforming the way we teach and learn.

Greater amount of learning takes place outside the classroom jurisdiction and the current generation has integrated mobile technologies into their lives. Therefore it is incumbent on educators to take advantage of this reality through anywhere, anytime learning solutions, such as smart phones, mobile phones, tablets, notebooks and laptop computers to leverage these devices for learning purposes taking into consideration the fact that students are surrounded by portable devices which keep them in constant contact with their families, friends and the world. Students today absorb, interact with and create content outside of the classroom more than they do inside.

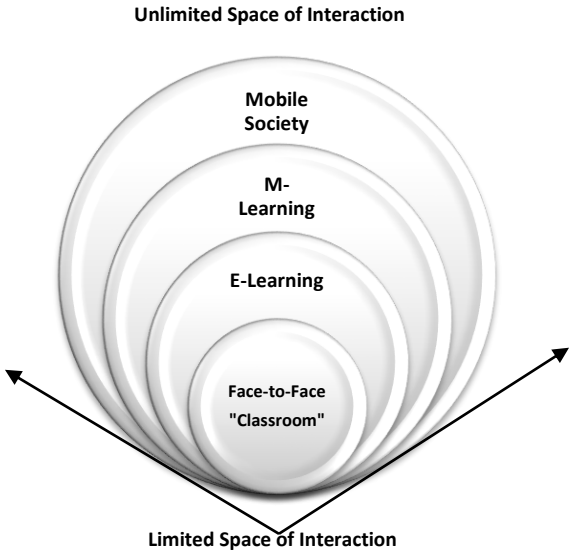


Fig- 1 is a conceptual framework which explains the amount of interaction and space offered by face-to-face, e-learning and m-learning in today's knowledge and mobile society.

The "anywhere", "anytime", "any device" phenomenon

Education delivery has come a long way and is advancing from a specific location context to ubiquitous space, which is teaching and learning anywhere, anytime with any device. This is a new paradigm in education which has received the attention of researchers over the past few years with several pilot projects being conducted across the globe.

"Anywhere" is a situation which is not limited to a specific location or venue. "Anytime" can be explained as an undecided time or wherever seems convenient or appropriate. 'Any Device'' in this context refers to all types of computing devices which have the capabilities for teaching and learning. These devices include smart phones, mobile phones, PDAs, tablets, palmtop, notebooks, laptops and desktop computers. The integration of anywhere, anytime, any device with ICT, creates a Mobile Learning Platform (MLP) which offers numerous opportunities for education delivery in the 21st century. This paper can confidently say that human-beings with the advancement in mobile computing are gradually attaining a "Virtual Omnipresence Status" (VOS) which apparently makes people feel like they are at anywhere anytime. The past five years have seen a rapid growth in research, development and deployment of mobile technologies to support learning. Although research in this area began with the seminal work of Kay and colleagues in the early 1970s with the Dynabook project from the Learning Research Group at the Xerox Palo Alto Research Center (Kay, A., & Goldberg, A. , 1997), the convergence of

technology and education started quite recently. The new technology includes multimedia-equipped smart phones, mobile phones, personal digital assistants (PDAs), tablets, palmtops, notebooks and laptop computers.

The M-Learning Case at Central University College

Central University College is a liberal arts institution located in Accra, the capital city of Ghana. The university was established in 1997 and currently has a total student population of ten thousand and two hundred teaching staff. The university, in March 2010, decided to take a bold step in harnessing mobile technology to facilitate teaching and learning to make teaching and learning available anywhere anytime any device. The university then collaborated with AD-CONNECT to conduct a pilot m-learning project in the University for a Section of the faculty and students.

The pilot project was conducted in all the two campuses of the university at Mataheko at Dansoman and Miotso near Tema in twelve (12) months from March 2010 to April 2011, which constitute two semesters. In all 44 courses including mathematics, English, bio-chemistry etc were used for the pilot. A total of 500 students and 22 lecturers were used for the pilot project. The subjects were picked randomly from level 100 to 400 with each level having a taste of the new learning technology.

