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SCHOOL OF COMPUTING AND INFORMATICS

Ph.D. THESIS

RESEARCH TITLE:

MODELLING AN INSTRUCTIONAL DESIGN AND DELIVERY MODEL FOR MOBILE LEARNING

RESEARCHER: IRERI BONFACE NGARI
ADNo. P80/83221/2012

SUPERVISOR: PROF. ELIJAH I. OMWENGA

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Declaration

I, Bonface Ngari Ireri, do hereby declare that this PhD research thesis is entirely my own work and where there is work or contributions of other individuals, it has been dully acknowledged. To the best of my knowledge, this Ph.D. research thesis has not been carried out before or previously presented to any other education institution or forum.

Signature..... Date..13/8/2015.....

Bonface Ngari Ireri

P.O. Box 19800- 00202 Nairobi, Kenya

I, Professor Elijah I. Omwenga, do hereby certify that this PhD research thesis has been presented for consideration for the admission to the degree of Doctor of Philosophy with my approval as the University of Nairobi Supervisor.

Signature ..... Date 13/8/2015.....

Professor Elijah I. Omwenga

School of Computing and Informatics

University of Nairobi, Kenya

Dedication

This Ph.D. work is dedicated to my dear family especially to my wife Ephraith, my daughter Caroline and to my Sons Wellington and Humphrey. The Almighty God shall bless them for the support and encouragement they offered me.

Acknowledgement

Thanks to Almighty God the Creator of Heaven and Earth and to Jesus Christ, Savior of all Mankind and the Holy Spirit for giving me grace to work on this Ph.D.

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I give special thanks to NACOSTI who directly supported my work by giving me a grant to aid me develop mobile learning application software (mobile learn) and to Africa Nazarene University for allowing me to use their resources to host the mobile learn system as I carried out my research.

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God bless you all.

Abstract

Mobile learning empowers learners to acquire knowledge anywhere and anytime. Using mobile technologies in a well-designed instructional and delivery system can highly complement if not replace traditional teaching methodologies. This study was designed to model a framework of an instructional design and delivery model. The framework is envisaged to aid system developers for mobile technologies and instructors who wish to use mobile technologies to instruct learners.

This study draws its strength from mobile learning theory which borrows a lot from Behaviorist, Cognitivist, Constructivism, Vygotsky's Learning Theory, Situated Learning , Context Awareness Learning, Collaborative Learning, Conversational Learning, Location-based learning (Keskin & Metcalf, 2011).

The study employed both quantitative and qualitative research designs. Various methods were used at different stages. For example, in the literature review stage, review as a method was used to analyze the research work that is ongoing in mobile learning; to determine the readiness of the institution to host the mobile learning system, a readiness survey was done before setting up the systems for the experiments. The development of the mobile learning software was implemented using rapid prototyping approach. The study was carried in an institution that had not adopted mobile learning before after establishing a readiness index of 2.6, which corresponded well with the Kenya Education Network (KENET) standards of 2.5.

After the mobile learning software was installed and configured, various experiments were conducted between two groups, a control group and a group that received treatment. The control group was instructed through traditional classroom methods. The treatment group was instructed through traditional methods while learners were treated with the mobile learning software by allowing them to interact with all learning channels (mobile web, IVR, USSD and android application). When all experiments were done and collected data analyzed, the research established that mobile learning can bridge the varied learner entry behavior. The data from control groups provided confirmatory evidence to conclude at 95% confidence that there was low chance of getting result by random chance at 1.7% while for the treatment group, the chance was at 69.8%. This confirmed that when mobile learning is not used learner entry behavior has a significance influence on learner performance. While the results shown that when

mobile learning is introduced, the leaner entry behavior has no influence, further research is required to conclusively generalize.

Results from other factors shows that there is enough evidence to believe that at 95% confidence they influence the expected learning outcomes. The researcher therefore recommend that the instructors intending to use mobile learning must: - make subject content relevant, package content in formats supported by mobile device, ensure the learner's attention is maintained, provide various delivery modes for the learner to give feedback and finally ensure the learner is conversant to and aware of the available mobile delivery channels within the learning environment.

This study recommends that developers of mobile learning software and instructors should be guided by instructional design requirements when designing and developing mobile learning applications.

Key words:

Mobile Learning, Instructional design, Learner, Entry Behavior, Instructor

LIST OF ABBREVIATIONS

ADDIE	Analysis Design Development Implementation Evaluation
ARCS	Attention Relevance Confidence and Satisfaction
CCK	Communications Commission of Kenya
CD-ROM	Compact Disc, Read-Only-Memory
DVD	Digital Versatile Disc
EFA	Education For All
E-learning	Electrionic Learning
GSM	Global System for Mobile Communication
GII	Global Information Infrastructure
ICT	Information Communication Technology
ID	Instructional Design
ID&DM	Instructional Design and Delivery Model
ISD	Instructional System Design
ISP	Internet Service Providers
IT	Information Technology
IVR	Interactive Voice Response
KENET	Kenya Education Network
LAN	Local Area Network
MAD	MobileApplication Development
MDGs	Millennium Development Goals
MWEB	Mobile website
Mbps	Megabit per second
M-learning	Mobile Learning
NRI	Networked readiness index
HE	Higher education
OPAC	Online Public Access Catalog
PDA	Personal Digital Assistant
PC	Personal Computer
SMS	Short Message Service
SP	Strategic Plan
SPSS	Statistical Package for Social Scientists
UNESCO	United Nations Education Social Cultural Organisation
UNDP	United Nations Development Program
USAID	United States Agency for International Development
USSD	Unstructured Supplementary Service Data
WAN	Wide Area Network

GLOSSARY

Glossary of Terms

Mobile Learning Readiness

The term refers to basic readiness, skills readiness, psychological readiness and budget readiness of students to engage in learning activities using mobile devices.

Instructional Design Model

This term refers to frameworks for the systematic production of instruction. It is the entire process of analysis of learning needs and goals and the development of a delivery system to meet the teaching and learning needs.

Intended Learning Outcomes

Intended Learning outcomes are the actual results of learning or the aspects of a student's learning that an instructor identifies to assess and reward. Course designs set out the instructor's intentions for learning (intended learning outcomes).

Learner Entry Behavior

This is an instructional analysis process that determines the skills and knowledge that a learner knows or is able to do before beginning to take new instructions. The Knowledge, Skills, and Abilities of the learner are expected to match the proposed level of instruction.

Delivery Mode

A delivery mode is the way training instructions are delivered to support and enable learning process. In mobile learning there are several modes of instructions. Some examples are SMS, USSD, Mobile application or Mobile Web technologies.

Content Relevance

This means the right content that enables the learner or instructor to be informed correctly in accordance with expected outcome. Instructors can have strategies of achieving the intended learning outcome by creating the right content such that when the learners interact with the content they are able to get the right information.

Content Format

A content format is an encoded manner for converting a specific data type to be displayed in certain ways e.g. text, graphics, voice and video.

Instructional Media

This the physical means by which the instructional message is communicated, such as television, print materials, chalkboards, handouts, charts, slides, overheads, real objects, and videotape or film, as well as newer materials and methods such as computers, DVDs, CD-ROMs, the Internet, interactive video conferencing and mobile devices.

Learner Attention

Learner attention is the interest shown by a learner in taking in the knowledge or skill that is being taught. Learner attention is influenced by the nature of task, learner skill level and duration of task (Storch, 2001; Williams, 1999; Leeser, 2004 and Williams, 1999).

Learner Feedback

Written or spoken information to an individual in response to an instruction. The individual provide a response of their view or performance.

Context Awareness

Whereas context awareness is defined as a property of mobile devices in relation to location awareness, location may determine how certain processes of learning are applied more flexibly with mobile users. The users in this case, are learners sensing their physical environment and adapting their behavior accordingly.

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CHAPTER 1: INTRODUCTION

1.0 Background of the Study

Definitions

Mobile Learning can be defined as any sort of learning that take place when the learner is not at a fixed, predetermined location or learning that takes place anytime and anywhere when the learner takes advantage of the learning opportunities offered by mobile technologies.

Mobile learning is viewed as an extension of e-learning. Mobile learning derives its name from two terms Mobile and Learning. The word "Mobile" refers to devices that are small in size and can be carried about by the users and "Learning" the active acquisition of knowledge and skills.

Scholars have offered many definitions on this subject, Quinn (2000) defines mobile learning as e-learning through mobile computational devices such as Palms top, Windows CE machines and even digital cell phones; O'Malley et al.(2003) defines it as any sort of learning that happens when the learner is not at a fixed, predetermined location, or learning that happen when the learner takes advantage of learning opportunities offered by mobile technologies; Trifonova (2003) defines it as any form of learning (studying) and teaching that occurs through a mobile device, or in a mobile environment; Georgiev et al.(2004) as a new stage of e-learning having the ability to learn everywhere at every time through use of mobile and portable devices; Keegan (2005), as the provision of education and training on PDAs/palmtops/handhelds, smartphones and mobile devices; Traxler (2005) as any educational provision where the sole or dominant technologies are handheld or palmtop devices; Doneva et al. (2006) as a next stage or a new form of e-learning through the use of mobile and portable devices and wireless network and communication technologies for teaching and learning; and Ally (2009) as the process of using a mobile device to access and study learning materials and to communicate with fellow students, instructors or institutions.

The scholars mentioned above, attempted to define Mobile learning and all of them acknowledge the use of mobile devices as a medium of delivering learning content to the learner who experiences learning anywhere anytime. Traxler emphasizes the delivery of content via mobile device of telephony and hand held computers. O'Malley et al emphasized M-learning 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 the learning opportunities offered by mobile technologies"

While the definitions use the term mobile learning, some scholars argue that, the term learning refers to a transformation or changes in a person's perceptions, attitudes, cognitive or physical skills that take place when some learning activity or process is done. It cannot be 'electronic' or 'Mobile'. Therefore, the term e-learning or even m-learning linguistically are misleading (Dichantz 2001). However, they agree that the terms have become popular and are commonly used and are accepted to emphasize the delivery of information that leads to learning.

Mobile Learning an emerging mode of learning

Mobile learning has emerged as a great contributor in solving Educational crisis. From 2011, EFA report by UNESCO, many African countries will not be able to achieve the EFA goals by the year 2015. However, the introduction of mobile learning technology in these countries have shown positive indication to achieving the EFA goals numbers 3 : promoting lifelong learning skills for young people and adults; number 4: increasing adult literacy by 50%; and number 6: improving the quality of education for all learners. This positive indication was considered to have been achieved as a result of high mobile technology penetration within the region. Many people can now afford a mobile device due to lowered cost of mobile devices (UNESCO, 2012).

The penetration of mobile devices in Africa has continued to increase. According to Ericsson Mobility Report of June 2013, Africa has 775 million subscribers (27%) of the world mobile subscription with a penetration of 75%. In Kenya,

mobile penetration was at 64.7% with 26.4 million subscribers in all Mobile Service Providers (CCK, 2012). Cell phones, laptops, notebooks, tablet and other mobile devices are getting cheaper than Desktops, servers or even cost of producing a book or other traditional teaching materials.

Due to their affordability, usability and accessibility, many people have continued to acquire mobile devices. In Kenyan universities, almost all student population own mobile devices (Githii J.K. et.al., 2013; Ireri B.N., 2014). On the other hand, lecturers, teachers and instructors continue to use classical instructional methods where notes are dictated or written on white boards. A few use e-learning resources that are not well coordinated since they have no pedagogical knowledge or any instructional design training. They limit learning in different circumstances depending on student learning styles and situation.

ICT-supported learning, popularly referred to as e-learning has also been introduced in some institutions and although they have been proven to be effective methods with regard to pedagogy in the teaching and learning process, especially when integrated into the teaching and learning process within schools and higher learning institutions (Omwenga, 2011), the cost of implementing such systems is high. E-learning and the traditional methods of teaching and learning require the learners to have access to a computer, library and other learning materials. These may limit the learner due to cost of computers and location of libraries especially for distance learners.

Mobile learning is characterized by learners' ease of access to learning content in a varied format (voice, text, pictures and videos) anytime and anywhere. Although mobile learning may be desirable since many people have access to mobile devices, they have their challenges. There is no single solution where rich, interactive multimedia teaching and learning content can be pushed to every single manufactured mobile device. Some devices can support all media but others cannot due to their limited features and functionalities (Elias Tanya., 2011). Although Taxler (2009) says that Mobile learning using handheld computers is relatively immature in terms of both its technologies and its pedagogies,

UNESCO (2012) report gives a ray of light in a dark tunnel by identifying mobile learning as new emerging methods of teaching and learning that is developing rapidly. Instructors and teachers play a great role in the success of any learning and teaching. Teacher's competence and expectations are important since teachers and instructors are instructive in nature and they design instructions in such a way that learner's attitudes, perceptions, styles of learning, motivation, confidence and satisfaction are achieved. They must design the content for the learner to access it easily and through a well-designed delivery medium.

Majority of mobile applications are constructed as multi-layered applications that are composed of three layers: - user experience, business, and data layers (J.D. Meier. et.al 2008). Some of the developed architectural frameworks for mobile application development are meant to provide a systematic and comprehensive solution to mobile applications development and maintenance. The frameworks are meant to bring together elements of software architecture and design in general. While these frameworks are great architectural work for general purpose mobile application development, developing a mobile application for purposes of teaching and learning require it to be guided by instructional design models if it is to achieve the desired learning goals or outcomes.

This research work provides a framework and a platform designed and built to reflect an instructional design for m-learning. Like other technological routine methods of learning, it can mediate learning through its form of delivery of learning content while instructional design applied by the instructor is integrated to assist instructors with no instructional design knowledge to apply the basic transformation of learning process.

Pedagogy and Quality of Education in Higher Learning Institutions

A speech given by the secretary of education questioning the importance of pedagogy prompted McKenzie, 2003, to publish an article named Pedagogy Does Matter. In the article, an explanation is given as to why new technologies do not realize their potential in the classrooms as lack of devotion to pedagogy by instructors.

Shortage of lecturers is a serious threat to offering quality university education (Mario et al. 2003., Mutisya, 2010 and Gudo, C.O., Olel, M. A. & Oanda I.O. 2011). Due to the shortage of lecturer, many universities use part time lecturer from other universities and overloading fulltime lecturer for over-load pay. Odebero, 2010 noted that for lecturers to survive the heavy workload, tutorial fellows and assistant lectures are assigned to teach while projects are given to lecturers from other disciplines as survival mechanisms. Majority of instructors in higher education require to build capacity to teach and do research by updating and improving pedagogical skills, through appropriate staff development programs in order to encourage constant innovation in curriculum, teaching and learning methods if quality of education is to improve (UNESCO, 1998). Many African countries will not be able to achieve the EFA goal number 6: improving the quality of education for all learners by the year 2015 (UNESCO, 2012). Scholars like Lueddeke (2003) and Lindblom-Ylanne et al. found out that lecturer from applied sciences were more likely to adopt an information transmission/teacher-focused approach to teaching than those from the soft disciplines (such as history) and applied soft disciplines (such as education) who were more inclined to a more conceptual change/student-focused approach, however, contrary to this Postareff et al. 2007, found teaching experience to be a significant variable on the self-efficacy scale of teachers who had been exposed to pedagogical training. Their research shown that faculty members who take pedagogical training or have pedagogical training has teaching related self-efficacy (Postareff & Neugi, 2007). Manyasi (2010) noted that lacked

instructional competencies amongst lecturers had effect on how information technology was used for teaching and learning in higher education.

1.1 Research Problem

Despite the prove that e-learning applications are effective methods when integrated in teaching and learning process (Omwenga, 2011) and the pedagogical needs being the driver to choice of an instructional technology (Chizmar & Walbert, 1999), majority of instructors, teachers and lecturers in higher learning institutions continue to use new instructional technologies without any instructional design guide and competencies. This is because many of them have no instructional design skills or are not equipped with pedagogical skills that can guide them to improve their teaching and learning experiences. Shortage of lecturers in Kenyan universities is a serious threat to offering quality university education (Mario et al. 2003., Mutisya, 2010 and Gudo, C.O., Olel, M. A. & Oanda I.O. 2011). Many universities use part time lecturer from other universities and overloading fulltime lecturer for over-load pay. Odebero, 2010 noted that for lecturers to survive the heavy workload, tutorial fellows and assistant lectures are assigned to teach while projects are given to lecturers from other disciplines as survival mechanisms. Pegagogical training is necessary since it matters (McKenzie, 2003). According to Postareff & Neugi, 2007, faculty members who take pedagogical training or have pedagogical training have teaching related self-efficacy. Therefore, there is need to build capacity in these universities if EFA goal number 6: improving the quality of education for all learners by the year 2015 (UNESCO, 2012) is to be achieved.

Also, despite high mobile penetration in Kenya, (CCK, 2013) and reports that mobile learning is gaining ground as a new instructional technology with positive indications to achieving educational goals (UNESCO, 2012), many existing mobile learning software used for instructional purposes are not designed with an instructional design model in mind and are not adequate to aid lecturers, teachers and instructors maximize their teaching and learning experiences.

1.2 The overall research Objective of the study

The main objective of the study was to model an instructional design and delivery model for mobile learning with a view that the instructors, teachers, lecturers and software developers in institutions of higher learning with or without skills on instructional designs can adopt to improve the teaching and learning experiences.

1.3 The Specific Research Objectives of the study

The following are the objectives that this research was envisaged to achieve

1. To establish the determining and moderating factors for modeling an instructional design and delivery model for mobile learning.
2. To develop a Mobile Learning software with four mobile delivery channels (IVR, Mobile Web, USSD and Android Application).
3. To validate the model using primary data obtained from an experiment conducted in an undergraduate course unit.
4. To recommend an instructional design and delivery model for mobile learning that will best guide instructors and mobile learning software developers.

1.4 Research Questions

1. Is there instructional software designed with an instructional design and delivery model for mobile learning?
2. How can the four channels of mobile learning (IVR, Mobile Web, USSD and Android Application) access same content management system?
3. Which factors can instructors consider when choosing an instructional Mobile learning technology?
4. What are the design issues for developing an instructional Mobile learning technology?

1.5 Significance of the research

The researcher believes that the outcome of the study will help developers of mobile learning systems to include pedagogical design issues in their overall system design making the work of instructors with no pedagogical skills easier.

The beneficiaries of this study are lecturers, teachers and instructors who may instruct their learners on online platform, distance learning or even on face to face modes of studies.

This study is grounded on very strong learning theories and a very enabling environment.

Enabling environment

In Kenya, mobile computing devices penetration has continued to rise from 51% in the first quarter of 2010 (CCK, 2010) to 67.4% (CCK, 2011) to 77.3% by June 2013 (CCK, 2013) due to low cost in devices, voice and data services. There is a high availability of mobile devices per households. The cost of voice communication over the mobile phone has also become more and more affordable to the consumer because of the stiff competition among competitors and unlike computers, mobile phones are easy to operate and can provide real- time interactive environment (CCK, 2012). With preliminary data of this research revealing 100% ownership of mobile devices amongst university students, it is only fair to make use of these devices for purposes of learning.

The introduction of mobile learning technology in Africa has shown positive indication to improving learning and meeting the EFA goals numbers three, four and six (UNESCO, 2012). The report clearly indicates the Africa region is significantly a good environment for mobile technology to be applied in solving educational challenges.

Benefits of using an instructional design

Instructional designs offer several benefits when introduced to learning: - first, compared with a human instructor, technology is less adaptive and once a plan of integration is implemented, it is less likely to change, and therefore instructional design plays an important role in bridging pedagogy and technology. Secondly, it helps educators to make the best use of technology by helping in organizing and strategizing teaching via the chosen medium. Thirdly, it provides consistency between various courses developed by various instructors/designers. Fourthly, it

focuses on the most effective way to present content to the learners, beginning with the learner and the learner's experience in mind. Fifthly, the quality of the course offered is ensured to cover all the phases of good development. Finally, instructional design gives structure to the student's process of working through course material and creates a transparent process that can be tracked and utilized by the experiences of developers (Chaudry. M.A & Rahman. F., 2010). It is therefore clear that the use of mobile learning in well-designed instructional design would exploit the potential of mobile penetration in Kenya.

1.6 The Scope of the Study

This study targets to provide an instructional design and delivery model for guiding mobile learning application developers.

1.6.1 Assumptions

The assumptions upon which a study rests usually flow from the research methods employed (Leedy & Ormrod, 2010). This research employs a design and development methodology and therefore the following assumptions were made:-

1. The learners who are the users of the Mobile learning platform (software) can access Mobile Telecommunication networks via their mobile devices and can use their mobile devices effectively well;
2. The instructors teaching using the mobile platform are both computer literate, good mobile device users and are able to develop e-content or m-content for teaching and learning;
3. The institution hosting the Mobile learning platform has a network connectivity that can provide enough bandwidth high traffic of mobile learning content;

1.6.2 Limitations

As in the case of assumptions, the limitations of a study are usually associated with the research methods employed (Leedy & Ormrod, 2010). The following limitations might be identified in design and development research:

1. Since the participants in the study are learners the results of the system testing was limited to their opinions and judgments on the effectiveness of the mobile learning application system in meeting the criteria established for testing it,
2. The instructional design is limited to teaching and learning. The tools for delivery of content are limited to a networked environment and the learners are in an environment where there is mobile network coverage.

1.6.3 Delimitations

The instructional design and delivery model is suitable to be used by instructors who use mobile learning software environment; however, instructors with pedagogical skills can use it to model their traditional teaching processes. In addition, although the mobile learning application software was tested and recommended for use in institutions of higher learning i.e. in a university, it can also be used at different educational levels e.g. Primary, secondary and even adult learners' levels.

1.7 Key Concepts

Mobile Learning

The term mobile learning also referred to as m-learning, has different meanings for different learning communities. Some think of it as e-learning, educational technology or distance education, which focuses on learning with mobile devices. Mobile learning is contextualized as learning that takes place when learners engage in learning activities across multiple contexts through content interactions using personal electronic hand held portable devices.

Instruction(s)

The word instruction is a noun that refers to direction or order. It is detailed information about how something should be done or operated (oxforddictionaries.com).

Instructor

It is a person who gives direction or orders. An instructor guides the learners, explains to learners, uses formal language to communicate and builds relationships with the learners.

Instructional design

Models for instructional design provide procedural frameworks for the systematic production of instruction. They include fundamental elements of the instructional design process i.e. analysis of the intended learner and setting goals and objectives. Instructional models give structure or a framework and meaning to an instructional design problem for the purposes of producing instruction. It is the entire process of analysis of learning needs and goals and the development of a delivery system to meet the teaching and learning needs.

Modeling

A model is defined by Oxford English dictionary as a representation of a designed or actual object. Researchers have defined a model as "A stylized representation or a generalized description used in analysing or explaining something" (Hilborn & Mangel, 1997).

Using path modeling, the study employed a correlational design. This technique allows the evaluation of models embodying hypotheses concerning interrelationships among variables. The arrows in path model reflect hypotheses about causation. This kind of analysis illustrates which of two or more competing variables, derived from framework is most consistent with the pattern of correlations found in the data. The value of any compound path is the product of its path coefficients. The product of the coefficients along the path reflects the weight of that path (Tompkin 1978, Ofori & Charlton 2002, Garson 2008).

1.8 Organization of the Thesis

This thesis uses simple language to make it easy to understand and to read. Whether the reader is technically inclined or not, it should be possible to follow the arguments developed in it.

The thesis has five chapters in total.

Chapter one introduces the research project. The research study foundation is well set, indicating the context of the study, the research problem, research question and objectives. In addition, key words are defined and the scope is indicated.

Chapter two reviews literature, analysing various theoretical and empirical underpinnings of the study. Out of the review, an analysis of various research done within the domain is carried out to identify the gap and the chapter lays out the conceptual framework and outlines the hypotheses.

Chapter three addresses the methodology. Starting from the population and sampling frame, the chapter elaborates how respondents were obtained, data collected and analysed. The chapter explains methods to select the institution where experiments were conducted, how mobile readiness indexes were computed and how data was analysed.

Chapter four outlines the mobile learning system designs and explains the various components of the system. The chapter also explains the importance of the designs in aiding this research.

Chapter five compiles the analysis and discussions. A very rigorous analysis was done to establish the various relationships that makes the model. After every output of the analysis, a discussion is presented linking the particular findings from the study to the rest of the study.

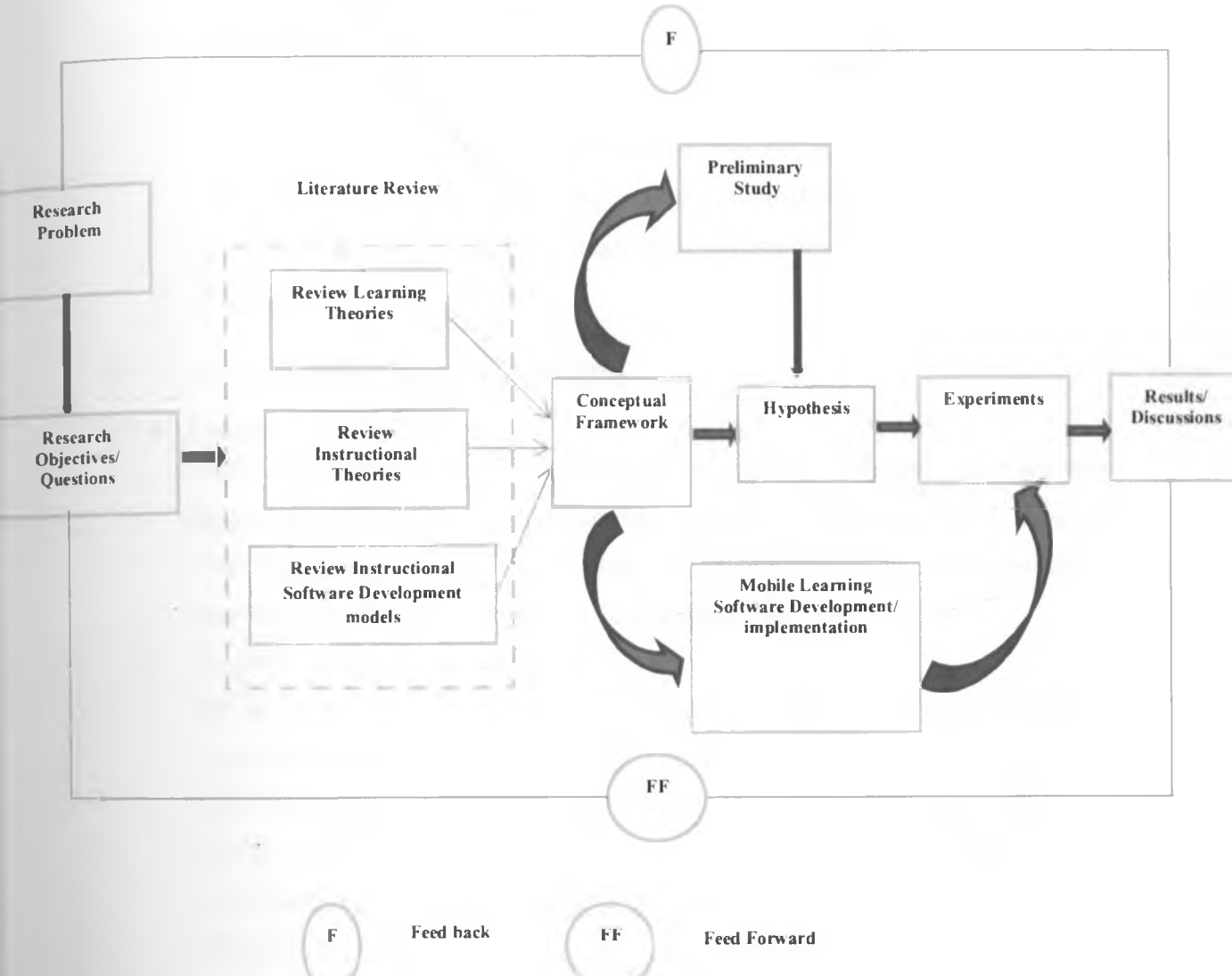
Chapter six elaborates on the conclusions and recommendations. After providing concluding remarks based on the study, linking the framework, hypotheses and objectives to the findings, the researcher makes recommendations on how this research study can be utilized by the target group. Research contributions, limitations and recommendations for further study are provided.

1.9 Overall Research Process

Research process is the method of gathering data, information and facts for the purposes of advancing knowledge (Shuttleworth, 2008). The researcher identified the problem, set out the objectives and research questions before reviewing related literature. Learning theories, instructional theories and software

development models were reviewed. The conceptual frame work was formulated. A team of mobile applications developers was constituted comprising of four developers in IVR, USSD, Android and Mobile Web. The team together with the researcher set targets to be achieved at various development stages. In order to achieve the testing of various variables, the team was guided by the researcher to include instructional steps leading to retrieval, interactivity and communications features with the content management system (Moodle) in each delivery channel (IVR, USSD, Android and Mobile Web). As this was iteratively being developed, a preliminary study was conducted. Learners were introduced to the early modules of each application to critic and give feedback. A questionnaire was given to establish mobile readiness index of the institution before full implementation of the system. While the development of the system was ongoing, the researcher formulated hypothesis that guided what experiments to conduct. Experiments were conducted, final results discussed that validated and lead to the new framework. Figure 1 is the graphical representation of the process followed.

Figure 1: The Research Process Diagram



CHAPTER 2: LITERATURE REVIEW AND CONCEPTUAL FRAMEWORK

2.1 Introduction

The literature review focuses on pedagogical issues surrounding technologies used for teaching and learning. Instructional theories are discussed focusing on the mobile learning and also learning theories. An analysis of literature is done to show the gap. Literature on design and development methodology is also discussed.

2.2 Learning and Pedagogical Theories

2.2.1 Learning theories

The study is grounded on the theory of mobile learning which borrows a lot from Behaviorist, Cognitivist, Constructivism, Vygotsky's Learning Theory, Situated Learning , Context Awareness Learning, Collaborative Learning, Conversational Learning, Location-based learning (Keskin & Metcalf, 2011).

Mobile Learning Perspectives

Educators are now focusing their attention on new methods of learning dammed as mobile learning that focuses on mobile devices and mobility Keagen (2005). According Keagen, the devices can be carried everywhere making the devices mobile as well as the learner. Mobile learning assumes the learner is continually on the move from one place to another or from one topic to another, from one subject course content to another and that learning can take place in all these contexts (Sharpes, Taylor & Vavoula, 2005).

Mobile learning is now accepted as a new mobile learning perspective that is creating a paradigm shift with many mobile research projects ongoing that are focusing on mobile technologies, mobility, individualism, ubiquitous, or e-learning (Keskin & Metcalf, 2011).

Mobile Learning and Learning Theories

The classical learning theories that support mobile learning are Behaviorism, Cognitivism, Constructivism, Vygotsky's, Situated Learning , Context Awareness

Learning, Collaborative Learning, Conversational Learning, Location-based learning (Keskin & Metcalf, 2011).

Mobile learning theories must take in cognizance of the fact that there is convergence of new learning and technology. Sharpes, et. al. 2005, elaborated this fact by showing that mobile learning is personalized while mobile technology is personal; the learner is able to use personal device anytime anywhere to collaboratively engage in learning activity in a networked environment (Sharpes, Taylor & Vavoula, 2005).

Behaviorism Theory

Response to stimulus can be observed, ignoring the possibility of thought processes occurring in the mind. Watson in his Pavlov law of classical conditioning believed that humans are born with a few reflexes and the emotional reactions of love and rage. All other behavior is established through stimulus-response associations through conditioning (Good & Brophy, 1990). Learners using mobile devices are motivated by the ease to use the devices and easy use of the application software for learning therefore applying the same theories and concepts; while learning occurs when learners evidence the appropriate reinforcement of an association between a particular response and stimulus (Smith and Ragan, 2005)

Cognitivist Theory

Behaviorism cannot explain certain social behaviors. For example, children do not imitate all behavior that has been reinforced. Children model new behavior days or weeks after their first initial observation without having been reinforced for the behavior. Individuals can model behavior by observing the behavior of others and reinforcement or operant conditioning may not be necessary before one is able to learn (Bandura and Walters, 1963).

Constructivist Theory

This theory advocates that someone's perception of the physical and social experiences shapes what one knows. The comprehension is done by the mind. Constructivists believe that learners can construct their own reality or can

interpret it based upon their perceptions of experiences, such that an individual's knowledge is dictated by one's prior experiences, mental structures, and beliefs (Jonasson, 1991). This theory is good in helping the designs of interactions between the learner and the content developed.

Vygotsky's Learning Theory

Vygotsky's theory is one of the foundations of constructivism. It asserts that learning takes place when learners engage in a social activity while being coached or mentored by a person with higher ability levels and that learning takes place at the point when the learner is able to carry out a learning activity under supervision. According to Vygotsky, **Social interaction** plays a fundamental role in the process of cognitive development. He notes that social learning precedes development. He also state that **The More Knowledgeable Other (MKO)**, who has a better understanding or a higher ability level than the learner, with respect to a particular task, process, or concept should mentor or coach the learners and when this happens learning will take place at **The Zone of Proximal Development (ZPD)**. The ZPD is the distance between a student's ability to perform a task under adult guidance and/or with peer collaboration and the student's ability of solving the problem independently (Vygotsky, 1978).

Situated Learning

Situated is defined as the Learning that takes place in the activity i.e.
Learning takes place in doing. According to Brown et al 1989, meaningful learning will take place if and only if it is embedded in the social and physical context within which it will be used. (Brown et al 1989). The implication of this theory is that the reward of interaction in a physical context is learning. Mobile devices are tools used to enable interaction, therefore is learning taking place in two ways, how to use the device and also the content delivered by the device.

The following table summarizes how each theory applies in mobile learning.

Table 1: Learning Theories that support Mobile learning

Learning Theory	Definition	Mobile learning
Behaviorism	Learning occurs when learners evidence the appropriate reinforcement of an association between a particular response and stimulus (Smith and Ragan, 2005) and that all other behavior is established through stimulus-response associations through conditioning (Good & Brophy, 1990).	Learners using mobile devices are motivated by the ease to use the devices and easy use of mobile devices. e.g. Mobile Response System through USSD, SMS, Interactive Voice Recognition software(IVR) or mobile Web.
Cognitivism	Learning is the acquisition or reorganization of the cognitive structures through which humans process and store information (Good and Brophy, 1990) or Learning take place when an individuals can model behavior by observing the behavior of others (Bandura and Walters, 1963).	Using Multimedia in mobile learning e.g. Images, audio, video, text, animations; Learner can observe and construct a mental model.
Constructivism	Learners can construct their own reality based upon their perceptions of experiences (Jonasson, 1991). Or Learning is an activity process in which learners construct new idea or concepts based on their current and past knowledge (Bruner, 1966)	Helps in the designs of interactions between the learner and the content on mobile devices.
Vygotsky's Learning	learning takes place when learners engage in a social activity while being coached or mentored by a person with higher ability levels and that learning takes place at the point when the learner is able to carry out a learning activity under supervision (Vygotsky, 1978)	The instructor role is critical in directing learning.
Situated Learning	Learning is not merely the acquisition of knowledge by individuals, but instead a process of social participation (Brown et all, 1989).	Social Context and Social participant dependent mobile learning e.g. Mobile performance support system modules like chat, feedback, upload, downloads.
Context Awareness Learning	Context awareness means gathering information from the environment to	Context aware in mobile learning e.g. Context-aware

	provide a measure of what is currently going on around user an the device (Naismith et all, 2004)	User (choice of learning channel according to time and location contexts)
Collaborative Learning	Learning is promoted, facilitated and enhanced by interaction and collaborations between students.	Collaboration and interaction dependent mobile learning e.g. Mobile computer supported collaborative learning Forum, mobile web (portal).
Conversational Learning	Learning is in terms of conversations between different systems of knowledge (Sharples, 2002).	Interaction and communication dependent mobile learning e.g. Mobile computer supported collaborative learning Calling, Interactive Voice Respond (IVR)
Location-based learning	Location-based learning holds promise for just- in-time learning tied to a student's physical location (Johnson et all, 2009)	Location context in mobile learning

Mwendia, Wagacha & Oboko 2014, classified Mobile learning projects into five classes:- Pedagogical ,Contextual, Blended, Application-Based and usability-based applications. According to them, the work of Sharple's et.al 2005, is classified under pedagogical category. They have argued that this category does not inform designer on usability of applications, however they concur that learning is a result of interactions between learner and content and instructor as advocated by pedagogical theories discussed in table 1. Each of these theories has something they contribute to mobile learning as indicated in the column for mobile learning.

2.2.2 Pedagogical Issues and Emerging Teaching and Learning Technologies

The choice of technology to aid teaching-learning process is the most challenging thing for an instruetor. E-learning and M-learning tools are examples of technologies that are used to support teaching and learning. While E-learning is gaining momentum faster in secondary and post-secondary institutions, M-learning is relatively new (Omwenga E.I., 2004; UNESCO, 2012). The argument is that instructional support is necessary to any technology that may be used as a learning tool and that all instructional activities need the following support:-

"**Modeling**: Demonstrating to the learner how (and why) to perform the activities necessary for the completion of some task or objectives.

Coaching: To intervene at critical points in the instruction in order to provide the learner with encouragement, diagnosis, directions and feedback.

Scaffolding: To adjust the task for the learner to match his/her level of performance. In the long run, the objective is to remove all support systems when the learner is ready to think on his/her own" (Omwenga E.I., 2004). Following these explanations, it is necessary that mobile learning should also be guided by instructional support. Instructional support meaning the instructor should guide, or mentor learners through well designed instructions that learners can follow bearing in mind levels the learner entry behavior.

Mobile Learning in relation to Learning Theories

Each of the learning theories discussed is limited to explaining some phenomenon of learning.

The most important thing about mobile learning is how instructional design for mobile learning environments can best be developed to improve learning and teaching experience of the learner. While learning takes place through sensory points of the learner as advocated by the behaviorist theory, the primary motivators are necessary to a sustained continuity to learning. The primary motivators accelerate learning. Vygotsky's theory which forms the foundation of constructivist theory underscores the importance of previous experiences both socially and individually to support sustained learning. Mobile learning is informed by these theories of learning.

Instructional Design Models

Models for instructional design provide procedural frameworks for the systematic production of instruction. They include fundamental elements of the instructional design process i.e. analysis of the intended learner and setting goals and objectives. Instructional models give structure or a framework and meaning to an instructional design problem for the purposes of producing instruction. It is the entire process of analysis of learning needs and goals and the development of a

delivery system to meet the teaching and learning needs. (Braxton et al. *1995*, Chaudry. M.A. & Rahman F. 2010).

2.2.3 Rationale for Instructional Design in Mobile Learning

The purpose of instructional design is to maximize the value of instruction for the learner. Pedagogical needs must drive the choice of instructional technology, not the other way around (Chizmar & Walbert, 1999). There are several benefits that instructional design offers: - First, compared with a human instructor, technology is less adaptive and once a plan of integration is implemented, it is less likely to change. The learners' reactions do not matter. Instructional design plays an important role in bridging pedagogy and technology. Secondly, the content has to be well organized and strategies for teaching via the chosen medium be put in place. Instructional design helps educators to make the best use of technology. Thirdly, It provides consistency between various courses developed by various instructors/designers. Fourthly, it focuses on the most effective way to present content to the learners beginning with the learner and the learner's experience in mind. Fifthly, the quality of the course offered is ensured to cover all the phases of good development. Finally, instructional design gives structure to the student's process of working through course material and creates a transparent process that can be tracked and utilized by the experiences of developers (Chaudry. M.A & Rahman. F., 2010).

Theory of Mobile Learning by Sharples et al. 2007

According to Sharples et al. 2007, the process of knowing come through conversations across multiple contexts among people and personal interactive technologies. This theory puts mobility and context as the central focus. The theory examines how learning flows across locations, timed, topics and technologies contrary to face to face classroom models which assume that learning occurs within a fixed location.

The early works of mobile learning started in early 1999 with Taxler and others who carried out research through projects funded by the European Commission in

Brussels. Some of these projects are Leonardo da Vinci: - from e-learning to mobile learning, Mobile learning: The next generation of learning; IST FP5:- The m-learning project and The MOBILearn project. The most important point to note is that these were projects and stopped after the funding stopped, however, their good works provided a foundation of mobile learning to mainstream education.

Sharple and his colleagues agree that understanding how to design technologies, media and interactions to support a seamless flow of learning across contexts is an important aspect when integrating mobile technologies within education. Most of the early researchers admit that "No single 'killer application' for mobile technology in learning can solve all instructional needs but instead each application only offers a set of promising scenarios (Sharples et al. 2007). The theory of mobile learning embrace learning that occurs outside classrooms and lecture halls as people initiate and structure their activities to enable educational processes and outcomes. This means that the theory ignores the instructor role in learning but focuses on learner individualized learning. Mobile learning is viewed as some may want to imagine self-instructing, however theories of instructional designs require instructions be organized by a mentor or someone knowledgeable than the learner in order to realize intended learning. It is therefore important to note that using mobile learning tools and combining them with face to face where instructors extend class work via mobile learning platform require an instructional design model. The theory of mobile learning focuses more on interactivity ignoring other aspects of learning e.g. content format, relevance, learner attention and feedback, and learner entry behavior.

In view of the works of early researchers in mobile learning further research is needed to address these instructional needs. Instructional designs for mobile learning that can promote enriching conversations between learners and teachers within and across contexts.

Theory of Mobile Learning by Edward Shih

While Keller's ARCS Model of motivational design explains a learning cycle with four steps:- Attention, Relevance, Confidence, and Satisfaction, Shih modified it to support mobile learning. Keller's model's emphasis is on motivation of learner which is determined levels of interactions (Keller, 1987). The initial step is to attract learners by stimulating their interest and curiosity. The learning cycle in the Shih's model includes:

1. Sending a multimedia message to mobile phones to trigger and motivate learners;
2. Searching the Web for relating information by using embedded hyperlinks (URLs) in the message received in the phone;
3. Discussing with learning peers by text, voice, picture, or video messaging;
4. Producing a digital story telling of what they learn by audio or video diary and;
5. Applying what they learn in the simulated environment, such as online educational gaming (Shih, 2005).

This model can only support smart devices that can push multi-media content making it only suitable for smart phones and tablets ignoring simple phones and feature phones.

Theory of Mobile Learning by Lorna Uden

Lorna Uden developed a theory to inform development of applications that are web based in nature. The activity theory was used to come up with a framework. The combination of context model and activity theory brought out the Uden model of 2007 activity theory for designing mobile application. The steps involved are many and complex which require one to be an expert in analysis using Engenstrom's activity diagram. While activity theory has its strength, it has its limitations to novitiate. One must understand the entire activity system under consideration, be an expert in unveiling activity system and be able to distinguish levels of activity actions and operations.

2.3 Classical Instructional Design Models

Dick and Carey Instructional Design Model

The model uses a systems approach for designing instruction. The approach to designing instruction is similar to that of software engineering methods. The design model describes all the phases of an iterative process that starts by identifying instructional goals and ends with a summative evaluation. This model has been used in designing k-12 instructional courses since it is a learner-centered model. Since it is a systems model, it is more involved with instructional development than design (Dick and Carey, 1996).

The model has the following steps:- instructional goals identification; instructional analysis; entry behavior identification; performance objectives writing; criterion reference tests development; instructional strategy development; instructional materials development; formative evaluation and summative evaluation development; and finally instructions revision.