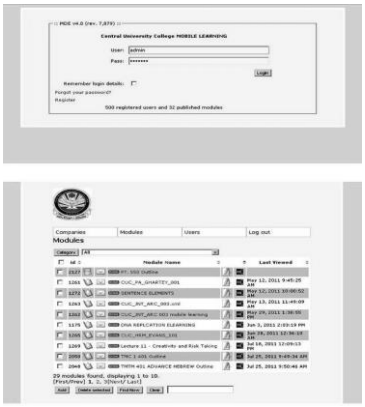


Fig. 2. This is a screen shot of the login and list of content on the m-learning system

METHODOLOGY

A twelve month m-learning pilot project was conducted at Central University College (CUC). The study used participatory action strategy to investigate firsthand experience gained by both teachers and students on the use of m-learning. The researchers were involved in the entire pilot project as facilitators. Observations, interviews and questionnaires were used to gather data from participants who directly or indirectly used the m-learning platform for either teaching or learning.

Different roles like teacher, student and technical support were played by the researchers as a way of fully being part of the project to obtain first-hand information from participants of the project in a natural setting. We also took part in the content development with the teachers and the technical support.

Data Collection Methods

a. Observation

We were daily involved in the project as participants and facilitators. We created a good rapport with participating students and teachers which gave us cordial interaction with them throughout the entire period of the project. We monitored participants' general behaviour towards the project from all perspectives.

B. Interviews

In all, 10 students and 5 teachers were interviewed. The purpose of the interviews was to gather data on personal experiences and perception on the project. Students were interviewed in a relaxed environment. Some of the interviews were done at school cafeteria, library and under study trees on campus. While the interviews of students

was informal, that of the teachers was formal and was conducted in their offices after appointments were booked and accepted.

C. Questionnaires

420 questionnaires were administered to students and teachers as a means to help collect some quantifiable data for quantitative analysis of their feedback. A variation of questions were asked including 5-point likert scale and "yes" and "no" questions.

D. Participants

The project was conducted mainly with teachers and students at all the CUC campuses. A total of 500 students and 22 teachers took part in the pilot exercise.
The following are statistics of the 500 students: 200 from level 100, 100 from level 200, 150 from level 300 and 50 from level 400. The 22 teachers had lectures with students at all the levels on different subjects.

The Pilot Project

AD-CONNECT, a mobile learning system was developed and mounted for CUC to provide m-learning platform for teaching and learning on pilot basis from March, 2010 to May, 2011. The m-learning solution from AD-CONNECT gave teachers the opportunity to publish simplified lecture notes, examinations, quizzes, questionnaires, assignments, poll and surveys with direct feedback to students with any kind of mobile device.

Teachers were given training on how to develop content for m-learning using learning mobile author (LMA). The LMA is a desktop tool for creating interactive modules integrated to mobile delivery and tracking system which allows content to be uploaded on the mobile learning platform for students to access. Students were also trained on how to effectively learn using the m-learning platform on their mobile phones.

After the training, lecturers were able to develop their own teaching content and they uploaded them onto the AD-CONNECT m-learning platform for students to access before and after class at anytime anywhere. Students access the m-learning system with a mobile phone using mobile broadband internet facilities. Students "log-on" to the m-learning system with a unique ID which enable lecturers to track individual learning activities on the system. On the platform, student were able to read lecture notes, do assignment, quizzes, group work and exams in a ubiquitous environment with their mobile phones.

In all 44 courses including mathematics, English, bio-chemistry etc., a total of 500 students and 22 lecturers were used for the pilot project. The subjects were picked randomly from level 100 to 400 with each level having a taste of the new learning technology. Questionnaires were administered to students and lecturers of Central University College to gather quantitative data on their views on the use of m-learning particularly after using the AD-CONNECT M-Learning system. Also, interviews were conducted to solicit subjective opinions from users which provided us with some qualitative data. Summary of the results are high-lighted under findings with graphic representation of the data.

Fig. 3. A screen shot of users' mobile phone. The pictures shows how content is displayed on the mobile phone.

How the AD-CONNECT m-learning system works

The teacher plays two main roles on the m-learning platform. The teacher doubles as a content developer and mentor user. First of all, the teacher develops appropriate content based on the institution's pedagogical framework. The education institution takes full ownership of the content which is then given to the content service provider (CSP) for publishing. The content service provider publishes the content by uploading the content onto the m-learning platform which is connected to the internet. The mobile internet service provider (MISP) serves as the medium through which users get access to the content. Thus the content is made available to all users via the MISPs. Users with their mobile phones using mobile broadband internet connect to the CSP to access content for learning. The users in this context are two; that is, the student who is basically a user as a learner and the teacher who is also a user as a mentor for the student in a social construction learning environment. Finally the teacher takes feedback from student users to make update and modification on content development.