Some critics feel that the systems approach is too focused on specific objectives to be successfully applied to the development of instruction which supports higher level thinking and the active construction of knowledge by learners. However, advocates of the systems approach dispute this, and believe the systems approach can be effectively employed to set appropriate goals and construct learning environments that facilitate the attainment of those goals (Merrill, Li, & jones, 1990).

Kemp Instructional Design Model

The Jerold Kemp instructional design method and model defines nine different components of an instructional design and at the same time adopts a continuous implementation and evaluation model. According to McGriff 2001, Kemp identifies nine key elements: - Identification of instructional problems and specification of goals for designing an instructional program; Examining learner characteristics; identification of subject content; statement of instructional objectives; sequencing content within each instructional unit; planning of

instructional messaging and delivery; development of evaluation instruments; and finally selection of resources to support instruction and learning activities.

The model is systemic and nonlinear and seems to encourage designers to work in all areas as appropriate (McGriff 2001).

While the model is useful for developing instructional programs that blend technology and pedagogy, it does not address the learner mobility and attention.

ADDIE Instructional Design Model

The ADDIE instructional design model is the generic process traditionally used by instructional designers. It has five phases: - Analysis, Design, Development, Implementation, and Evaluation. In the analysis phase, the instructional problem is clarified, the instructional goals and objectives are established and the learning environment and learner's existing knowledge and skills are identified. The design phase deals with learning objectives, assessment instruments, exercises, content, subject matter analysis, and lesson planning and media selection. The design phase should be systematic and specific. The development phase is where instructional designers and developers create and assemble the content assets that were blueprinted in the design phase. In this phase, storyboards are created, content is written and graphics are designed. If e/m learning is involved, programmers work to develop and/or integrate technologies. During the implementation phase, a procedure for training the facilitators and the learners is developed. The facilitators' training should cover the course curriculum, learning outcomes, method of delivery, and testing procedures. The evaluation phase consists of two parts: formative and summative.

It is an Instructional Systems Design (ISD) model. Most of the current instructional design models are spin-offs or variations of the ADDIE instructional design model; other models include the Dick & Carey and Kemp Instructional System Design (ISD) models. One commonly accepted improvement to this model is the use of rapid prototyping.

Gagne's 9 Events of Instruction

Robert Gagne is considered to be the foremost contributor to the systematic approach to instructional design and training. Gagne and his followers are known as behaviorists, and their focus is on the outcomes (or behaviors) resulting from training. He created a nine-step process called the events of instruction, which correlate to and address the conditions of learning:- Gain attention; Inform learner of objectives; Stimulate recall of prior learning; Present stimulus material; Provide learner guidance; Elicit performance; Provide feedback; Assess performance; Enhance retention transfer

Bloom's Learning Taxonomy

In 1956, Benjamin Bloom headed a group of educational psychologists who developed a classification of levels of intellectual behavior important in learning. Bloom found that over 95 % of the test questions students' encounter requires them to think only at the lowest possible level i.e. the recall of information. He identified six levels within the cognitive domain: - Knowledge; comprehension; application; analysis; synthesis and evaluation.

Knowledge refers to ability of learner to recall what they have learnt; Comprehension refers to ability of learner to explain ideas or concepts; Application refers to the ability of learner to apply information in a new way; Analysis refers to the ability of learner to distinguish different parts of a concept; Synthesis: Refers to the ability of learner to construct or design new arrangement from existing information; while Evaluation refers to the ability of learner to judge and predict leading to creation of new knowledge.

Gerlach & Ely Instructional design Model

The Gerlach-Ely Design Model is a prescriptive model that was tested to work for both K-12 levels of education and higher education. The model is suitable for its emphasis on content section and media selection within instruction. It is also good for resource allocation ((Gerlach, 1980). The model includes strategies for selecting and including media within instruction. It also handles the allocation of resources but only focus on resource allocations and enhancement of behavior while ignores other factors like learner characteristics e.g. attention.

Table 2: Comparison of Instruction Design Models (Strength and Weakness)

Model	Strength	Weakness
Dick & Carey	Effective in setting instructional goals and Focuses on strategy	Ignores learner behavior and delivery medium
Kemp	Focuses on learner characteristics and strategy of delivery	Ignores learner attention and context awareness
ADDIE	Common in all designs. It is a process	Very general, Needs an expert to interpret or someone with knowledge in instructional design
Gagne's Events of Instruction	Focuses on learner attention, context awareness, knowledge retention and learner guide	Ignores delivery model and medium
Blooms Taxonomy	Purely cognitive	Ignores learner behavior and characteristics, delivery medium and attention
Gerlach & Ely	The model includes strategies for selecting and including media within instruction. It also handles the allocation of resources.	Only focus on resource allocations and ignores other factors like learner characteristics like attention and entry behavior
Shih's Model	It focuses on learner Attention, content Relevance, Learner Confidence and satisfaction	Ignores learner behavior and characteristics, delivery medium and attention

Table 2 shows a comparative analysis of the various instructional design models, the strength of the model in regards to its focus on learning and its weakness in terms of what it does not focus on in learning.

In 2007, Traxler, acknowledges that although many forms of services are being offered by mobile learning, it is still immature in terms of its technological limitations and pedagogical considerations . And although some researchers such as Sharples, Taylor, & Vavoula, in 2005, and Uden, 2007 have developed some frameworks for theorizing about mobile learning, instructional designers, instructor and instructional software developers require a solid theoretical foundation for mobile learning (Park, 2011). Shih's Mobile Learning Model an instructional design model that can be used to helps instructional designers motivate and engage learners and instructors, however it ignores the learner

context and asssumes the content relevance and attention as key factors in learner motivation.

From researchers' perspectives, the existing theories and frameworks of mobile learning are successful in their purpose and objectives (Deegan & Rothwell 2010), however, none alone is appropriate for achieving an instructional design and delivery model for mobile learning.

2.4 Literature review analysis and the Research gap

Introduction to Journal review

Although literature review is limited to a snapshot and critical reports of current publications, a comparative analysis of various existing works is done.

The basis of journal review is to review thoroughly and exhaustively the literature of journals published between 2010 and 2013. The journal review offers a survey of mobile learning and or instructional design model articles based on a systematic review of publications.

Literature Review Analysis Method

In the institution of learning where the research was carried out, 215 journal papers were sampled from 39 databases for journals that the institution has subscribed to. The journal papers were scanned through to find out those that publish issues of education, science and technology. Then a further scan was done to establish journals that publish on instructional design or mobile learning.

All Mobile Learning publications that focused on frameworks, infrastructure and content delivery were thoroughly screened. The search criteria focused on existence of Mobile Learning system; Existence of Instructional Design Model(s); and Educational-oriented user systems.

The research focused on collecting abstracts and full papers from 27 journals out of 215 that were sampled using the search criteria. Only 3 out of 27 journals were found to publish issues of instructional designs and mobile learning i.e. International Journal of Teaching and Learning in Higher Education (IJTLHE, British Journal of Educational Technology, Journal of Education and Practice and

International Institute for Science, Technology and Education). The lenses for screening the three journals focused on whether the research paper indicates an Instructional Design Model was used and if used did it address ways of identifying learner readiness, instructor readiness, support for instructor to deliver a course, support student learning process, availability and accessibility of information, did it engage students in learning-related activities in diverse physical locations, Enable quick content delivery, Provide evaluation criteria, provide solutions to barriers of learning and allow learner feedbacks?

Results of Journal Review Analysis

Table 3: Selecting Journals that Publish Issues of Education, Science and Technology

Journal or Book or database	**Subject strengths**							
	Educ-ation	Science & techno-logy	social sciences	health	language & literature	arts	Agri-culture	Others
Africa Journals Online (AJOL)	X	X	X	X	X	X	X	
AGORA			X				X	X
ALUKA								X
American Institute Of Physics Journals								X
American Physical Society Aps								X
Annual Reviews								X
Caliber: Journals Of The University Of California Press								X
Cambridge University Press		X	X	X				X
Chicago Journals Online	X	X	X	X				X
Cochrane Library				X				X
Directory Of Open Access Journals (DOAJ)			X	X	X	X		X
EBSCO Host		X						X
Emerald Publishing		X						X
Expanded Academic ASAP	X	X	X	X	X	X	X	X
Geological Society								X
Google Scholar	X	X	X	X	X	X	X	X
Health & Wellness Resource Center				X				X
HINARI							X	X

Table 3 continued

Journal or Book or database	**Subject strengths**							
	Education	science & technology	social sciences	health	language & literature	arts	Agricultural	Others
Institute Of Electrical And Electronics Engineers		X						X
Institute Of Physics (IOP) Publishing		X						X
JSTOR	X	X	X	X	X	X	X	X
Mary Ann Liebert		X						X
Mineralogical Society Of Great Britain & Ireland								X
National Academies Press		X						X
Nature Publishing Group Journals								X
Optical Society Of America (OSA)		X						X
Organizational For Economic Co-Operation And Development								X
OUP E-Books Oxford English Dictionary Online								X
Oxford Journals	X	X	X	X	X	X	X	X
Pal Grave Macmillan Journals	X	X	X	X	X	X	X	X
Project MUSE	X	X	X	X	X	X	X	X
Royal Society For Chemistry-RSC Journals Archive								X
Royal Society For Chemistry-RSC Journals Online								X

Table 3 continued

Journal or Book or database	Subject strengths							
	Education	science & technology	social sciences	health	language & literature	arts	Agricultural	Others
Royal Society Journals Online		X						X
Sage Journals Online	X	X	X	X	X	X	X	X
Springer	X	X	X	X	X	X	X	X
Symposium Journals	X							
Wiley Interscience	X	X	X	X	X	X	X	X
World Bank Online Resources	X	X	X	X	X	X	X	X
Ebrary Collection	X	X	X	X	X	X	X	X
Academic Journals African Journals Archive	X	X	X	X	X	X		X
Bangladesh Journals OnLine (BanglaJOL)	X	X	X	X	X	X	X	X
Biomed Central: the open Access Publisher	X	X	X	X	X	X	X	X
BioOne	X	X	X	X	X	X	X	X
Sri Lanka Journals Online(SLJOL)	X	X	X	X	X	X	X	X
Virginia Tech Electronic Library	X	X	X	X	X	X	X	X

Table 3 continued

Journal or Book or database	Subject strengths							
	Education	science & technology	social sciences	health	language & literature	arts	Agricultural	Others
Academic Journals African Journals Archive	X	X	X	X	X	X		X
Bangladesh Journals OnLine	X	X	X	X	X	X	X	X
Biomed Central: the open Access Publisher	X	X	X	X	X	X	X	X
BioOne	X	X	X	X	X	X	X	X
Sri Lanka Journals Online(SLJOL)	X	X	X	X	X	X	X	X
Virginia Tech Electronic Library	X	X	X	X	X	X	X	X
Worldbank publications	X	X	X	X	X	X	X	X
World health organization (WHO)				X				X
CSIR Research Space	X	X	X	X	X	X	X	X
University of Stellebosch.	X	X	X	X	X	X	X	X
Opendoar	X	X	X	X	X	X	X	X
Kenya Law Reports								X
Hinari (e-journal)	X	X	X	X	X	X	X	X

Table 3 shows a categorization of journals and publishers that publish various issues. Out of the entire database of the university library, 69% (i.e. 27 out of 39) of the journals publish on issues of education, science and technology and 11% of them (i.e. 3 out of 27) published issues of instructional design models and mobile learning i.e. International Journal of Teaching and Learning in Higher Education (IJTLHE, British Journal of Educational Technology, Journal of Education and Practice and International Institute for Science, Technology and Education. This categorization reveals that very few publishers in the domain of education and technology have issues of instructional design.

The review method search criteria focused on:- existence of Mobile Learning system; Existence of Instructional Design Model(s); and Educational-oriented user systems. A google search for the key words was used screening each journal publication between 2010 and 2013. Table 4 shows the results of the various journals that publish issues regarding instructional designs and mobile learning from year 2010 to 2013. In each journal, the volume number is identified, the numbers of articles are indicated and the number of articles with issues of instructional designs and mobile learning are noted for each year. At the bottom of the table, a percentage of published issues noted are calculated.

The literature reviewed in this study was limited to a few examples from the rapidly growing body of research on mobile learning and instructional design. Although a small number of journals were introduced here, there are several other exemplary projects which can be classified.

However, this review reveals that there is few researchers involved in the research for instructional designs for technology.

***Table 4**: Selecting Journals that Publish Issues of Instructional Designs and Mobile Learning*

Journal	2013			2012			2011			2010		
	Volume	Total articles	Obser-ved	Volu me	Total article s	Obser-ved	Volum e	Total articles	observe d	Volume	Total article s	Obser-ved
International Journal of Teaching and Learning in Higher Education	-	-	-	24(3)	13	0	23(3)	13	0	22(3)	16	1
	-	-	-	24(2)	16	0	23(2)	13	3	22(2)	13	6
	-	-	-	24(1)	14	0	23(1)	15	7	22(1)	11	6
British Journal of Educational Technology	-	-	-	43(6)	32	2	42(6)	34	3	41(6)	44	4
	-	-	-	43(5)	18	7	42(5)	30	2	41(5)	32	2
	44(4)	15	4	43(4)	30	6	42(4)	28	1	41(4)	16	1
	44(3)	25	3	43(3)	28	2	42(3)	21	0	41(3)	26	1
	44(2)	27	2	43(2)	25	1	42(2)	25	1	41(2)	31	6
	44(1)	27	5	43(1)	32	3	42(1)	28	3	41(1)	17	1
Journal of Education and Practice	4(12)	27	0	3(16)	31	2	2(12)	3	0	1(4)	3	0
	4(11)	28	0	3(15)	23	0	2(11)	4	0	1(3)	3	1
	4(10)	26	0	3(14)	26	1	2(10)	6	1	1(2)	3	0
International Institute for Science, Technology and Education	4(9)	22	0	3(13)	21	0	2(9)	6	0	1(1)	3	0
	4(8)	28	0	3(12)	26	0	2(8)	6	1	-	-	-
	4(7)	27	1	3(11)	8	0	2(7)	9	0	-	-	-
	4(6)	29	1	3(10)	12	0	2(6)	10	0	-	-	-
	4(5)	24	1	3(9)	24	1	2(5)	11	1	-	-	-
	4(4)	35	0	3(8)	33	0	2(4)	21	0	-	-	-
	4(3)	24	0	3(7)	21	2	2(3)	16	0	-	-	-
	4(2)	22	0	3(6)	13	0	2(2)	8	0	-	-	-
	4(1)	22	2	3(5)	9	1	2(1)	4	0	-	-	-
		408	19		412	28		270	13		178	16
		4.7%			6.8%			4.8%			9.0%	

Results and Discussions of the review of literature analysis

From table 4, between January 2010 and July 2013, each year records less than 10% of the total published work. In 2013, 2012, 2011, and 2010 only 4.7% , 6.8%,4.8% and 9.0% articles featured having issues of mobile learning or instructional design issues respectively.

After thorough search and examining each paper's abstracts, majority of the papers reviewed focused on the following areas: Emerging technologies; Technology adoption; Pedagogy and Policy & Practice.

On emerging technologies, mobile learning was one of the emerging teaching and learning technologies. All papers on this issue concur that mobile learning has not yet been widely embraced but there is increased use of mobile technologies especially in developing world.

On technology adoption, all papers revised on this issue acknowledge that the use of mobile technologies has the potential to transform the teacher-learner relationship.

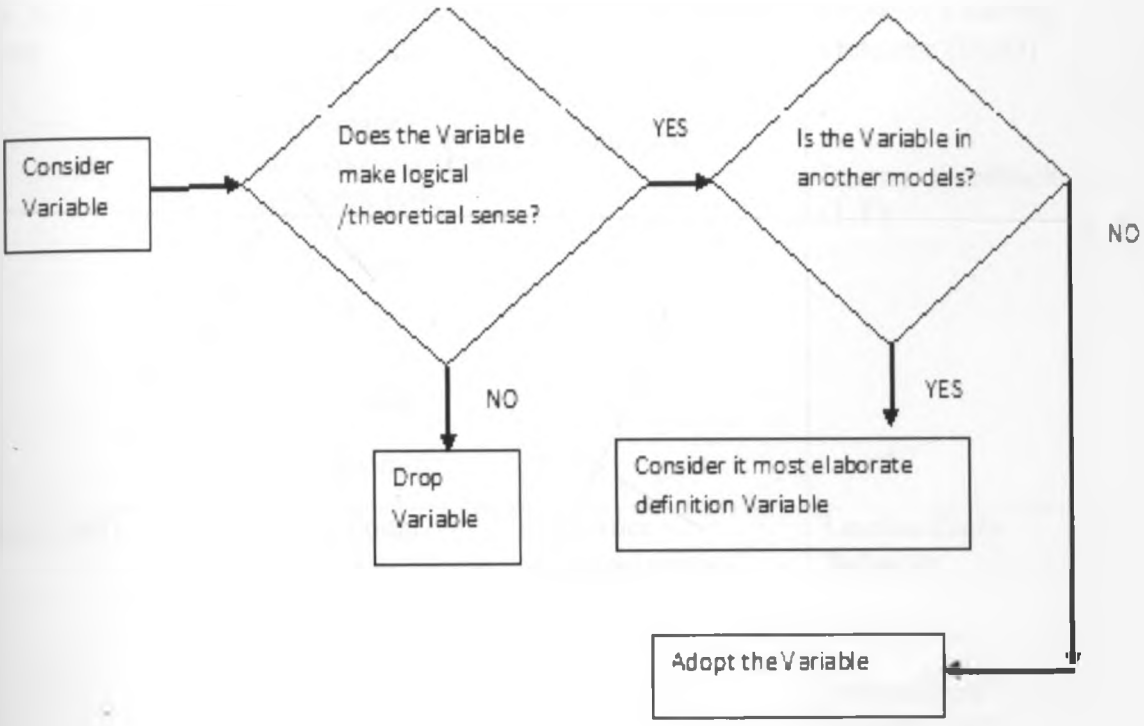
On Pedagogical issues, framework for integrating technology on mobile learning has not been fully developed and many learning environments of mobile learning are adapting IDM for web 2.0 technologies and many research on this area have focused on learner experiences, attitude, acceptability, adoption and usability.

In conclusion, research work reviewed show that there is need for instructional designers and educators to research more on instructional design models for emerging technologies like mobile technologies since they have high potential to be used as a learning tool. Since little research has been done to in this area and few instructional design guidelines based on a solid theoretical framework for mobile learning exist, it is clear therefore, that there is a gap to be filled by carrying out research on issues of instructional design and delivery of teaching and learning using modern hand held devices.

2.5 Conceptual Framework

Criteria of Selecting Variables from Existing Instructional Design Models

Figure 2: Variable Selection Criteria from Existing Models



Source and author: Researcher

Figure 2 was designed and authored by the researcher as a mental process of enabling one to arrive to a logical conclusion for each variable considered. If a variable make logical sense is accepted if not dropped. If it is common to many other models it is accepted as it is or renamed if it is not common.

Table 5: Variable Selection and Naming

INSTRUCTIONAL DESIGN MODEL	VARIABLES IDENTIFIED	SELECTED VARIABLE	NEW VARIABLE NAME
Dick & Carey (1990)	Instructional goals, Instructional analysis, performance objectives, criterion reference task, Instructional strategy Content development Evaluation	Instructional goal Evaluation	Intended Learning Outcome (I.L.O) Learner Feedback (L.F)
Kemp(1985)	Instructional problem, Learner characteristics, Task analysis, instructional objectives, Content sequencing, instructional strategies, Design messages, Instructional delivery, Instruction evaluation, Revision	Learner characteristics Instructional delivery Instructional goal	Learner Entry Behavior Instructional delivery mode (D.M)

Table 5 Continued

INSTRUCTIONAL DESIGN MODEL	VARIABLES IDENTIFIED	SELECTED VARIABLE	NEW VARIABLE NAME
Gerlach & Ely	Content specification, Objectives specification, Entry behavior, Strategy, Group organization, Resource selection, Performance evaluation, Feedback analysis	Resource selection Feedback analysis Instructional goal	Content Format/Packaging (C.F.P) Learner Feedback (L.F) Intended Learning Outcome (I.L.O)
Gagne's 9events of Instruction	Gain attention, Learners context awareness, Stimuli to recall, Learners guide, Performance, Enhanced referential	Gain attention, Learners context awareness, Learners guide Performance	Learner Attention (L.A) Context Awareness Intended Learning Outcome (I.L.O)
Shih's Model	Attention, Relevance, Confidence, satisfaction	Confidence satisfaction Learners Satisfaction	Learners Feedback

Table 5 was designed to help in identifying various variables for each selected instructional design model. From the variables identified, and using logic explained by figure 2, variables are selected and renamed as new variables to be used for constructing the conceptual framework. The aim of an instruction to a learner is to achieve an intended learning outcome.

Figure 3: Layout of Variables

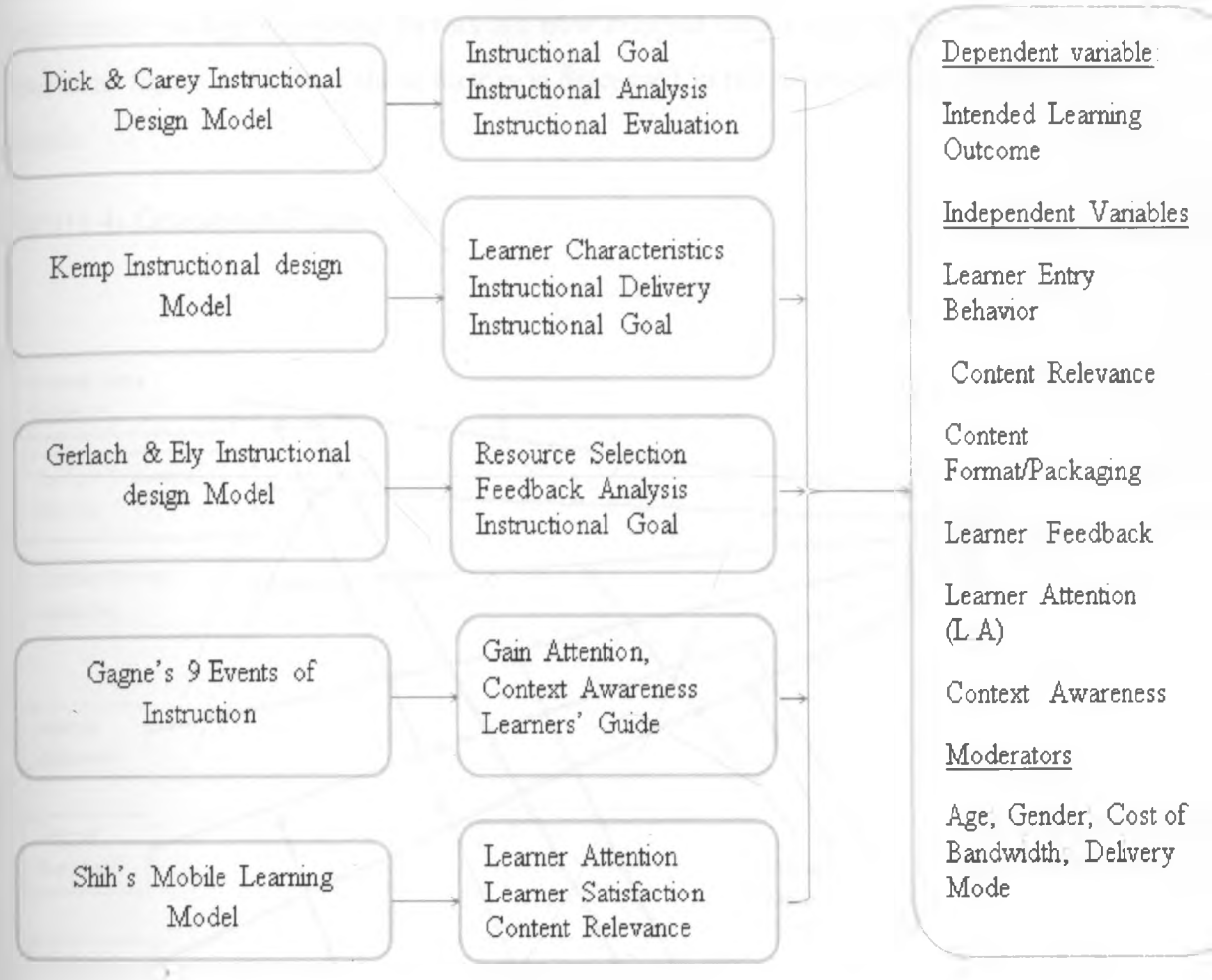


Figure 3 shows the mapping of variables as selected from various instructional design models to the final variables for the conceptual model. The strength of each instructional model was identified and renamed for purposes of modeling instructional design model for mobile learning.

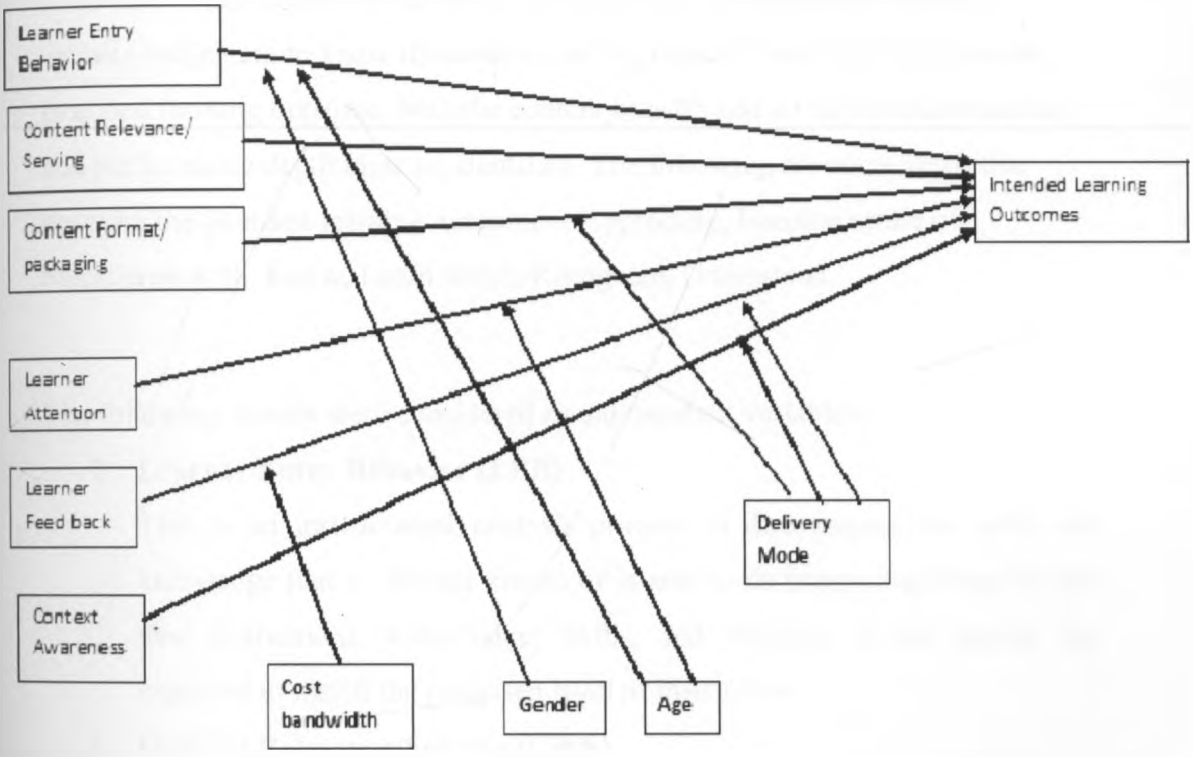
Dependent Variable

Intended learning outcome: This variable refers to the instructional goal that the instructor sets to achieve after the learners go through the learning activities directed by the instruction.

From the discussions of the previous section and this section, and from the researchers' perspectives, the existing theories and frameworks of mobile learning are successful in their purpose and objectives (Deegan & Rothwell 2010), however, none alone is appropriate for achieving an instructional design and delivery model for mobile learning. Therefore, a combination of the strength of each one of them is

necessary in addressing critical aspects of mobile learning in relation to pedagogical needs. Figure 2 provides a logical method of combining these factors and as represented on figure 3, these factors are now mapped onto a conceptual frame work shown as figure 4. Each of these factors is discussed in the following section 2.5.1 in details.

Figure 4: Conceptual Framework



Author: The Researcher

Figure 4 shows the various independent variables identified for modeling the instructional design model for mobile learning placed on the left (Learner entry behavior, Content relevance and serving, content format and packaging, learner attention, learner feedback, and context awareness) and the dependent variable on the right (Intended Learning Outcome). The moderators are placed at the bottom (Cost of bandwidrh, Gender, Age and Delivery Mode).

2.5.1 Model factors

The modeling process considered the following factor as dependent variable:-

Intended Learning Outcomes (ILO)

Intended Learning outcomes are the actual results of learning or the aspects of a student's learning that an instructor identifies to assess and reward. Course designs set out the instructor's intentions for learning (intended learning outcomes). Intended learning outcome entails: - The very best understanding that the learner could be reasonably be expected to achieve at a declarative level at a level that would warrant a Pass. The instructor uses an assessment task that enables judgement to know if standard can be graded. When instructors set the intended learning outcome, both the content breadth and levels of understanding and performance depth must be identified. The following are some verbs that describe the intended learning outcome: - Appreciate, Become aware of, Familiarise with, Know, Learn about, Recognize, Understand.

The following factors were considered as independent variables:-

1. **Learner Entry Behavior (LEB)**

   This is an instructional analysis process in determining the skills and knowledge that a learner knows or is able to do before beginning to take new instructions. Knowledge, Skills, and Abilities of the learner are expected to match the proposed level of instruction.

2. **Content Relevance/Serving (CR/S)**

   This means the right content that enables the learner or instructor to be informed correctly in accordance with expected outcome. Instructors can have strategies of achieving the intended learning outcome by creating the right content such that when the learners interact with the content they are able to get the right information while using certain devices.

3. **Content Format / Packaging (CF/P)**

   A content format is an encoded manner for converting specific data types to be displayed in certain ways. It is also referred as instructional media or the physical means by which the instructional message is communicated, such as: TEXT (print materials, hypertexts, sms text, USSD text etc.), GRAPHICS(charts, pictures, artworks etc.), VIDEOS (films,

animations, video clips etc.) , VOICE (recorded sound bytes, real time voices/calls) , PACKAGING (slides, overheads, real objects, and videotape or film, DVDs, CD-ROMs, the Internet, interactive video conferencing etc.)

4. **Learner Attention (LA)**

   Learner attention is the interest shown by a learner in taking in the knowledge or skill that is being taught (Storch, 2001; Williams, 1999; Leeser, 2004 and Williams, 1999).

5. **Learner Feedback (L.F)**

   Written or spoken information to an individual in response to an instruction about his/her view or performance.

6. **Context Awareness (C.A)**

   Whereas context awareness is defined as a property of mobile devices in relation to location awareness, location may determine how certain processes of learning may be applied more flexibly with mobile users. The users in this case are learners sensing their physical environment and adapting their behavior accordingly.

Moderators

The following were considered as the moderators to achieving intended learning outcomes:-

1. **Delivery Mode (D.M)**

   Delivery mode is the way instructions are delivered to support and enable the learning process. In this study, several modes of instructions were considered i.e through SMS, USSD, and Mobile application or Mobile Web technologies.

2. **Age**

   The age is the period the respondent has lived since birth.

3. **Gender**

   The gender is the sexual nature of the respondent (either male or female)

4. **Cost of bandwidth**

   The cost of bandwidth is the money the respondent spends to access internet

2.6 Hypotheses

Based on the conceptual framework and the discussed underpinning theories of learning, the following hypotheses were formulated; To find out:-

1. If the factors (Learner Entry Behavior (L.E.B), Content Relevance (C.R), Content Format and Packaging (C.F.P), Learner Attention (L.A), Learner Feedback (L.F), and Context Awareness (C.A)) have a significant relationship to influence the intended Learning Outcomes (I.L.O).
2. If the moderators (Gender, Age, Cost of band width and Delivery Mode) have any significant impact on the influence of determinants towards achieving the I.L.O.

The hypotheses are written as follows:-

a) Direct path hypotheses;

b) Moderator hypotheses.

2.6.1 Direct path hypotheses

The direct path hypotheses consider the independent variable and how it relates and affects the dependent variable. They form an important part of the research finding that help model the instructional design and delivery model for mobile learning. They were stated as follows:-

H1: The Learner Entry Behavior (L.E.B) has a significant influence to achieving the intended Learning Outcome (I.L.O);

H2: The Content Relevance and Serving (C.R/S) has a significant influence to achieving the intended Learning Outcome (I.L.O);

H3: The Content Format and Packaging (C.F.P) have a significant influence to achieving the intended Learning Outcome (I.L.O);

H4: The Learner Attention (L.A) has a significant influence to achieving the intended Learning Outcome (I.L.O);

H5: The Learner Feedback (L.F) has a significant influence to achieving the intended Learning Outcome (I.L.O);

H6: The Context Awareness (C.A) has a significant influence to achieving the intended Learning Outcome (I.L.O).

2.6.2 Moderator Hypotheses

The moderators are the variables that affect independent variable in influencing the dependent variable. The researcher intended to find out how

the moderator variable affects the relationship between the independent variable and the dependent variable. The hypotheses were stated as follows:-

H1a: The effect of L.E.B on intended Learning Outcome (I.L.O) is moderated by gender;

H1b: The effect of L.E.B on intended Learning Outcome (I.L.O) is moderated by age;

H3a: The effect of C.F.P on intended Learning Outcome (I.L.O) is moderated by Delivery mode;

H4a: The effect of L.A on intended Learning Outcome (I.L.O) is moderated by Age;

H5a: The effect of L.F on intended Learning Outcome (I.L.O) is moderated by Cost of Bandwidth;

H5b: The effect of L.F on intended Learning Outcome (I.L.O) is moderated by Delivery Mode;

H6a: The effect of C.A on intended Learning Outcome (I.L.O) is moderated by Delivery Mode;

2.7 Summary of Chapter Two

The major goal of any instructional model is to guide instructors how to plan, develop, implement, evaluate, and organize learning activities. Learning theories alone cannot be used as instructional design models, for example Constructivism theory is a learning theory that requires an instructional designer to interpret it into activities that help learners to construct knowledge. When using a learning theory, an instructor must know the strength and weaknesses of the theory in order to make optimum use of it in an instructional design strategy. In order to understand the impact of instruction to the learners, the instructor must also understand all the factors influencing learner performance, so that they could be applied properly to improve the learning process. Mobile learning has emerged as one of the new teaching and learning technologies that can improve teaching and learning experiences; the early works of mobile learning layed a foundation by providing theories of mobile learning, however, many focus on device, mobility ignoring critical instructional aspects like content format, relevance and learner attention. From the discussions in this chapter, the published journal articles on issues of

instructional designs and delivery models from year 2010 to year 2013 are less than 10%. Those that have published have recommended that research should be done on areas of instructional designs on emerging technologies. From table 2, all models of instructions discussed assume learning in a traditional classroom where the learner environment is static. The only learning theories that support mobile learning are Shih's model by Keller and Mobile learning theory by Sharpe. Shih's model assume mobile device is a smart phone that can push multimedia content to the learner making it not able to support simple phones and feature phones while the Sharpe's theory of mobile learning focuses only to learner context and mobility. All these models assume that instructors can interpret them assuming that they have pedagogical skills, however, majority of instructors in higher learning institutions are using supportive technologies like mobile technology to instruct learners despite them having no pedagogical skills. It is therefore necessary that a mobile learning system designed with ability to support mobile learning technologies for instructional purposes is required. This research was designed to fill this gap by providing a model that can guide instructor when planning, developing, evaluating and organizing their teaching and learning activities that are supported by mobile devices. The conceptual framework was formed by considering common variables used by other models of instructional designs and researcher viewpoints. A logical process was used to arrive at every factor or variable to be studied and hypotheses formulated to aid in finding out the relationships.

CHAPTER 3: METHODOLOGY

3.1 Introduction

In the previous chapter, a review of related literature was discussed to inform the conceptual model that guided the study. This chapter describes the various stages conducted in order to achieve the set objectives. It focuses on the method used to review the related literature, the general methods of identifying the population, sampling and data collection, the development of mobile learning system, the establishment of readiness for institutions to host the mobile learning system, experimental designs and the data analysis methods.

3.2 Research Approach

3.2.1 The general Research Design

Different research objectives require the use of different research approaches. The methods can be classified in different ways, quantitative and qualitative. While quantitative methods originated from the natural science, social sciences have applied the method through surveys, experiments, formal methods and others. The interpretation provides strong scientific evidence of how a phenomenon exist (Mugenda 2008). In order for this study to answer the research questions, the study is designed to use both approaches. For example, when determining the institution to host the mobile learning system, investigations on the readiness to adopt such a system was done where both quantitative and qualitative research designs were used.

3.2.2 Experimental designs

Experimental designs are frameworks or structure of an experiment Kothari (2004, p.39-41). He classifies experimental designs into informal and formal designs. Informal consisting of (i) before and after without control, (ii) after only with control, (iii) before and after with control while formal consisting of (i) completely randomized, (ii) randomized block, (iii) Latin square and (iv) Factorial design.

This study has used completely randomized i.e. randomized replication design. This design involves replication and randomization principles of experimental

design. This design method takes care of extraneous variables and differential effects.

3.3 Location of the Study

The study is carried out in Kenya, Africa. A Kenyan university is purposefully sampled. The university is located in the outskirts' of Nairobi city. It has campuses in various cities in Kenya with a total population of approximately 4000 students. It offers its programs through three main modes, i.e. Day (regular), School-based, and Distance learning. Purposive sampling is sampling technique that allows a researcher to use cases that have the required information with respect to the objectives of to his or her study (Mugenda, 2008). Many universities have rigorous procedures of allocating classes to lecturer. The researcher chose the university where class allocation was possible without complexity. Secondly, the university offers different mode of learning.

3.4 Target Population

For purposes of this study, the population of the institution was targeted by the pre –study to evaluate the institutional readiness to adopt a mobile learning system. The pre- study targeted a population of 1800 learners in the selected institution of higher learning. It is from this population that the samples were obtained using a formula (Mugenda, 2008). Among these learners, there are those that take their studies through distance learning mode, school based mode or regular (day and evening) mode.

During preliminary data collection, samples were collected from the entire population. The total target populations in all modes of study were approximated follows:- Day and Evening 1000, School based 600, Distance learners 200 all totaling to 1800 learners.

During experiment, the courses that were selected had class sizes that were not very large and the entire class was targeted to be studied. According to Mugenda, 2008, when the population targeted is small all members are studied.

3.5 Sample and Sampling Methods

3.5.1 Sample for Mobile Learning Readiness

To determine sample size, one needs to have the precision level, confidence level and degree of variability (Kothari 2004). The level of precision or sampling error is the range in which the true value of the population is estimated; The confidence level or risk level is the average value of the attribute obtained by repeatedly sampling population which is deemed to be distributed normally about the true mean and the degree of variability is the distribution of attributes in the population being studied. Kothari (2011), Mugenda (2008) all provide a formula for computing samples of finite population and also for infinite population. They propose the following formulae for computing sample size:

For finite population

$$n = \frac{z^2 p.q.N}{e^2 (N-1) + z^2 p.q}$$

for infinite population (Mugenda says for population >10,000)

$$n = \frac{z^2 p.q}{e^2}$$

Where:

n = the sample size desired

z= standard normal deviation at the required confident level

p= the proportion in the target population estimated to have the characteristics

q=1-p

e = the level of statistical significance

Using the formula of finite population, the samples shown on table 6 were drawn from the target population.

Stratified sampling was done across the three modes of the study i.e. regular day students, school based and distance learning. Students were randomly given the questionnaire during their session. The distance learners were given the questionnaire when they visited campus for their end trimester exam and school based student were given the questionnaire during their class session breaks.

Table 6: Table of Calculated and Used Samples

Learners mode	Total number of learners	Calculated sample size	Sample used
Day and Evening	1000	277.24	270
School based	600	234.086	230
Distance learners	200	131.639	130

Table 6 shows the samples calculated in each mode of study the learners are registered.

3.5.2 Method used in Calculating Mobile Learning Readiness

A survey was carried out to establish the key variables that lead to readiness to adopt M-learning as an instructive mode of teaching and learning. Under qualitative interviews are done while under quantitative questionnaires are administered to investigate various indicators that lead to readiness. It is important to measure how an institution is ready to adopt a technology. Mobile learning readiness involves institutional readiness (Kashoda & Waema, 2008) and student and faculty ownership, use, and readiness for mobile learning (Corbeil, J. R., & Valdes-Corbeil, M. E. 2007).

Staging framework for Mobile Learning

The mobile readiness framework used in this research was derived from Kenya Education Network (KENET) e-readiness framework. The e-readiness framework was the first diagnostic tool to be used in Kenya to assess e-readiness for higher education in the year 2002 (Waema and Kashorda, 2002, 2013). It was used to evaluate ICT readiness for 17 universities in Kenya.

The five categories used in the e-readiness framework were retained and used by the mobile readiness framework. However, the indicators were modified from 17 to 13. The following criteria was used to select relevant indicators from e-readiness Framework

Figure 5: M-learning Readiness Selection Criteria

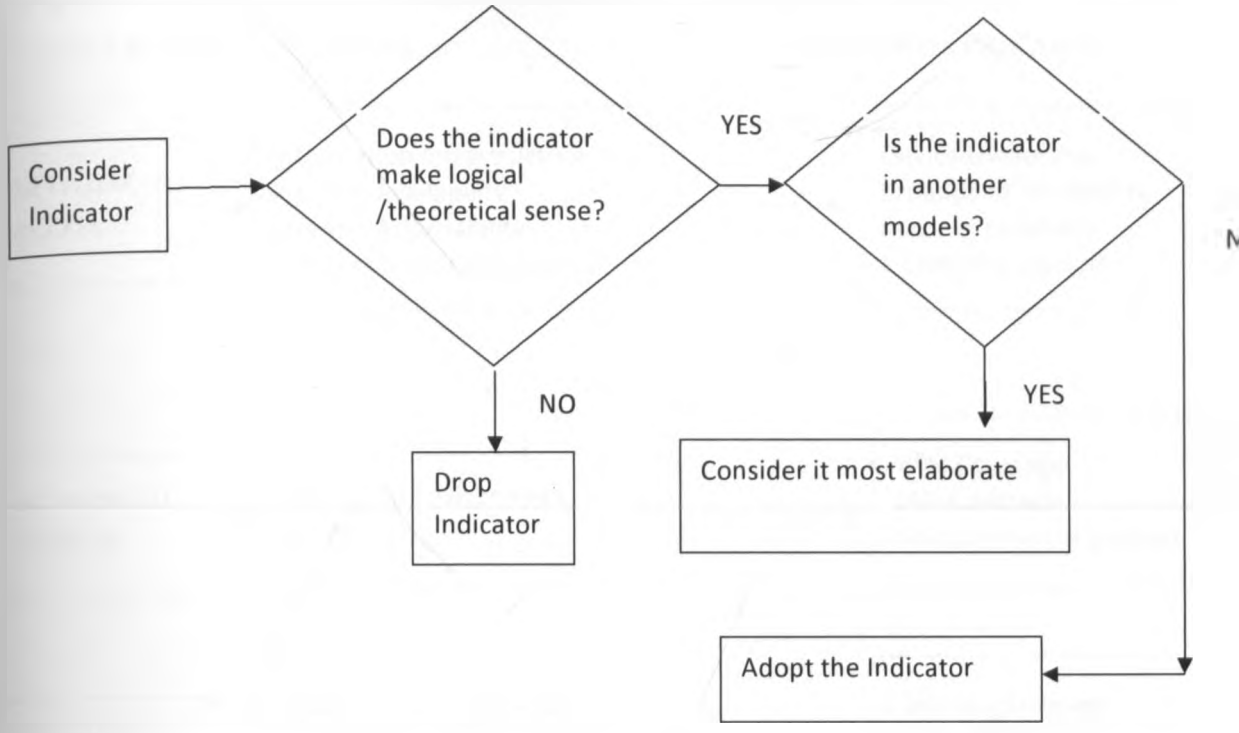


Figure 5 shows the logical flow the researcher used to identify the variables to use in calculating mobile learning readiness from the Kenya Education Network (KENET) e-readiness model. A factor is chosen from the KENET framework, if it does not make logical sense to mobile learning it is dropped if it does it is accepted by either adopting it as it is or it is renamed.