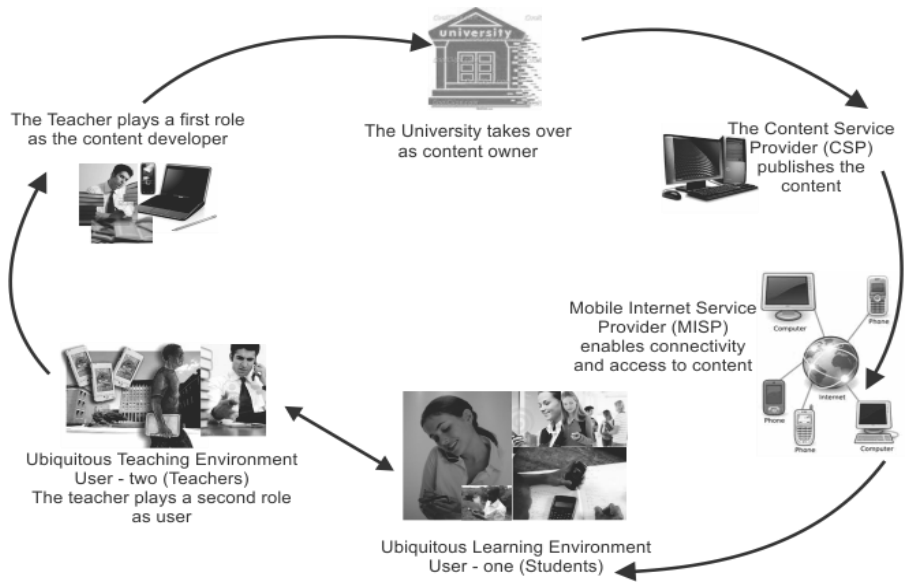


Fig. 4. This diagram shows the m-learning process at Central University College-Ghana

FINDINGS

The first thing that stands out in this project is the substantial social impact it produced in the CUC community which emphasized on the great support given to the project by the University Council, teachers and students involved. This showed that the m-learning technology is a tool that can be used to improve the quality of education delivery.

During the entire process we observed a high level of motivation in the students. This was due both to the expectation and changed pedagogic framework produced by the introduction and blend of m-learning, with face-to-face classroom setting mode of education delivery.

Some students said: "wow, this is different and great. It is an entirely new style of learning; it takes away fear and builds confidence in students. Learning with mobile phone is entertaining, stress free, didactic, and easier". Another also added: "It is a platform that engages our interest to learn new things and at the same time save time".

The report of the lecturers of Central University College to the Academic Board of the University stated that "Mobile learning enhances collaboration between students and lecturers, by lecturers sending their notes to them and getting instant feedback. This would prevent students from being idle with their time and put them into better use, by learning their notes and doing their assignments. It enables lecturers monitor progress of their students through mobile learning. Mobile learning helps lecturers assess students with

assignments and Mid-Semester Examinations and get immediate response (when Multiple Choice questions are adopted).

Some benefits of using Mobile Learning include, track students understanding of lessons taught. what students do with their lecture notes, delivering assignments, conducting polls and surveys, instant examination results and help students to revise before coming for lectures, However students must be encouraged to have compatible phones and schools should provide reliable wireless internet services to ensure that the process works smoothly. Lecturers are of the view that Mobile Learning will be useful to both students and lecturers and will promote healthy academic environments.

The result of the survey questionnaire gave a strong indication that most students and teachers answered *strongly agreed* or *agreed* to the questions which were positive on m-learning with an insignificant number of students and teachers disagreeing. *Fig 5* gives a graphical representation of the results.

Teachers

We observed that some of the teachers were not comfortable with the system for several reasons thus: (1) some teachers are not familiar with using computers to develop content for teaching. (2) Some teachers do not have smart phones. (3) The perception of some teachers that more time is needed for content development. (4) Lack of motivation from school authorities (5) Intellectual property rights (6) attitudinal issues. (7) Pedagogical issues (8) cost of mobile broadband to the teacher (9) mobile learning extends working hours of teachers beyond the classroom providing 24hrs access to students. (10) Lack of instructional design facilitators. (11) Inadequate teaching assistants to assist lecturers on content development. (12) Inconsistent internet connectivity at school and home makes it difficult to publish or upload content on the m-learning platform frequently. (13) Mobile phones and smart phones have small keypads which sometimes makes it difficult to use if you have to type many words. (14) Good and sophisticated smart phones are relatively expensive. (15) The need for m-learning policy in Ghana

Students

Contrary to the teachers, students were highly enthusiastic to use their mobile phones to access learning materials on the m-learning platform. Students were rather unhappy about the unsatisfactory internet service by service providers in Ghana.