Figure 6: E-readiness Framework Modified for Mobile Readiness Framework

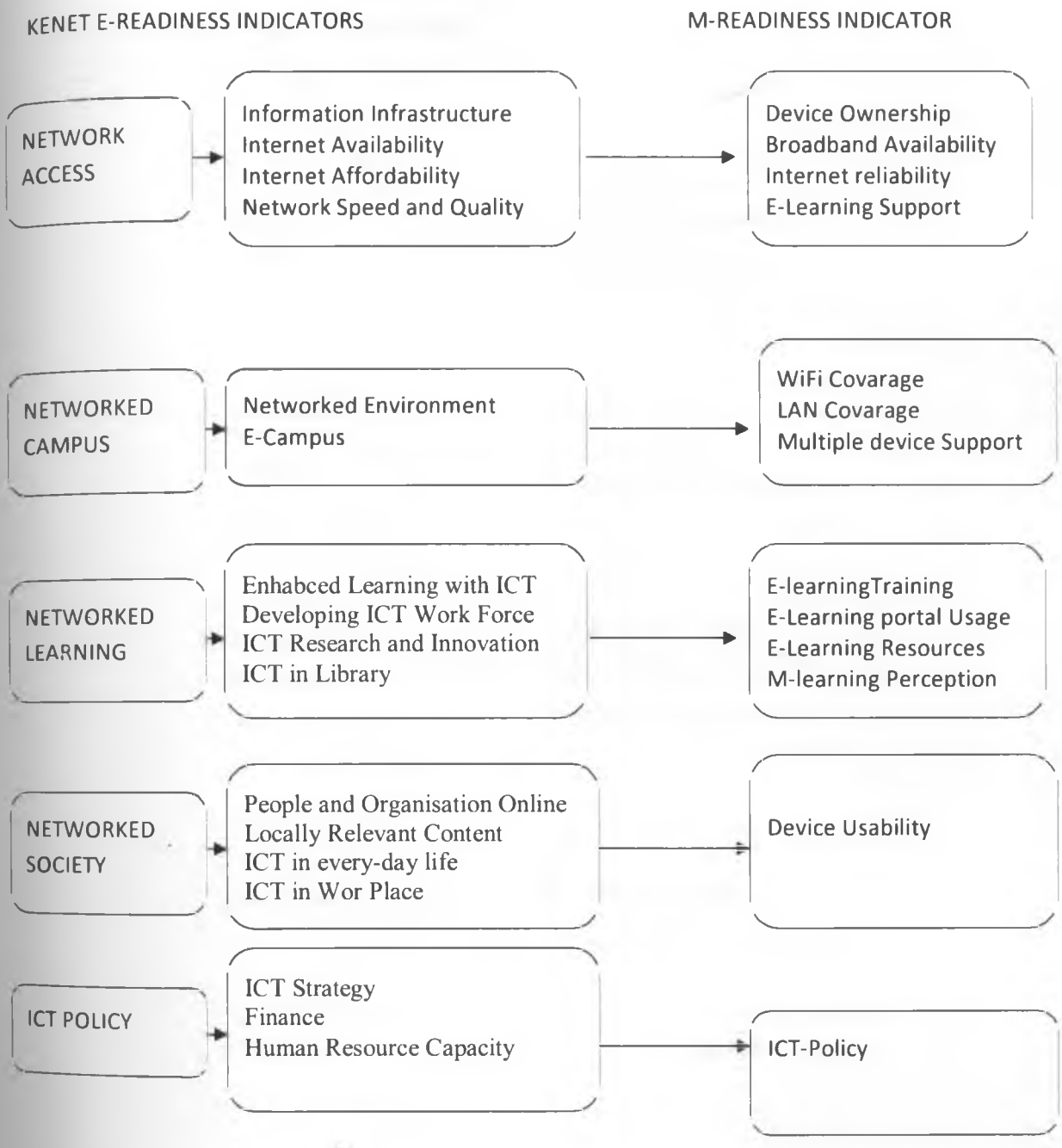


Figure 6 shows the mapping of KENET model and the identified indicator for mobile learning readiness model.

Figure 7: Mobile Readiness Framework

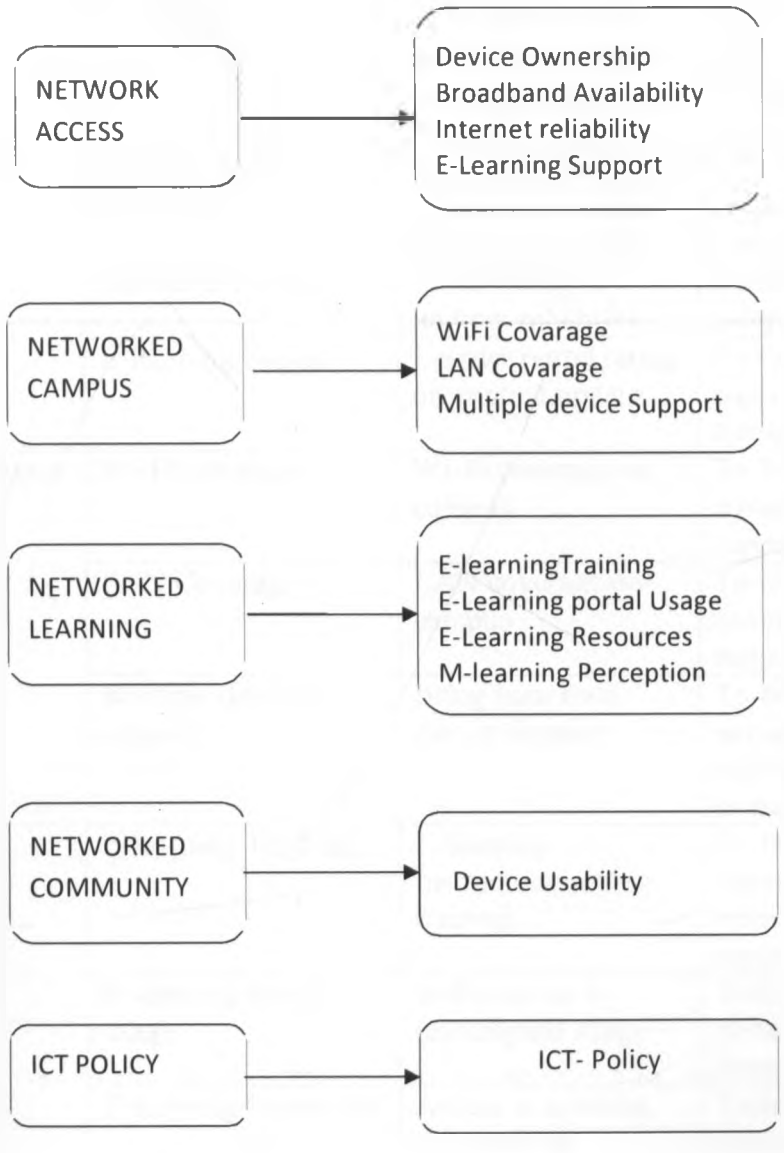


Figure 7 shows the new model derived from the logical flow diagram shown by figure 6 through logical flowchart shown by figure 5. On the left are factors and on the right are the indicators associated with each factor.

Staging of Indicators

Table 7: Selected Indicators and their Purposes

Category	Indicator	Description	Purpose
	Device Ownership	% ownwership of smartphone, feature phone or simple phones	To determine delivery mode SMS, USSD, Mobile WEB orVoice recognition
Network Access	Availability of Broadband	% access mode of Internet on campus and out of campus	To find out broadband covarage and access by faculty and students
	Internet reliability	User rating of internet reliability	To find out if internet on campus is reliable
	E-learning Suport	Learner portal rating on content update	To find out if student get support while learning through e-learning
Networked Campus	Wi-Fi coverage	Wi-Fi coverage on campus	To find out if Wi-Fi coverage is adequateto support multiple devices
	LAN Covarage	LAN coverage on campus	To find out if LAN coverage is adequateto support multiple devices
	Multiple devices support	Bring your own device Support	To find out if the university support multiple mobile devices to learners
Networked Learning	E-learning Training	E-learning Instructions and or training	To find out if e-learning training or self help manuals are provided to support learners
	E-learning portal usage	Software for e-learningand usage	Tofind out if e-learning portals are used forpurposes of learning
	E-learning Resources	Access to e-books, e-journals in university library	Tofind out if learners are able to access e-learning materials
	M-learning Perceptions	Learner belief on mobile learning	To find out what thelearner percieve mobile learning
Networked Community	Device Usage	Prefered use of mobile device to connect to others	To find out most prefered use of mobile device to communicate on campus
ICT Policy	ICT Policy	ICT policy and budgetery support	To find out if the university policy exist to support ICT growth

Table 7 shows a description of each indicator used in the mobile learning readiness model and the purpose of each indicator.

Computing M-Readiness indexes

Having collected data on the 13 indicators across the 5 categories and after staging, the formula

$$m - readiness = \frac{\sum_{j=1}^{n} W_{ij} e_{ij}}{n}$$

was used to compute m-readiness index for the institution, where:

m is the overall m-readiness value

i is mode of study

j is each of the 13 indicators

w_{ij} is relative weights assigned to the 13 measures (j)

e_{ij} is individual score for each measure on a scale of 1 to 4

n is total number of measures (13)

The computing procedure is summarized as follows:

Step 1: select the list of learning modes whose m-readiness is to be compared

Step 2: gather data on the individual 13 measures for each mode

Step 3: sort the data in step (2) by category. Since there are 5 categories, this will create 5 groups of data

Step 4: choose one category in step (3) along with its indicators

Step 5: examine the first measure of the chosen category. Identify the smallest and the largest values; determine the range by subtracting the smaller value from the larger

Step 6: create a normalized scale for the indicator

i. Divide the range in step (5) into 4 equal intervals
ii. Assign 1 to the smallest number in step (5)
iii. Assign 4 to the largest number
iv. Assign 2and 3 corresponding to the interval data created in step 6(i)

Step 7: compare each learning mode value for the measure against the normalized scale in step (6)

Step 8: assign the closest normalized values for each mode

Step 9: repeat steps (5) – (8) until all indicators for the factor are done

Step 10: compute the weighted average of the values in step (8); this gives the m-readiness value for the given category

Step 11: repeat steps (4) – (10) until all categories are done

Step 12: average the values of all categories in step (10); this gives the m-readiness index for each learning mode.

The reason for normalizing the raw data into a range 1 to 4 is to enable the comparison between learning modes m-readiness with that of other modes. The normalization scale is chosen such that a value of 1 represents a mode that is least m-ready whereas a value of 4 indicates one that is most m-ready.

3.5.3 Sampling method for Mobile learning Experiment

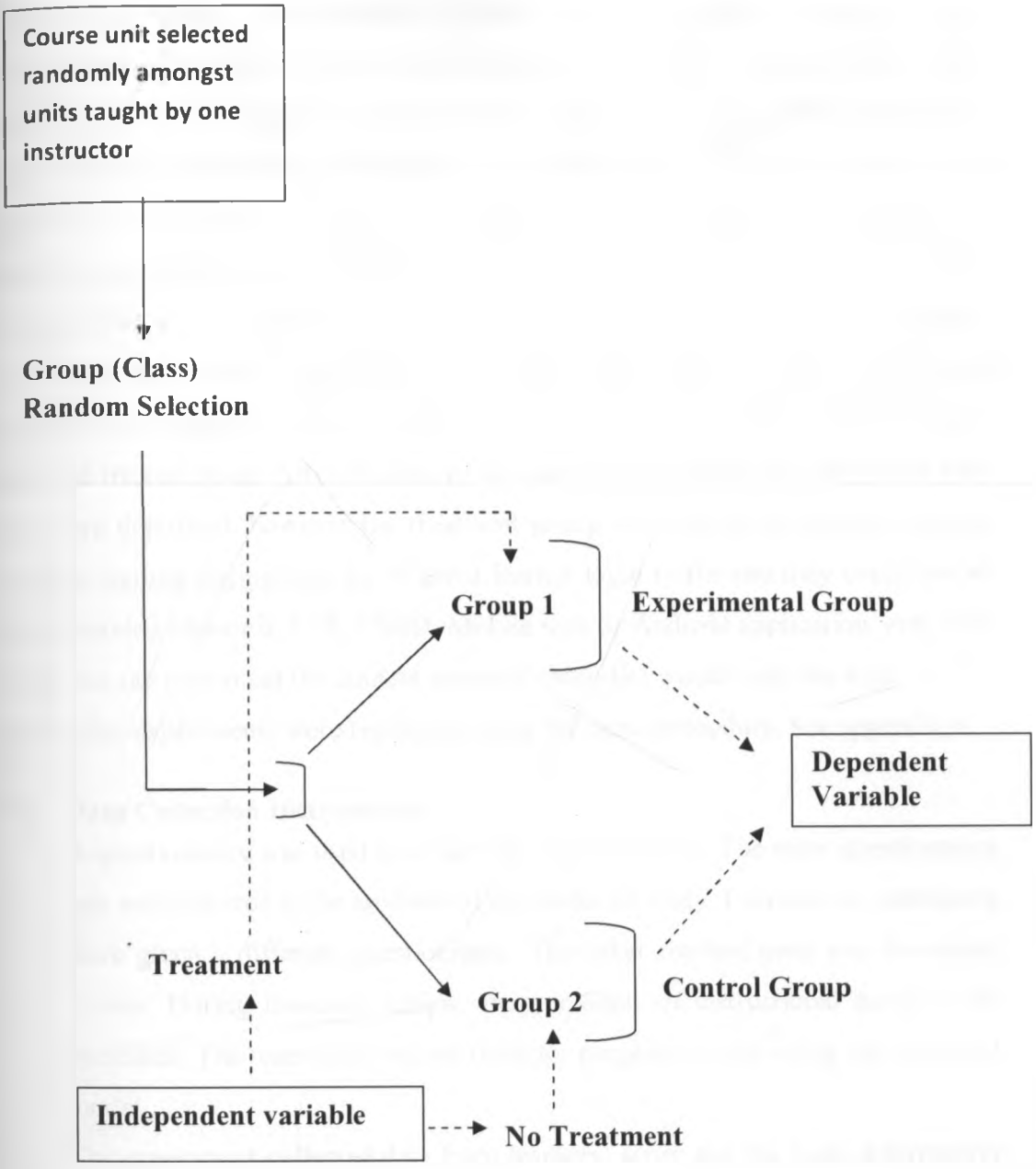
From the trimester's course offering, all course units that were offered in both campuses were sampled and one randomly selected for experiments.

Random replication design was used. This method requires the researcher to have two groups of learners. One group must be the control group and the other to receive the treatment. The replications come as a result of carrying out several experiments and all must be similar. The researcher had to decide the treatment group and the control group. This decision was done purposively due to constrain given by one of the delivery channel IVR. This channel consumes a lot of institutional bandwidth and could only be accessed on campus local area network. On that basis the main campus group was selected to be the treatment group. One group was taught in town campus and the other in the main campus. Both groups were regular day and evening learners. The town campus group was taught in the evenings. It was the control group and the other was taught during day in main campus. The group on main campus was the group that received treatment. Both groups were taught by the same lecturer. Both groups were given a pre- test at the beginning of the trimester. The test was a written examination that tested previous pre-requisite knowledge on programming concepts. The control group was taught normally using traditional methods of face to face while the treated group was instructed using traditional methods of face to face but also provided mobile learning channels (IVR, Mobile Web, USSD and Android application). Four

continuous tests were given at equal intervals of two weeks interval and a final exam given. Figure 8 shows the design diagram.

The two groups did not meet due to differences in class time and the distance between the two campuses. The experiments conducted were aimed at introducing various components of mobile learning to the treatment group while denying access to such components for the control groups. The tests evaluations given were the same for the treated group and the control group. The scores were recorded for evaluation.

Figure 8: Random Replication Design Diagram



Author: The researcher

In Figure 8 continuous arrows show the selection and grouping of the experimental group and the control group while the dotted lines shows flow of independent variable through both groups to the observed results of dependent variable. The independent variable is the observed learning that brings out the learning outcome dependent variable.

Experiment one lead to test one, experiment two lead to test two and so on for four experiments done.

For example, experiment 1 was designed as follows:-

This being the first topic, the learners were expected to have covered computer fundamentals where computational concepts and programming languages were introduced. In this topic the learner was introduced to a specific language and in this case it was C++. The instructor set the learning outcomes which were grouped into three categories, **cognitive, psychomotor and affective** such that the learner was expected to know how to construct simple program using C++ language by constructing data types, operators and syntax. The learner was also expected to write by typing the code on machine (Psychomotor) and run the programs after debugging it in case it had errors. The instructor designed instructions for each activity that would help the learner to learn and follow. The activities were same for both control group and treated group. After the lessons all learners were directed to the portal were notes were deposited, however the treatment group were given the mobile learning site, http://mobile-learn.anu.ac.ke. When a learner login to the site they could use all mobile learning channels, IVR, USSD, Mobile web or Android application. Any time they access site or content the content manager (Moodle) would keep the logs.
All the other experiments were replicated using the same procedure. See appendix 6.

3.6 Data Collection Instruments

A questionnaire was used to collect the empirical data. The same questionnaire was administered to the students of all modes of study. Lecturers or instructors were given a different questionnaire. The other method used was document review. During literature review, many models of instructional design were identified. The researcher studied them for purposes of informing the proposed model.

The experiment collected data from learners' score and the login information from the m-learning system (software).

3.7 Data Analysis

Table 8: Data Analysis Plan at all Stages

Stage	Design	Data Collection Instrument	Sampling Method	Data Analysis
LR	Qualitative	Intenet search engine	Random	Content analysis
Mobile Readiness	Quantitative	questionaire	Stratified Random	KENET Staging algorithm
Mobile Learning software development	Qualitative/ Prototyping	Software Developers Focus group	Purposive	Testdroid tool Callflow tool USSD-API
Experimental	Quantitative	Tests, Score Sheets, System Logs	Random replication	SPSS- tools

Table 8 shows the data analysis plan at all stages. It indicates the stage, research design, instruments used to collect data, sampling method and data analysis method used.

Table 9: Hypothesis Testing Plan

Factor	Hypothesis	Indicators	Statistical Measure
Learner Entry Behavior	The Learner Entry Behavior (L.E.B) has a significant influence to achieving the intended Learning Outcome (I.L.O)	Pre-test scores & Post-test	Pearson's Chi Square P value (<.05) Somers d value (>.15)
Content Relevance& Serving	The Content Relevance and Serving (C.R/S) has a significant influence to achieving the intended Learning Outcome (I.L.O)	System logs on Notes, quiz, video clips, chat room, android app., lessons, Bible verses	Pearson's correlational values p values (<.05) Effect size (F>10)
Content Format and Packaging	The Content Format and Packaging (C.F.P) have a significant influence to achieving the intended Learning Outcome (I.L.O)	Plain text, Discussion forums, video clips and graphics	Pearson's correlational values p values (<.05) Effect size (F>10
Learner Attention	The Learner Attention (L.A) has a significant influence to achieving the intended Learning Outcome (I.L.O)	System Time stamp (time taken to hand in work or respond to discussion)	**Pearson's Chi Square** P value (<.05)
Learner Feedback	The Learner Feedback (L.F) has a significant influence to achieving the intended Learning Outcome (I.L.O)	System logs on Number of uploaded feedback or discussion response)	**Pearson's Chi Square** P value (<.05)
Learner Context Awareness (L.C.A)	The Context Awareness (C.A) has a significant influence to achieving the intended Learning Outcome (I.L.O)	System log in (IVR, Android App, Mobile Web, USSD)	Pearson's correlational values p values (<.05) Effect size (F>10

Table 9 shows the hypothesis testing plan. It has the factor under investigation, hypothesis, indicators and SPSS statistic used.

3.8 Reliability and Validity Tests

Reliability Test

The questionnaire was developed and pretested on a sample of 20 respondents from another institution of higher learning. This was a pilot study that was aimed at evaluating the questionnaire instrument to see if it can be relied on to collect data. The instrument was edited before and after the pilot study (Robson 2007). Baker et. al. 2003, found that a sample size of 10-20% of the sample size for the actual study is a reasonable number of participants to consider enrolling in a pilot. The reliability of the research instrument was computed using Cronbach's alpha scale. It shows how closely related a set of items are as a group. A high value of alpha is often used as evidence that the items measure an underlying (or latent) construct. A reliability coefficient of .700 or higher is considered "acceptable"(Hair et. al. 2006). After the pilot, data was entered in SPSS software and a scale test of reliability test was run. The Cronbach's alpha for the unstandardized items was .789 while for the standardized items was .874. Both figures are above .70. When values are too high above 0.7, it indicates that the individual variables could be measuring the whole construct and there may be elements of redundancy. However, such high values can occur in cases where there are strong views from respondents. In this case the value is not too high above .70 and therefore right to conclude the instrument is reliable.

Validity Test

Validity is a measure that establishes the relationship between the data and the variable or construct of interest. It measures the degree of accuracy to which an instrument measures what it purports to measure (Mugenda, 2008).Validity analysis was used to determine how consistently the selected variables measured some construct. Researchers have indicated that it is much easier to define validity than to demonstrate it conclusively, mainly because validity is more a relative than an absolute concept (Hair, et al., 2010). There are two popular forms of validity the research computed, i.e. content validity and construct validity.

Content Validity

Content validity is the systematic examination of the test content to determine whether it covers the appropriate knowledge domain (Mugenda, 2008). The

researcher examined content validity by letting expert to judge the instrument and providing the researcher with feedback right from the first draft of the instrument to the final one, consultation. Three experts in the field of e-learning, instructional technology and computer science were given the instruments to review and give suggestions. Gall, Borg and Gall (2003), points out that content expert help determine content validity by defining in precise terms the domain of the specific content that test is assumed to represent and then determine how well the content universe is sampled by the test items. The research tool was be revised according to the experts' suggestions.

According to Bogdan and Biklen (1998), use of multiple and different sources of information (triangulation) ensures validity of the data. In this study use of more than one expert to verify the content; use of multiple subjects to provide information was important since mobile learning is multidisciplinary.

Construct Validity

Construct validity refers to the degree to which measurement variables represent its intended constructs. This also shows the extent to which a construct is truly distinct from other constructs. There are two forms of construct validity that were utilized, namely convergent validity and discriminant validity (Hair, et al., 2006). Variables or measures of constructs that are related to each other show a correspondence or convergence while measures that theoretically should not be related to each other discriminate.

Convergent validity (sometimes called correlational or criterion analysis) assesses the degree to which measures of the same construct are correlated. To establish convergent validity, the researcher ensured the following:-

During piloting, all questions that were not clear were reconstructed and retested to ensure clarity; No two questions were asking similar concept, experts were consulted and feedback from respondent was taken seriously. During experiments, all experiments were conducted in replica to ensure same procedures were followed and consistency was maintained; the selection of the two campuses that are far away from one another and different times of learning ensured there was no crossover effect that would otherwise temper with results; The choice of class that were of same level doing same subject also ensured there was no disparity in terms of content variations. In testing, the two groups were given same test and all measure taken indicated the

construct measured the intended aspect (Hair, et al., 2006). The Cronbach's alpha test indicated the instrument was reliable hence it is right to conclude items that are indicators of a specific construct converge and those that measure dissimilar concepts discriminate.

It has discriminant validity since it has a low correlation with measures of dissimilar concepts (Hair, et al., 2010).

3.8 Data collection procedures for Experiments

After getting authorization to collect data from relevant authorities, a pilot survey was conducted to a small group of 50 students sampled randomly from all modes of learning. This allowed validity and reliability checks of the data collecting instruments. After verifying that the data collection tools were reliable, enough copies of the questionnaires were made and distributed to all target groups.

Experimental data was collected from pre-test and post-test scores and also from learner's logs to the M-learning system.

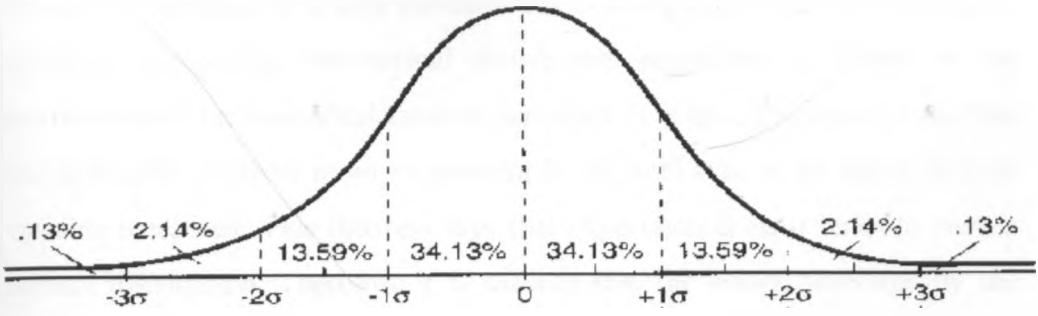
The sampled course unit had both regular day and regular evening learners; the evening group was used as the control group while the regular day was given the treatment. The replication was done by repeating experiments three times. All assessments done were averaged to provide the post test score.

A second questionnaire was administered to mobile learners to find out their perceptions, regarding the new mode of learning.

3.9 Data analysis: Experimental Data

The sample chosen for this study was normally distributed. Therefore, the probability density function f(x) considered in this case is symmetric and is centered at the mean of f(x). The area under the curve lies within $\mu \pm \sigma$ capturing 68.2%, $\mu \pm 2\sigma$ capturing 95.4% and $\mu \pm 3\sigma$ capturing 99.7% of the total probability as shown on figure 13. The area beyond is considered insignificant.

Figure 9 : The Normal Distribution Curve



Source: Google images:

A frequency distributions and P-P plots was carried out on data using SPSS. Observing the P-P plot for all variables and computing the correlations, the p-value was found to be greater than 0.05, which indicates normal distribution of data.

Table 10 shows the results of correlations obtained from cross tabulations to establish the p values and Sommer's d values.

Figure 10: Bivariate Measure using Somer's D statistics

Directional Measures	P-Value	Asymp. Std. Error[a]	Somers' d
Learner Entry Behavior (LEB)	.811	.032	-.045
Content Format (CF/P)	.810	.032	-.145
Content Relevance and Serving (CR/S)	.782	.032	.006
Average time to Respond(LAttention)	.812	.032	.065
Context Aareness (CA)	.922	.032	.100
Learner Feedback(LFEEDBACK)	.645	.032	-.005

The errors in the observations are normally distributed and that it is not the variables themselves that are normally distributed.

Following Somer's D value that are less than .15, it is right to conclude that each of these variables are not correlated and each is independent since their relationships are very weak. Somers' D is a transformation of the Pearson correlation coefficient. It can be defined in terms of Kendall's τa (Kendall and Gibbons, 1990). It measures the difference between the probability that the two variables are concordant or discordant (Newton, 2014).

The central limit theorem supports the choice of the sample. It says that as the number of variables in a sum increases the distribution of the sum of random variables approaches the normal distribution regardless of shape of the distribution of the individual random variables. It is true, therefore to say that the aggregate of errors in an experiment is the total sum of all errors in each variable measured. This theorem says that experimental error tends to have a normal distribution. Therefore it is assured that the errors generated by the experiment are distributed normally.

3.10 Ethical Considerations

Ethics is a matter of commitment to and behaviour guided by certain values (Vogt, Gardner and Haeffele 2012). Some ethical considerations that were considered in this research study include:

1. Written permission was obtained from National Council for Science and Technology to allow researcher conduct the study in Nairobi county and its environs.
2. Written permission was obtained from The Vice Chancellor to allow researcher conduct the study at the University.
3. Respondents were required to voluntarily enrol in the mobile learning system.
4. The target population was requested to fill in the questionnaire willingly and purpose was stated clearly at the beginning of the questionnaire.
5. Confidentiality was ensured before asking the respondents to fill the questionnaire anonymously.
6. The treatment group in the experiment seemed favoured by the exposure to mobile learning, however all learners in the university can access student portal where same content is deposited for online access. The portal is purely web-based where all communications to the learners is posted too.

CHAPTER 4: MOBILE LEARNING SYSTEM ANALYSIS AND DESIGN

4.1 Introduction

In order to model instructional design and delivery model for mobile learning, and also conduct experiments, it was necessary to use an existing mobile learning system or develop one that would enable these objectives to be met. The researcher intended to test instructional delivery using mobile devices. It was important to develop mobile learning system that supported features of the framework. It was also necessary to implement the system in an environment that is ready to adopt the system. Having conducted a survey to establish the readiness to adopt the mobile learning system, the researcher proceeded to develop the system.

The method used to develop the system was prototyping and the following steps were used:

Step 1: Basic Requirement Identification: At this step, a few students of computer science and instructors were involved in coming up with the basics system requirements. The critical aspects, especially user interface, were captured from a student's and instructor's perspectives.

Step 2: Developing the initial Prototype: Mobile application for android phone, USSD interface, mobile web interface and IVR interface were developed. The features in all applications were expected to provide learners and instructors a chance to critic. After all corrections were made, the system went for testing.

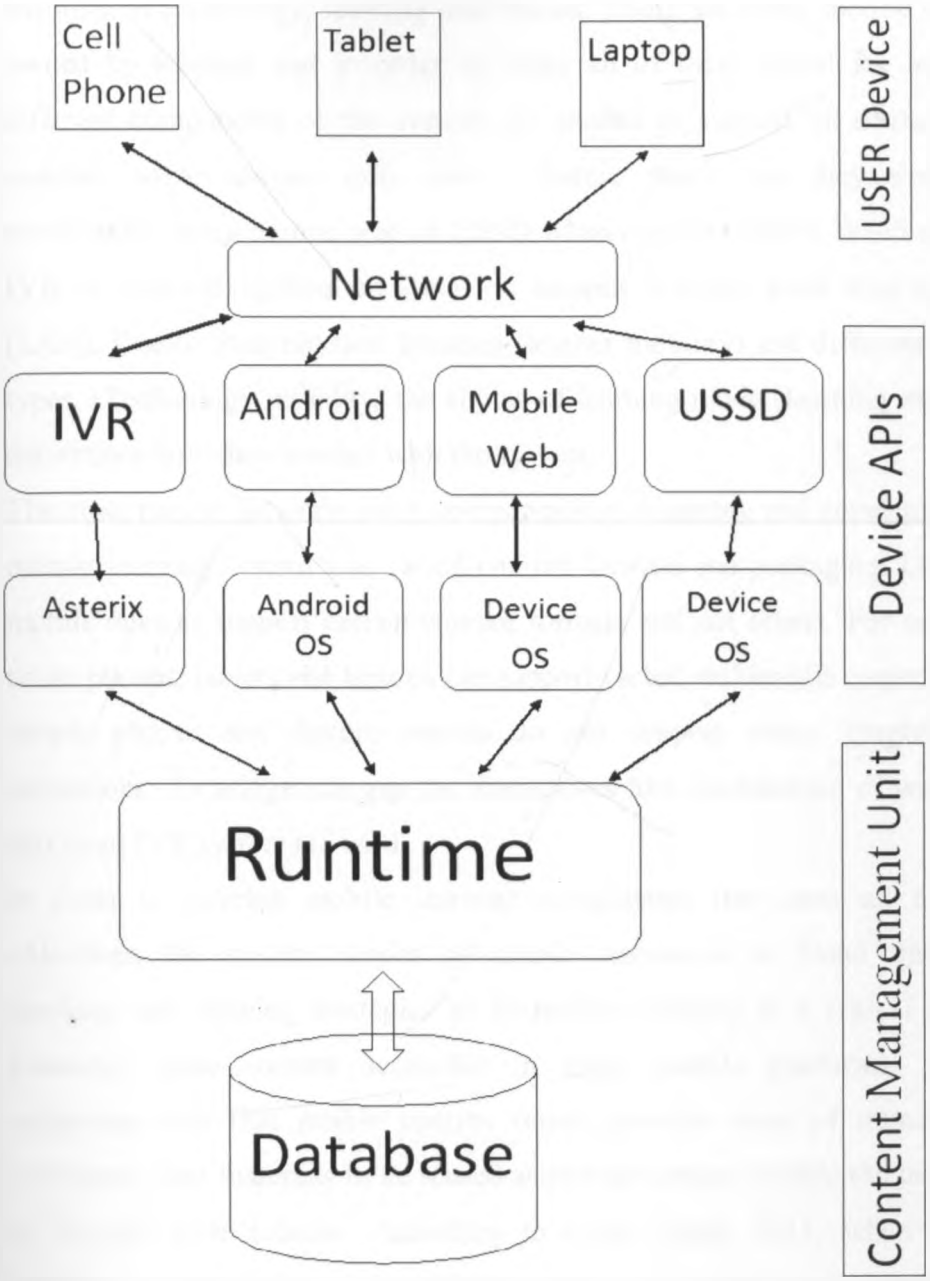
Step 3: Review of the Prototype: Continuous testing of modules was done by the developers for further enhancements of the modules.

4.2 System Designs Architecture

The mobile learning system was designed to host four components i.e. mobile application for android phone, USSD interface, mobile web interface and IVR interface. All the components are integrated together to post or retrieve data and information from one database.

Figure 14 below shows the architectural design of the whole system.

Figure 11: The Architectural Design of the System



Source: Author (Researcher)

Figure 11 shows the design of content management which is the server side of the system. It has a database and various scripts for running various mobile applications i.e. asterix, android, mobile web and USSD. The device application interfaces (API's) for various devices link up with the servers through sessions that are created by server when clients make such request.

According to El-Hussein and Cronje (2010), the tripartite of mobility is an important design issue that needs to be paid attention to when designing and

developing a mobile learning system. The tripartite of mobility includes the mobility of technology, learning and learner. There are many mobile devices owned by learners and in order to make all of them useful for learning, different components of the system are needed to support all devices. For example some learners only own a feature phone and they would be comfortable using mobile web or USSD when outside campus Wi-Fi and use IVR or Android application when on campus wireless local area network (LAN). Due to their physical location (learner mobility) and different device types, (Technology mobility) the choice of learning mode (learning mobility) determines how they interact with the system.

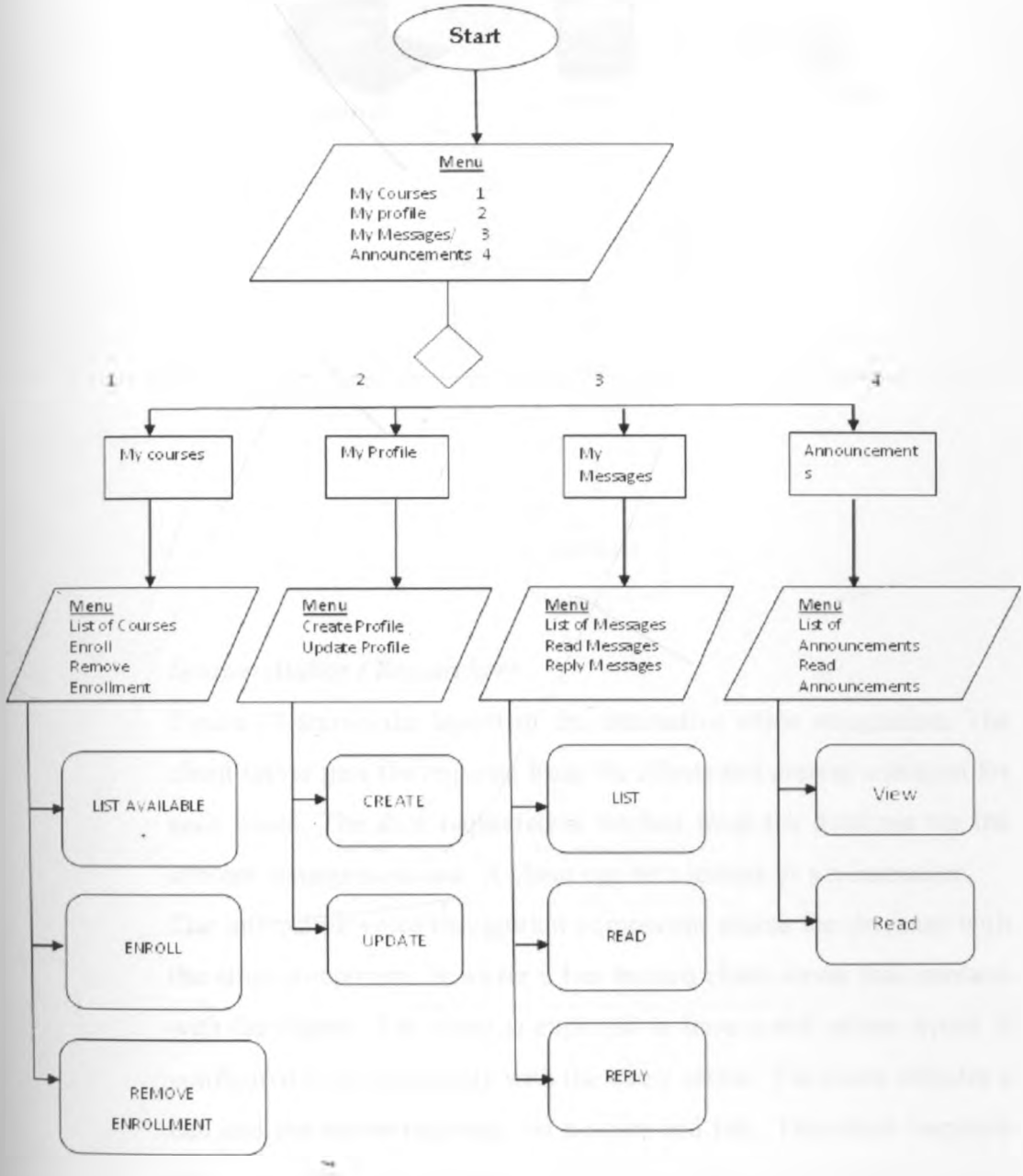
The other reason for using many components in designing and development of mobile learning system was varied content formats and packaging. Different mobile devices support certain content formats and not others. For example, smart phones, tablets and laptops can support varied multimedia content while simple phones and feature phones do not support video, graphics and animations. To bridge this gap the alternatives like combination of voice and text in an IVR system are used.

In order to develop mobile learning components that meet all research objectives, the system needed to enable instructors to blend traditional teaching and learning strategies to fit mobile learning is a critical step in planning; make content accessible in many mobile platforms; provide authoring tools that enable content reuse; provide ways of transforming traditional class materials to be reused as mobile content; enable the instructor to recreate own content. According to Chad Udell, 2013, when mobile learning systems have these capabilities, they are easier to use because the devices can be managed, access can be restricted, data can be protected and usage can be monitored.

4.3 System Components Architecture

The four components in the mobile learning system are Mobile web; USSD; Android Application and Interactive Voice Recognition (IVR). All the components are designed to run in the same logic with minimum difference. Figure 15 is a flowchart that shows the logical flow.

Figure 12: Flowchart for Template for all System Components

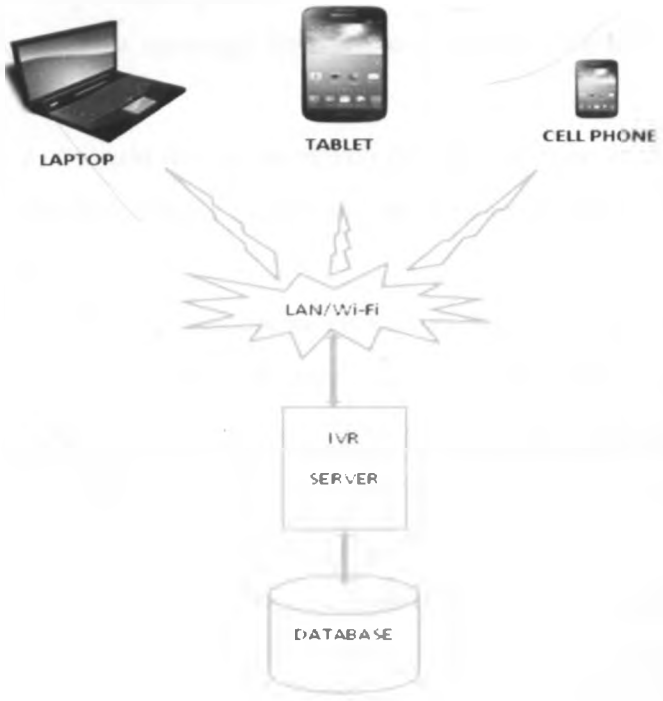


Source: Author (Researcher)

Figure 12 is the common template that developers of each component followed to maintain a common view for the learners. All the flow of menu from one stage to the other followed the logical flow shown by the flowchart.

4.2.1 The Interactive Voice Recognition (IVR) Component

Figure 13: IVR Layout Diagram



Source: Author (Researcher)

Figure 13 shows the layout of the interactive voice recognition. The client server gets the requests from the clients and creates a session for each client. The data requested is fetched from the database via the content management unit. A client can be a learner or a n instructor.

The interactive voice recognition component shares the database with the other component; however it has its own client server that interacts with the clients. The client is expected to have a soft phone which is configured to communicate with the client server. The client initiates a call and the server responds via a voice and text. The client responds back via a text or a voice. The server recognizes what the client command is and responds back with the results. The interactions between the client and the server help the learner to access content posted by the instructor and also to respond back to the instructor.

The IVR system converts text to speech and also supports student discussion groups by allowing them to join a conference through a call. The voice system uses asterics to power the interactions between the learner and content management system. In order to access the content,

one needs to be registered to the system and once this is done, the system sends out an email with instructions on how to setup the communication configurations.

e.g. One receives a message from system (interractive tutor) like the one below:-

"Hello 1, I would like to thank you for your interest in subscribing to our mobile learning. Follow the instructions below to start using the service.

1. *You will need a soft phone client. - If you are using a Windows computer - laptop or desktop - you can follow the link below to download a softphone - http://www.counterpath.com/x-lite-download.html - If you are using Android smartphone or tablet, go to Google Play and search for SipDroid.*
2. *Registration for Softphone client. Once you have installed your soft phone client, use the following registration information. - userid = 6748 - userpass = 6748 - host = 192.168.0.172*
3. *You need to verify the registration is correct. Dial 0001 and follow the instructions.*
4. *If you fail to get audio instructions, contact: system administrator*

Kind regards"

The following are instructions for any user of IVR system:

1. To use this service one must have a soft phone installed in their mobile device. There are many soft phones downloadable (open source).
2. Every user who is registered has a unique user identification (userid) which is also their password (userpass). The host is the same for all users:- *192.168.0.172 local host.*
3. This service can only be used while on the university LAN, Wi-Fi NOT out of this range.
4. If one knows another user, one can call them through their soft phone or can call to join a conference via voice call or video call.
5. To access content, the instructor must have given the user the five digit course ID. This ID is given any time the instructor creates a course.