On the other hands both teachers and students admitted that the m-learning platform offers the needed capacity for enhancing teaching and learning anywhere anytime and with any device. They did not hesitate to outline the relevance of m-learning in tertiary education to the research team as follows: (1) ubiquitous teaching and learning (2) Increase student and teacher interaction anywhere anytime (3) Boost confidence of timid students (4) Instant multiple choice knowledge assessment feedback (5) Makes it easier to handle large numbers of students with less difficulty (6) If m-learning is well designed it can save teachers enough time to do research instead of spending all their time attending to students face-to-face and marking large volumes of students scripts all the time. (7) It supports constructivism, behaviouralism and cognitive models of pedagogy. (8) 100% of students have mobile phones and smart phones which are suitable for m-learning. (9) M-learning is good for distance education and lifelong learning (10) It supports both personalised and social collaborative learning (11) It provides flexibility in teaching and learning (12) It provides just-in-time teaching and learning (13) The mobile phone attracts the interest of students to learn.

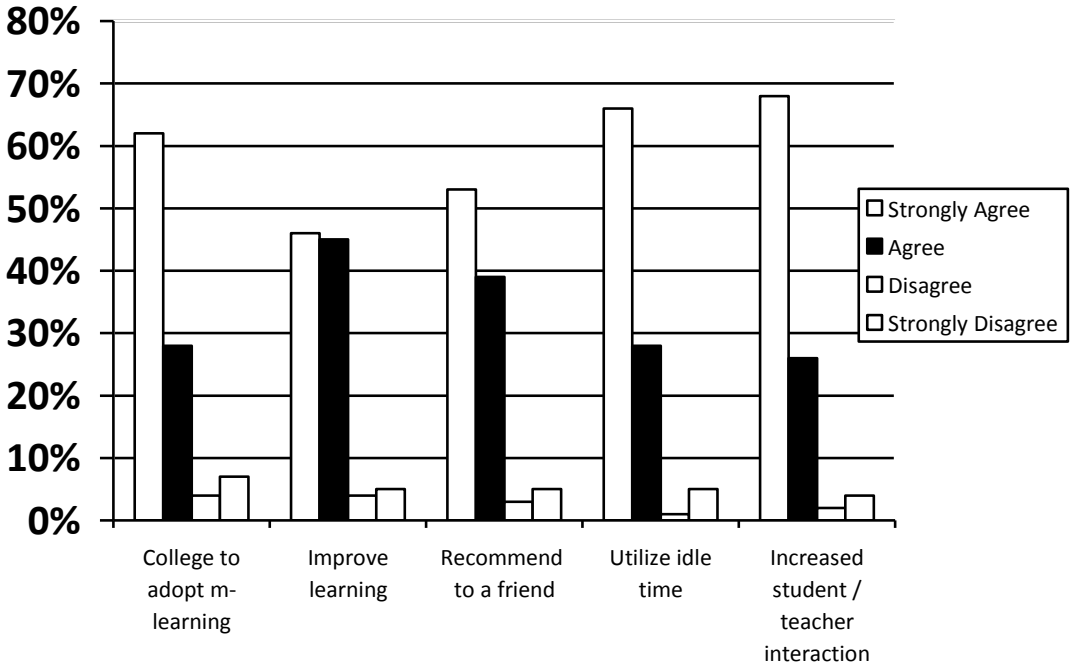


Fig. 5. Graphical presentation of questionnaires administered to some teachers and students.

Discussion and Conclusion

Our observations and survey gave strong indications that there is the need for more pilot projects on m-learning to be conducted in especially higher education institutions in Ghana to offer teachers and students the chance to experience teaching and learning anywhere, anytime with any device.

One of the serendipities of mobile communication technology is the computing abilities of the technology which makes it convenient for teaching and learning anywhere anytime. This overcomes the limitations of traditional face-to-face classroom education. The findings of the study provided some answers to the research questions on the perceptions of teachers on m-learning, the effects of m-learning on students and the contribution it adds to face-to-face teaching and learning. Although the findings from the study cannot be generalized, it has generated some basic information for further research in the area of m-learning.

Reference

[1] Dadebo, E. K, et al, "ICT in Education Policy Framework, Government of Ghana," 2008.

[2] G. Caudil, "The growth of m-learning and the growth of mobile computing: Parallel developments.," *The International Review of Research in Open and Distance Learning*, pp. 8(2) 1492-3831, 2007.

[3] Shih, Y., & Mills, D., "Setting the new standard with mobile computing in online learning.," *International Review of Research in Open and Distance Learning*, pp. 8(2), 17pp., 2007.

[4] G. Qinyang. (2003) Teaching English with Technology, 3(2). [Online]. http://www.iatefl.org.pl/call/j nt13.htm

[5] Sharples, M., Taylor, J., & Vavoula, G., "Towards a theory of mobile learning," in *Proceedings of mlearn 2005 conference*, Cape Town, 2005.

[6] O' Malley, C., Vavoula, G., Glew, J., Taylor., Sharples, M., & Lefrere, P. (2003) Mobilearn project deliverable. [Online]. http://www.mobilearn.org/download/results/guidelines.pdf

[7] Mostakhdemin-Hosseini, A., & Tuimala, J., "Mobile learning framework.," *Proceedings IADIS International Conference Mobile Learning 2005*, pp. 203-207, 2005.

[8] Castleman, W. A., Harper, R., Herbst, S., Kies, J., Lane, S., & Nagel, J., "The impact of mobile technologies on everyday life. In CHI '01 Extended Abstracts on Human Factors in Computing Systems (Seattle, Wahington, March 31 - April 05, 2001).," *CHI '01. ACM*, pp. 227-228. DOI:19.1145/634067. 634202, 2001.

[9] Jacob, S. M., & Isaac, B, "Mobile technologies and its impact: An analysis in higher education context. ," *International Journal of Interactive Mobile Technologies*, p. 2(1), 2008.

[10] J. Traxler, "Learning in a mobile age.," *International Journal of Blended Learning,* , pp. 1(1), 1-12, 2009.

[11] S. J. Gedded, "Mobile Learning in the 21st Century: Benefit for learners.," *Knowledge tree e-journal*, pp. 1-13, 2004.

[12] Sharples, M., Taylor, J., & Vavoula, G., "A Theory of learning for the mobile age.," *In R. Andrews & C. Haythornthwaite (Eds.), The Sage handbook of e-learning research*, pp. (pp. 221-247)., 2007.

[13] Wang, M., Shen, R., Novak, D., & Pan, X., "The impact of mobile learning on students' learning behaviours and performance: Report from a large blended classroom.," *British Journal of Educational Technology*, pp. 40(4), 673-695, 2009.

[14] Boyinbode, O. K., & Akinyede, R. O., "Mobile learning: An Application of mobile and wireless technologies in Nigeria learning system," *IJCSNS International Journal of Computer Science and Network Security*, vol. 8 No.11, November 2008.

[15] J., Traxler, "Current State of Mobile Learning," *International Review on Research in Open and Distance Learning (IRRODL)*, vol. 8, No.2, 2007.

[16] J. Traxler, "Defining mobile learning.," *IADIS International Conference Mobile Learning 2005*, pp. 261-266, 2005.

[17] Laouris, Y., & Eteokleous, M. (2005, October) Proceedings of the 4th World Conference on Mobile Learning. [Online].

[18] Georgiev, T., Georgieva, E., & Smrikarov, A, "Me-learning: A new stage of e-learning.," *Proceedings of the International Conference Systems and Technologies, CompSysTech 2004*, pp. IV.28, 1-5, 2004.

[19] M. Sharples, "The design of personal mobile technologies for lifelong learning.," *Computers & Education, 34, 177–193.*, 2000.

[20] C. Quinn, "mLearning: Mobile, Wireless and In-Your-Pocket Learning.," *Line Zine Magazine. http://www.linezine.com/2.1/features/cqmmwiyp.htm*, 2000.

[21] C. Shepherd, "M is for Maybe. Tactix: Training and communication technology in context.," *http://www.fastrak-consulting.co.uk/tactix/features/mlearning.htm*, 2001.

[22] C. Murray, "Mobile learning in the classroom.," pp. 45(1), 48-54, 2010.