Once all installations are done and setup is complete, one can dial 0001 (4 digit) to test and to get to the mobile learning MENU. One should follow the instructions and provide their user identification (id) and course identification (C.ID).

4.2.2 The Android Application Component

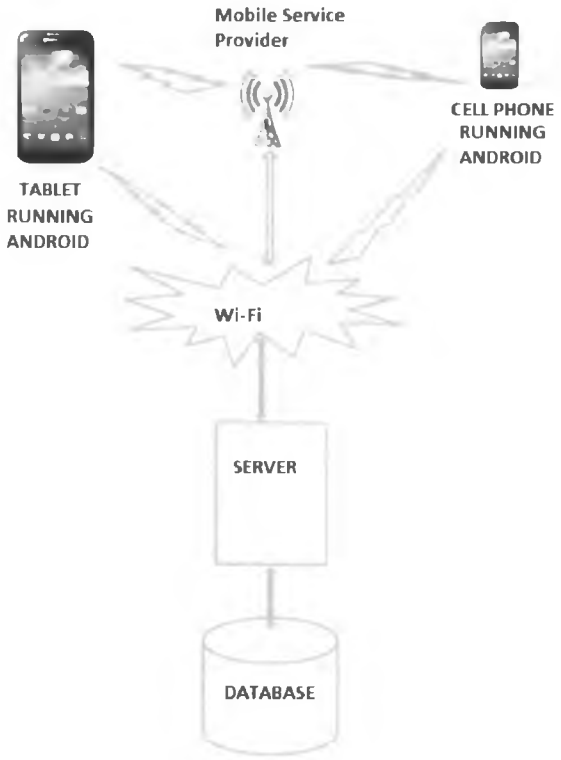
The android application runs on mobile devices that run on android operating system. It helps the learners who are enrolled to a particular course to view all the course topics, quiz, and assignments. Instructors and learners can also chat and share ideas with each other. They can also be able to update their profile information. Learners can be able to download relevant tutorials from the application. The application also has a web view where the learners can be able to access the mobile learning site within the application and they can be able to login to the site.

For one to use the Mobile Learning application, one must be connected to the internet and also must use their username to gain access to the Mobile Learning application. The Mobile Learning application is supported by android version 2.3 and above. To get the mobile learning web site, one is expected to go to this link http://mobile-learn.anu.ac.ke. If one is an instructor, one can be able to add a new topic, assignment, quiz and also chat. All this components can be viewed in the mobile application. For the learner to view the course, one must be enrolled to that course by either the site admin or by the course instructor.

Figure 14 shows the design layout for the Android application component.

The learner can make request from the mobile learning server through the Wifi connectivity while on campus or through the mobile service provider. When the request comes to the mobile learning server, the learner is authenticated before getting the services by first logging in. The android application connects outside the campus if the learner's mobile device is able to access internet.

Figure 14: Android Application Component Layout



Source: Author (Researcher)

4.2.3 Mobile Web Application Component

The design layout of mobile web is similar to that of android application as shown on figure 14. The mobile web component was designed to enable mobile learners to use their mobile devices that can support web applications and browsers. The other reason was to enable desktop access for content posting by instructor to the content management system. The content management system that was customized and reprogrammed was Moodle version 2.4.9. To have all scripts from all other components work together, the following applications were installed in the server. i.e. Java and tomcat. Scripts for android, USSD and asterix were also installed. The mobile web allowed content to be posted by the instructor while the various scripts installed enabled the different applications to access the same content.

4.2.4 USSD Component

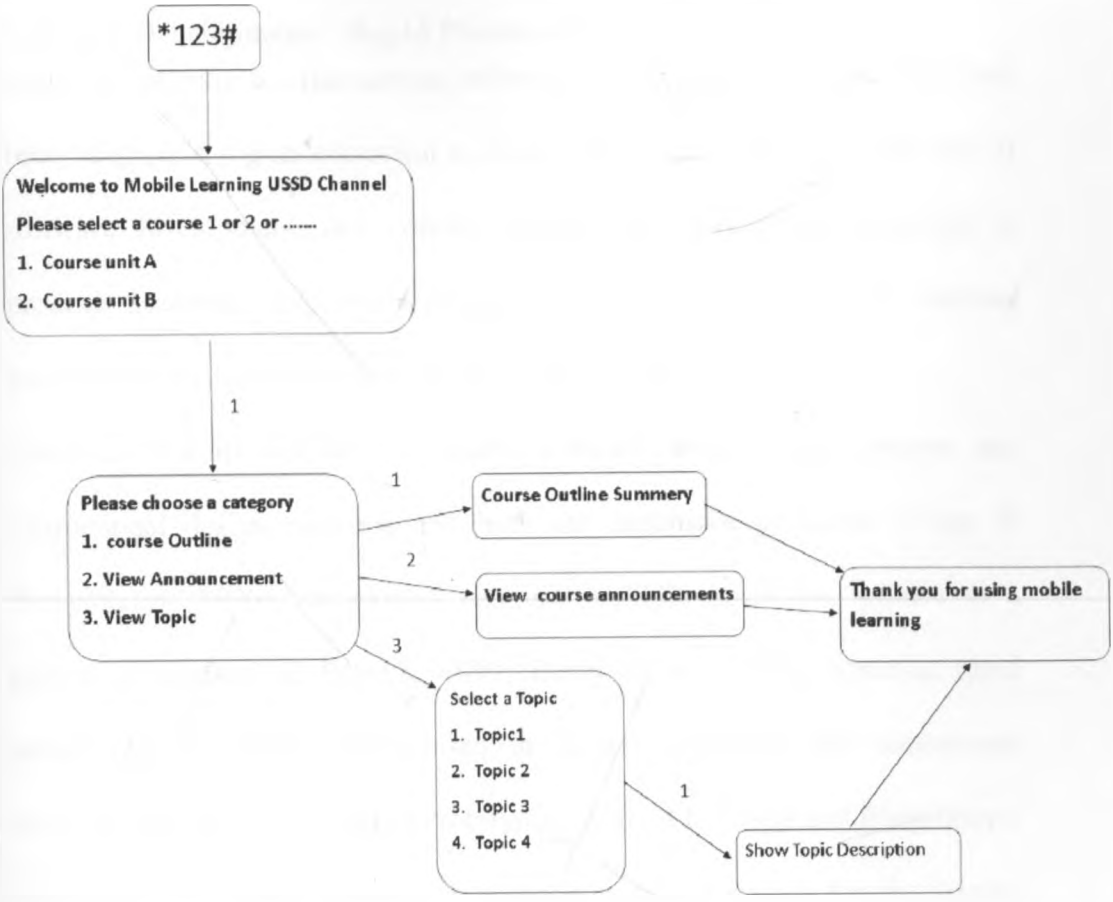
The content for USSD is limited to 240 characters per page menu frame. The design for this component uses many menu page frames which are linked to one another by sending menu item code in one session. For users to access the USSD menu, they must be registered with Mobile Learning system accessed through mobile web. While still in the mobile web module, one is expected to login and find the link "Edit Profile" within "My Profile Settings". In the mobile phone field, one should type their phone number, and update profile. The format for mobile phone should be: country code – phone number e.g. a valid phone number would be: 254725347734; One is expected to replace the "msisdn" with their phone number. These settings of the profile enable one to access mobile learning contents via USSD.

To access the USSD through a browser, the USSD menu can be accessed via the URL: http://mobile-learn.anu.ac.ke:8080/MobiLearn/callback one needs to put the expected parameters.

e.g.http://mobilelearn.anu.ac.ke:8080/MobiLearn/callback?session_id=35&service_code=555&msisdn=254724149679&ussd_string=1, otherwise the normal way via GSM or Mobile service provider is to Dial *384*6543# then follow the instructions.

Note that this code is bought and expires unless renewed. It also differs from one service provider to another. The one quoted was used to collect data during the experiment for this research. The figure 15 shows the USSD designs for the menu frames.

Figure 15: Mobile Learning USSD Flow Diagram



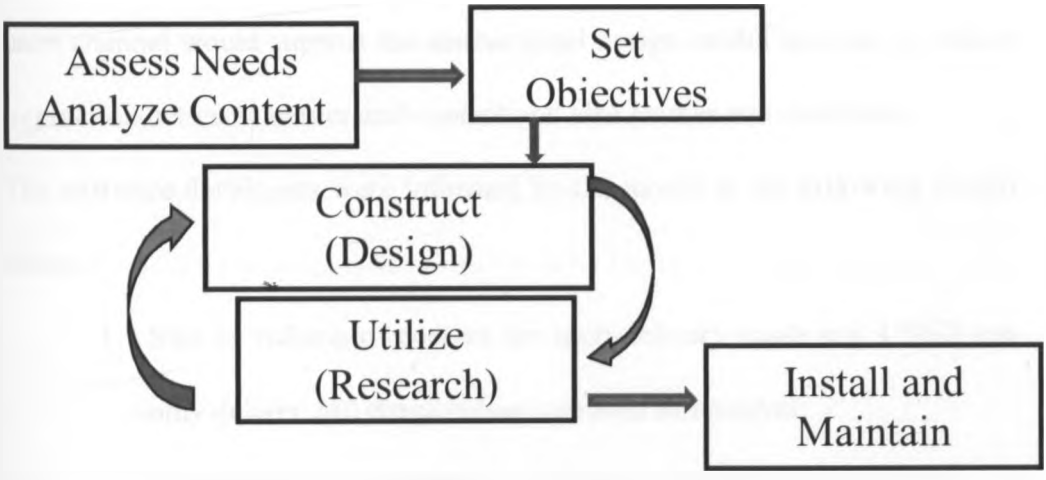
Source: Author (Researcher)

4.4 Software Development – Rapid Prototyping

Rapid prototyping is a time saving software development technique which has been adapted in higher education to design learning systems. As a method of software development, new content, design, and delivery are leveraged to produce academic software applications within a short time yet meeting institutional quality assuarance standards (Desrosier, 2011).

There is alot of similarity between software development process and instructional design methods and both are expensive processes (Tripp & Bichelmeyer, 1990). Developers can use multiple prototype formats in a project (Gustafson & Branch, 1997; Berry et al., 1994), however rapid prototyping has been widely used in diverse industrial and educational solutions (Novac, 2007). Rapid Prototyping method by Tripp and Bichelmeyer saves time and costs therefore making it popular method for developing instructional applications (Desrosier, 2011). Figure 16 shows the rapid prototyping method by Tripp and Bichelmeyer.

Figure 16: Rapid Prototype development Stages



Source:Tripp & Bichelmeyer (1990).

Int his method, there are five stages in development, needs assessment, setting objectives, construction of a prototype, using the prototype and finally

installation and maintainace (implementation). According to Tripps & Bichelmeyer, traditional software development processes have extensive documentation that does not solve communication problems, nor track project cost or reduce them. It has well design stages but doesn't decrease project time. On the other hand, rapid prototyping allow users to try out the system, discover problems, provide input, reduces development costs and reduces development time significantly. Some other researchers consider rapid prototyping to be a working part of the final product (Tessmer (1994); Jones, Li, and Merrill (1992)).

The development team met to analyze the systems requirements regularly. The following was resolved:-

1. Four channels would be built (IVR, USSD, Mobile Web and an Android Application);
2. An open source content management system would be adopted i.e. Moodle version 2.4.9

The team led by the researcher analyzed in details for every channels and how each channel would support the instructional design model in order to realize interaction between learner and content and also learner and instructor.

The software developers were informed by the model in the following design issues:-

1. Size or volume of content for each delivery mode e.g. USSD can only deliver 240 characters at one send or retrieval;
2. Auto resize web screen for different screen size depending on content format;
3. Readers and players of various multimedia content;

4. Hashing algorithm for data encryption e.g MD3 for Moodle;
5. Flow of instruction path e.g. Access of topic content from USSD or IVR from Moodle (CMS);
6. Storage capacity for a learner upload of assignments (feedback)

The developer of a specific delivery channel, require following a sequence that is sequential and has a common protocol to communicate with other components of the mobile system.

4.5 Challenges Faced in System Development and How They Were Addressed

The first challenge was to select a good team of developers who would interpret the designs appropriately to bring out the intended functionalities of the system. In order to constitute a good team I conducted practical tests and an interview to potential developers. A total of five developers and a system administrator were subjected to the practical and interview tests. Out of the six, the system administrator was selected to do system integration and configurations, one android developer was chosen, one USSD developer was selected and one IVR system developer was selected. Later the USSD developer was replaced due to costs that he attached to the development process.

There were a few challenges that the researcher faced when designing the mobile learning system. The wide spectrum of mobile devices, from simple phones, feature phones, smartphones, tablets and laptops required specific applications that can run in each one of them. The questions of what devices to target, how to create simple and effective applications, how to retrieve the data and information that would be uploaded or downloaded were critical to answer. There are two approaches that could be used to solve this problem, either by using native approach where one targets the specific device or by use of cross platforms where an application can run in all devices. From the survey conducted to establish the mobile readiness, more than 97% of all learners had a device that could browse internet hence the decision to have a mobile web application. On the other hand, 73% had smart phones and majority run on

Android platform; hence the decision to develop a native application running on android was arrived at.

While configurations and testing were challenging within the new upgraded institutional network, the greatest challenge was integration of all applications to work from the same database. All developers had to agree on the encoding scheme which was MD5 for the content management database (My SQL). This enabled all applications to read and write the database.

4.5 Summary of Chapter 4

The use of mobile learning systems has created an improvement in learning processes. The characteristic of such systems is that they have the ability to connect to a central server in order to access learning content and instructions. When developing a suitable mobile system, the developers need to be guided by a learning theory or an instructional design model. The decisions taken to include or exclude some components of the system must be informed well. The researcher considered four components to build the mobile learning system. The four components were used to give a variety of tests in the experiments conducted while testing the variables. IVR module was important to examine voice and text formats, mobile web application was needed for multimedia content, USSD was required for text formats and android application was important for both multimedia and learner context awareness.

Developers of mobile learning systems are not necessarily trained to interpret the instructional design models but needs to know the basic requirements for an effective system. This chapter provides a simple architecture for any developer to follow. The architecture gives the developer several options in modular format design that allow addition or reduction of modules for delivery. The system architecture allows one database for content management and several routes to presentation layer. The flowchart template discussed above replicate the logic for each module providing consistency in all module navigations.

CHAPTER 5: RESULTS AND DISCUSSIONS

5.1 Introduction

This chapter presents result and discussions of data analysed from pre-survey done to determine institutional readiness and the experiments conducted. Data was analysed using SPSS software. The first part of the results addresses the descriptive statistics from respondent's on mobile readiness to adopt mobile learning and the second part, the results from the experiments conducted to verify the hypotheses. The goal of the analysis was to establish the statistical significance of the relationships between the various constructs outlined in the conceptual framework with a view to model the instructional design and delivery model for mobile learning.

5.2 Descriptive Statistics

5.2.1 Mobile Learning Readiness

The objective of conducting a readiness test was to establish if the learners and the institution of learning are ready for the experiments. In order to conduct the experiments, a mobile learning system must be in place and the learners must be able to access the mobile devices for purposes of learning. Since 2002, KENET has carried out the e-readiness survey with the latest report done in the year 2013. This is the only readiness report done in Kenya ranking and determining the e-readiness of higher learning institutions in Kenya (Kashorda & Waema, 2013).

5.2.2 Normalizing and Staging data

After giving the undergraduate students questionnaires to fill, like KENET or CID, readiness assessment framework, each indicator is staged to a scale of 1 to 4, where 1 means unprepared and 4 means prepared or ready.

5.2.3 Mobile Learning Readiness Results

Table 10: Cross tabulation between Ownership of Mobile Device and Age

Crosstab

			Age of respondent			Total
			Below 18	19-23	Above 24	
Do you own a Mobile device	Yes	Count	2	80	19	101
		% of Total	2.0%	79.2%	18.8%	100.0%
Total		Count	2	80	19	101
		% of Total	2.0%	79.2%	18.8%	100.0%
What is your Phone type?	Smartphone	Count	2	60	15	77
		% of Total	2.0%	59.4%	14.9%	76.2%
	Feature Phone	Count	0	15	2	17
		% of Total	.0%	14.9%	2.0%	16.8%
	Simple Phone	Count	0	5	2	7
		% of Total	.0%	5.0%	2.0%	6.9%
Total		Count	2	80	19	101
		% of Total	2.0%	79.2%	18.8%	100.0%

From the cross tabulations in table 10, all respodents of the sampled population own a mobile device. 76.2% own a smart phone, 16.8% own a feature phone and 6.9% own asimple phone.

This means 93.5%ofthe learners can access internet through their mobile phones and only 6.5% cannot. All sampled respodents can connect to Campus LAN via a mobile device which means that even the 6.5% owning a simple phone own another mobile device like a laptop.

Table 11: Cross Tabulation between Mobile Device Type and Gender

			Genderof Respondent		
			Male	Female	Total
What is your Phone type?	Smartphone	Count	50	27	77
		% of Total	49.5%	26.7%	76.2%
	FeaturePhone	Count	12	5	17
		% of Total	11.9%	5.0%	16.8%
	Simple Phone	Count	3	4	7
		% of Total	3.0%	4.0%	6.9%
Total		Count	65	36	101
		% of Total	64.4%	35.6%	100.0%

Table 12: Chi-Square Tests between Mobile Device Type and Gender

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.710[a]	2	.425
Likelihood Ratio	1.644	2	.439
N of Valid Cases	101		

a. 2 cells (33.3%) have expected count less than 5. The minimum expected count is 2.50.

From table 11 and 12, the Pearson's chi square asymptotic value for two sided has a significance (p=.425) p>.05. This implies that the null hypothesis is accepted that there is no significance difference between gender and mobile device ownership.

5.2.4 Mobile Readiness Factor's Results

Table 13: Raw Scores for Network Access

Study Mode	Device Ownership	Internet Availability	Internet Affordability	Internet Reliability	Learning support
RD	97	42	43	30	49
RE	100	33	80	66	33
DL	100	60	60	50	50
SB	100	50	16	50	100

Key: RD= Regular Day; RE= Regular Evening; DL=Distance Learning; SB=Schoolbased

Table 14: Normalised Score index for Networked Access

Study Mode	Device Ownership	Internet Availability	Internet Affordability	Internet Reliability	Learning support	Index (average score)
RD	3	2	2	2	2	2.2
RE	4	1	4	4	2	3.0
DL	4	4	4	3	3	3.6
SB	4	3	1	3	4	3.0
			Networked Access Index			2.95

Table 15: Raw Scores for Network Campus

Study Mode	Wi-Fi Coverage	LAN Coverage	Multiple Device Support
RD	62.1	70.4	44.5
RE	66.7	66.7	33.3
DL	40	40	30
SB	50	50	40

Key: RD= Regular Day; RE= Regular Evening; DL=Distance Learning; SB=Schoolbased

Table 16: Normalised Score Index for Networked Campus

Study Mode	Wi-Fi Coverage	LAN Coverage	Multiple Device Support	Index (average score)
RD	4	4	4	4.0
RE	4	4	2	3.3
DL	1	1	1	1.0
SB	2	2	3	2.3
			Networked Campus Index	2.65

Key: RD= Regular Day; RE= Regular Evening; DL=Distance Learning; SB=Schoolbased

Table 17: Raw Scores for Network Learning

Study Mode	E-learning Training	E-Learning portal Usage	E-Learning Resources	M-learning Perception
RD	63	73	78	71
RE	33	33	67	67
DL	60	60	70	90
SB	50	50	50	100

Key: RD= Regular Day; RE= Regular Evening; DL=Distance Learning; SB=Schoolbased

Table 18: Normalised Scores for Network Learning

Study Mode	E-learning Training	E-Learning portal Usage	E-Learning Resources	M-learning Perception	Index (average score)
RD	4	4	4	1	3.25
RE	1	1	3	1	1.5
DL	4	3	3	3	3.25
SB	3	3	1	4	2.75
			Networked Learning Index		2.69

Key: RD= Regular Day; RE= Regular Evening; DL=Distance Learning; SB=Schoolbased

Table 19: Raw Data for Networked Community and ICT Policy

Study Mode	Networked community – Device preferred mode of communication	ICT policy – policy awareness
RD	23	46
RE	33	66
DL	70	50
SB	50	50

Key: RD= Regular Day; RE= Regular Evening; DL=Distance Learning; SB=Schoolbased

Table 20: Normalised Data for Networked Community and ICT Policy

Study Mode	Networked community – Device preferred mode of communication	ICT policy – policy awareness
RD	1	2
RE	1	4
DL	4	2
SB	3	2
Index(average)	2.25	2.5

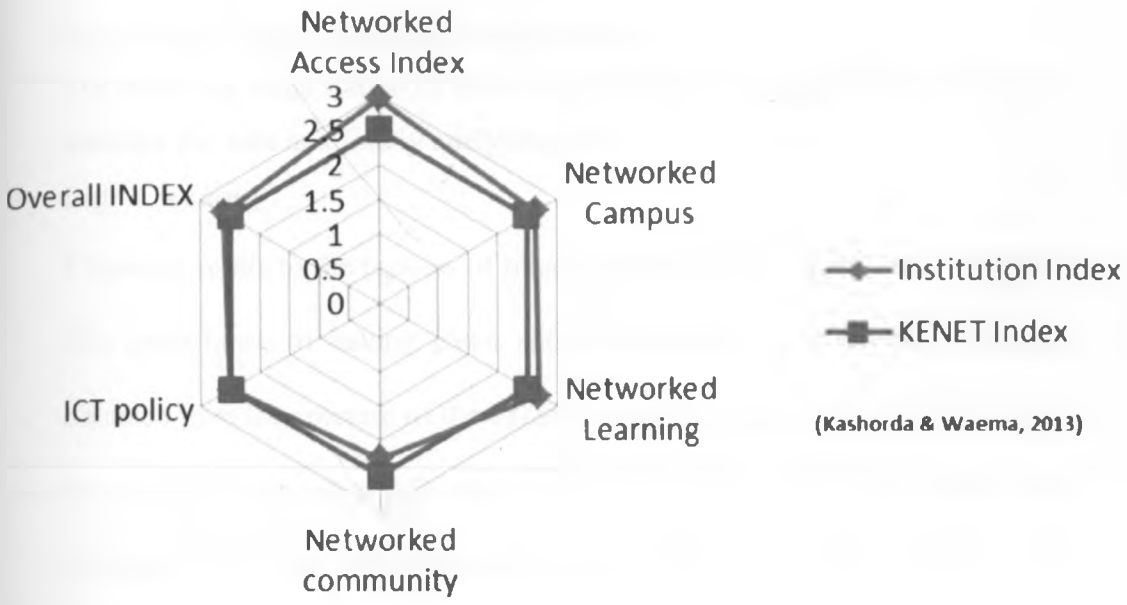
Key: RD= Regular Day; RE= Regular Evening; DL=Distance Learning; SB=Schoolbased

Table 21: M-Learning Readiness Index

Factor	**Index**
Networked Access Index	2.95
Networked Campus	2.65
Networked Learning	2.69
Networked community	2.25
ICT policy	2.5
Overall INDEX	**2.61**

The benchmark value obtained from KENET report is 2.5 (Kashorda &Waema, 2002, 2008. 2013).

Figure 17: Radar Diagram Benchmark with KENET



Source: Researcher

From table 21, the overall mobile readiness index computed from all indexes is 2.61. This value is slightly higher than 2.5 which is the KENET Benchmark. This is also clearly demonstrated by the radar graph, Figure 17. From the results, the institution and the learners are ready to adopt mobile learning after meeting the threshold benchmark point.

Significance of Computing Mobile Readiness Index

The results obtained after computing the mobile readiness index were of great significance in determining if the research experiment will be done in that sampled institution or not. It is important to note that institutional readiness to adopt the learning technology plays a big part of the success to meeting the learning outcomes. The fact that the institution was ready, it gave the researcher focus on modeling instructional design and delivery model based on learner responses to the treatments without fear of interference by external variables.

The decision to continue with development of various components of the mobile learning system was also informed by which institution was to be used for experiments. If the institution was found not to meet the critical

benchmark, the sampled institution would have been dropped and another one sampled.

5.3 Experimental Data Results and Discussions

The modeling stage started by data collection from the experiments conducted, cleaning the data and finally analyzing data.

Data Cleaning

'Cleaning' refers to the process of removing invalid data points from a dataset. The importance of having clean and reliable data is to ensure the results obtained give true picture of the situation being investigated. In order to get a true picture, nine out of fifty five (16%) of the data points were dropped and the rest 84% of the data points were used for data analysis. In the control group, 3 cases out of 26 were dropped from analysis. Two did not sit for examination due to incomplete fees and one did not attend all class lessons. In the treatment group, 6 out of 29 cases were dropped. Four of them were distance learners and the other two cases did not do all examinations due to fees balances. The distance learners did not receive the treatment for interactive voice recognition since the system was only restricted to campus environment where Wi-Fi coverage was good.

5.3.1 Hypotheses Testing: Results and Discussions

Factor 1: Learner Entry Behavior (L.E.B)

In order to establish the determining and moderating factors for modeling an instructional design and delivery model for mobile learning, one of the factors considered was learner entry behavior.

Direct path hypothesis stated for this factor was:

H1: Learner Entry Behavior (L.E.B) has a significant influence in achieving the intended learning outcome.

The hypothesis for moderating factors on this relationship was:

H1a: The effect of L.E.B is moderated by gender.

H1b: The effect of L.E.B is moderated by age.

After data was collected from both groups, control and experimental group, on pre-qualifications the results were as follows, in both groups only 7% had a diploma, 28% had a certificate in IT, and the rest 65% had only the mandatory prequalification to the course unit.

Figure 18: Pre-Qualification Status

Figure 18 shows a pie chart of various pre-qualifications in both groups.

Table 22 : Chi-Square Tests prequalification and pre-test

Control or treated group		Value	df	Asymp. Sig. (2-sided)
Control	Pearson Chi-Square	46.000[a]	30	.031
	Likelihood Ratio	42.246	30	.068
Treated	Pearson Chi-Square	20.638[b]	18	.029
	Likelihood Ratio	25.495	18	.042

Table 23 : Chi-Square Tests Pre-qualification and Post-test

Control or treated group		Value	df	Asymp. Sig. (2-sided)
Control	Pearson Chi-Square	46.000[a]	28	.017
	Likelihood Ratio	42.246	28	.041
	N of Valid Cases	23		
Treated	Pearson Chi-Square	13.554[b]	17	.698
	Likelihood Ratio	17.177	17	.442
	N of Valid Cases	23		

From table 22, the chi-Square test results on pre-test for control group is p=.031 while for the treatment group is p=.029. In both cases it is less than .05 (p<.05). This means pre-qualification had a significant effect on performance for both groups. From table 23, the post-test, the control had p=.017 while the treatment group had p=.698. This means while there is a significant different between pre-qualification and performance for the control group, there is no significant difference for the treated group. Therefore we can conclude that prequalification has an effect on performance, however mobile learning bridges the difference.

Table 24: Cross tabulation between pre-test and post-test

Directional Measures			Value	Asymp. Std. Error[a]	Approx. Sig.
Ordinal by Ordinal	Somers' d	Symmetric	.811	.032	.000
		CAT one test score Dependent	.810	.032	.000
		Final score Dependent	.812	.032	.000

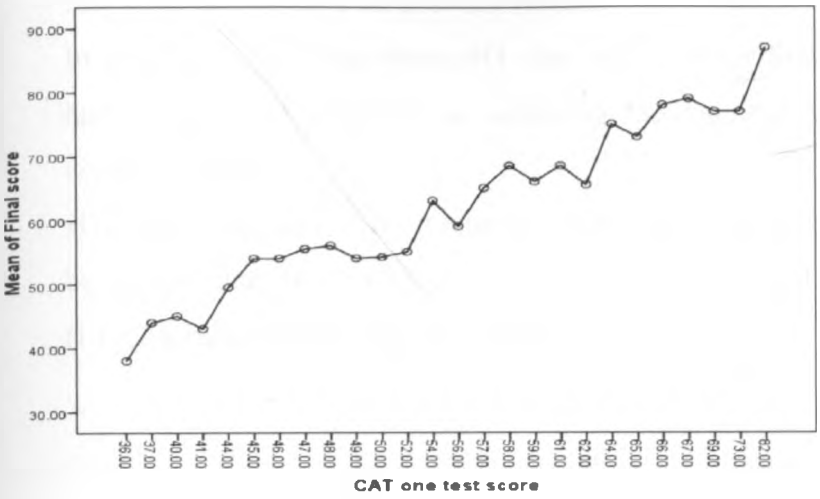
From table 24, the Approx. significance is (.000) less than (.05), it is right to conclude there is a statistically significant relationship between pre-test and post-test. With asymptotic significance of .032 and Somers'd value being (.811) greater than (.15), we can conclude that the relationship between pre-test and post-test is strong.

Table 25: ANOVA between Control and Treatment Groups

ANOVA

Final score	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	5573.526	25	222.941	17.031	.000
Within Groups	261.800	20	13.090		
Total	5835.326	45			

Figure 19: Mean Graph between final score and CAT scores



From figure 19, the relationship is linear and from table 25, the deviations between the two groups was (25) greater than within the group (20). The F value from the ANOVA analysis is 17.031(F=17.031) and since it is greater than 10 (F>10) we can therefore deduce that there is a significant difference between the two groups. In conclusion, the treatment given had a significant positive effect on leaner performance.

Table 26 : Univariate Tests of Subjects Effects of Age and Gender on Final score

Dependent Variable:Final score

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	660.326[a]	6	110.054	.829	.554
Intercept	48197.081	1	48197.081	363.224	.000
Age	511.488	3	170.496	1.285	.293
Gender	1.157	1	1.157	.009	.926
Age * Gender	32.661	2	16.331	.123	.885
Error	5175.000	39	132.692		
Total	178591.000	46			
Corrected Total	5835.326	45			

a. R Squared = .113 (Adjusted R Squared = -.023)

On table 26, the univariate analysis between age, gender and final score on post-test show that the p values are Age p=.293, Gender p=.926 and the interaction between age and gender p=.885. All these values of p are greater

than .05. It is therefore evident from the data that there is no significant effect that these factors have on post-test results.

In conclusion, the hypotheses H1 that state Learner Entry Behavior (L.E.B) has a significant influence in achieving the intended learning outcome is accepted while

H1a: The effect of L.E.B on intended Learning Outcome (I.L.O) is moderated by gender and H1b: The effect of L.E.B on intended Learning Outcome (I.L.O)is moderated by age are rejected.

Factor 2: Content Relevance and Serving

The second factor considered was content relevance and serving. Its direct path hypothesis stated:

H2: Content relevance and serving (C.R/S) has a significant influence in achieving the intended learning outcome.

In each experiment, content was designed to serve various devices and learner groups. Monitoring content access by mobile learning system, statistical logs were taken and analyzed.

Table 27: Correlations between Content Packaging and Serving

Correlations

		Access of class notes	Acess to quick tests	Acess to Video Clips	Acess to Chat room	Acess to Android Application	Acess to Bible verses	Acess to Lessons	Final score
Access of class notes	Pearson Correlation	1	.979**	.861**	.826**	.712**	.388	.904**	.816**
	Sig. (2-tailed)		.000	.000	.000	.000	.074	.000	.000
	N	23	23	23	23	23	22	23	23
Acess to quick tests	Pearson Correlation	.979**	1	.817**	.793**	.697**	.361	.884**	.807**
	Sig. (2-tailed)	.000		.000	.000	.000	.099	.000	.000
	N	23	23	23	23	23	22	23	23
Acess to Video Clips	Pearson Correlation	.861**	.817**	1	.845**	.643**	.515*	.805**	.816**
	Sig. (2-tailed)	.000	.000		.000	.001	.014	.000	.000
	N	23	23	23	23	23	22	23	23
Acess to Chat room	Pearson Correlation	.826**	.793**	.845**	1	.690**	.545**	.654**	.821**
	Sig. (2-tailed)	.000	.000	.000		.000	.009	.001	.000
	N	23	23	23	23	23	22	23	23
Acess to Android Application	Pearson Correlation	.712**	.697**	.643**	.690**	1	.409	.607**	.618**
	Sig. (2-tailed)	.000	.000	.001	.000		.059	.002	.002
	N	23	23	23	23	23	22	23	23
Acess to Bible verses	Pearson Correlation	.388	.361	.515*	.545**	.409	1	.183	.502*
	Sig. (2-tailed)	.074	.099	.014	.009	.059		.415	.017
	N	22	22	22	22	22	22	22	22
Acess to Lessons	Pearson Correlation	.904**	.884**	.805**	.654**	.607**	.183	1	.764**
	Sig. (2-tailed)	.000	.000	.000	.001	.002	.415		.000
	N	23	23	23	23	23	22	23	23
Final score	Pearson Correlation	.816**	.807**	.816**	.821**	.618**	.502*	.764**	1
	Sig. (2-tailed)	.000	.000	.000	.000	.002	.017	.000	
	N	23	23	23	23	23	22	23	23

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

* Correlation is significant at the 0.05 level (2-tailed).

Table 28: Asymptotic Significance of Correlations for Content Packaging & Serving

Correlations									
		Access of class notes	Acess to quick tests	Acess to Video Clips	Acess to Chat room	Acess to Android Application	Acess to Bible verses	Acess to Lessons	Final score
Access of class notes	Sig. (2-tailed)								
Acess to quick tests	Sig. (2-tailed)	.000							
Acess to Video Clips	Sig. (2-tailed)	.000	.000						
Acess to Chat room	Sig. (2-tailed)	.000	.000	.000					
Acess to Android Application	Sig. (2-tailed)	.000	.000	0.001	.000				
Acess to Bible verses	Sig. (2-tailed)			0.014	0.009				
Acess to Lessons	Sig. (2-tailed)	.000	.000	.000	0.001	0.002			
Final score	Sig. (2-tailed)	.000	.000	.000	.000	0.002	0.017	.000	

Table 27 and 28 shows the results of correlations between final scores and content posted to learners on the mobile learning system for the treatment group. The results reveal that access to notes was statistically significant to quick test, video clips, chat room, android app., lessons and final score. The (p=.000) values were all less than .05 level for two tailed test. Their Pearson's correlational values were .979, .861, .826, .904 and .816 respectively. It implies there was a very strong correlation between access to class notes and access to quick tests, video clips, chat room, android app. and lessons which had a direct effect on performance of post-test. On the other hand, there was no statistical significance between accessing class notes and reading bible verses that were posted to the mobile learning system. The Pearson's value was low .388 and asymptotic significance (P=.0740) which is greater than .05 (P>.05) for a two tailed test. Bible reading had nothing to do with passing or failing the intended learning outcome tested on post-test.

The results also show that the asymptotic significance between access to quick test and access to video clips, chat room, android application, lessons and final score (post-test) was (p=.000). This implies there was statistical significance to conclude that the test had a relationship with access to video clips, chat room, android application, lessons and final score (post-test).

The data shows that access to video clips and chat room was statistically significant to all factors considered for content. The learners accessed content via video clips and engaged in chat room for all content. All the p values are less than (p>.05) as shown on table 25.

Majority of learners who downloaded the android application or accessed lessons also accessed all other content frequently apart from bible content. The asymptotic significance are all less than (p< .05) apart from access to bible verses that were greater than (p>.05) i.e. .409 and .183 respectively.

From table 28, the asymptotic significance between access to bible content and access to class notes (p=.074), quick tests (p=.099), android application (p=.059) and class lessons (p=.415) shows no statistical significance. The p values are all greater than (p>.05). Their Pearson's correlational values are all less than .500 respectively.

Table 29: Pearsons' Correlations of Content Packaging & Serving

Correlations									
		Access of class notes	Acess to quick tests	Acess to Video Clips	Acess to Chat room	Acess to Android Application	Acess to Bible verses	Acess to Lessons	Final score
Access of class notes	Pearson Correlation	1							
Acess to quick tests	Pearson Correlation	0.979	1						
Acess to Video Clips	Pearson Correlation	0.861	0.817	1					
Acess to Chat room	Pearson Correlation	0.826	0.793	0.845	1				
Acess to Android Application	Pearson Correlation	0.712	0.697	0.643	0.69	1			
Acess to Bible verses	Pearson Correlation			0.515	0.545		1		
Acess to Lessons	Pearson Correlation	0.904	0.884	0.805	0.654	0.607		1	
Final score	Pearson Correlation	0.816	0.807	0.816	0.821	0.618	0.502	0.764	1

The final score or post-test results have a statistical significance to all content. Although access to bible has a higher asymptotic value (p=.017), it is significant since it is less (p<.05).

In conclusion from the results provided, it is evident that content relevant to a subject taught has a significant influence to the expected learning outcome and therefore we accept the direct hypothesis that stated that H2: Content relevance and serving (C.R/S) has a significant influence in achieving the intended learning outcome.

Discussions on content relevance and serving

Majority of learners are in social networks like Facebook and others and they use their mobile devices to communicate with their peers. Instructors are exploring possibilities of using social networks to push content to learners for purposes of teaching and learning (Mills, 2011). Two reasons for this exploration are to be where learners are and to be relevant. Relevance is defined as

> *"a perception of personal needs being met by instructional activities or as a highly desired goal being perceived as related to instructional activities" (Keller, 1983).*

Relevance of content is related to learner motivation to learn (Frymier and Shulman, 1995). When most learners are asked to remember the content they learnt many years ago, majority can remember few instances. Research has shown that learners learn skills better by doing and not listening. Learners reflect what they have learnt by thinking through the content (Burkholder, 2014). The content remembered had relevance to the subject matter. Patrick Allitts claims that instructors should not teach content to cover syllabi for the sake of coverage but to do so in a way that the intended learning outcomes are achieved. This therefore requires the determination of what content should receive treatment (Patrick, 2010). This research confirms and agrees with Patrick's findings. The learners' access to the various contents posted to the mobile learning system had significant influence on their final test performance. Though learners accessed content like Bible verses that are not relevant to the course, the bible verses content did not significantly influence performance.

Factor 3: Content Format and Packaging

The direct hypothesis on content Format and packaging stated as follows:

H3: The Content Format and Packaging (C.F.P) have a significant influence to achieving the intended Learning Outcome (I.L.O);

H3a: The effect of C.F.P on intended Learning Outcome (I.L.O) is moderated by Delivery mode;

There are many formats of packaging content. This research sought to find out whether the different content formats and packaging influence the intended learning outcomes when learners are instructed via a mobile learning system.

The packaging studied were: Text (XML, Word processor, slides, Pdf); Graphic (Images, diagrams); video (animations, movie clips); Voice (recorded audio); hardcopy (handouts; manuals, textbooks).

Table 30: Descriptive Statistics for correlational analysis on content format and packaging

Content formats	Mean	Std. Deviation
Audio format	2.00	1.000
pdf format	2.65	.487
Plain text format	1.52	.511
discussion Forums	3.43	.507
Video clips	3.00	.603
graphics	3.30	.635
animated examples	2.70	.470

From table 30, the content formats with highest means above 3.00 are discussion forums, video clips and graphics. Many learners accessed the contents that were in these formats. The lowest was Plain text and audio formats. Although audio had a relatively higher mean (M=2.00) out of 5 it had the highest standard deviation of 1.000. The pdf format had an average mean (M=2.65) out of 5 but with low deviation which means there were high access to pdf for both high and low performers. Table 31 and 32 gives a correlational analysis of all formats. From the results in table 29, Audio formats has no significant difference in relationship with all other formats apart from discussion forums with a Pearson's correlational factor of .628 which is

greater than .500. It means learners who preferred taking part in discussion forums also did so in audio format. The audio format made a significant difference in the performance of the learner since at 95% degree of confidence, the two tailed significance was .019 meaning rejecting the null hypothesis and failing to reject the alternate hypothesis. The Pearson's factor of .485 confirms there is a relationship though weak.

The pdf format was preferred by all learners. The results show no relationship with any other format and made no significant difference to the final score. The Pearson's correlational factor of .179 was too low. This confirms that although it was highly accessed content it made no difference in performance between high and low scorers.

Plain text, Discussion forums, video clips and graphics all had a significant difference between them and the final score with Pearson's correlational factors of .635, .550, .671, and .653 respectively. All are strong relations since they are greater than .500. Animation format had a low significance difference with p value of .08 which is slightly greater .05. It has a very strong relation with plain text and weak relationship with final score. Many learners prefer animations with a mean of M=2.7 and like pdf format, the relationships are weak since both high and low scorers accessed the content with high access hits. .

Table 31: Pearson Correlation Sig. (2-tailed) Correlations between content formats

	Audio	pdf	Plain text	discussion Forum	Video clip	graphics	animations	Final Score
Audio		1.000	.033	.001	.492	.185	.020	.01
pdf	1.000		.886	.689	.481	.094	.188	.41
Plain text	.033	.886		.001	.003	.002	.000	.00
discussion forum	.001	.689	.001		.033	.006	.004	.00
Video clip	.492	.481	.003	.033		.022	.136	.00
graphics	.185	.094	.002	.006	.022		.131	.00
animations	.020	.188	.000	.004	.136	.131		.08
Final Score	.019	.413	.001	.007	.000	.001	.080	

*. Correlation is significant at the 0.05 level (2-tailed).

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

Table 32: Pearson Correlations between content formats

	Audio	pdf	Plain text	discussion Forum	Video clip	graphics	animations	Final Score
Audio	1	.000	.445*	.628**	.151	.286	.483*	.485
pdf	.000	1	.032	.088	.155	.358	-.285	.179*
Plain text	.445*	.032	1	.664**	.590**	.609**	.691**	.635*
discussion forum	.628**	.088	.664**	1	.446*	.559**	.580**	.550*
Video clip	.151	.155	.590**	.446*	1	.475*	.320	.671*
graphics	.286	.358	.609**	.559**	.475*	1	.324	.653*
animations	.483*	-.285	.691**	.580**	.320	.324	1	.373*
Final Score	.485*	.179**	.635**	.550**	.671**	.653**	.373**	

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).

Table 31 shows the significance values while table 32 shows the Pearson's' correlational values between content formats.

Table 33: Tests of Between-Subjects Effects

Dependent Variable:Final score

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[b]
Corrected Model	1680.904[a]	4	420.226	4.147	.007	.288	16.589	.886
Intercept	113083.679	1	113083.679	1.116E3	.000	.965	1116.023	1.000
preferedmode	1680.904	4	420.226	4.147	.007	.288	16.589	.886
Error	4154.422	41	101.327					
Total	178591.000	46						
Corrected Total	5835.326	45						

a. R Squared = .288 (Adjusted R Squared = .219)

b. Computed using alpha = .05

From the univariate analysis as shown on table33, the effect size of preferred mode on the final score is big with (R squared=.288), the p value is .007 ($p<.05$) and the power=.886. The results show that at 95% degree of

confidence we can conclude that the delivery mode significantly has a big moderating effect size on the content format and packaging to achieving the intended learning outcome.

Discussions on Content Formats and Packaging

Many challenges involved in delivering quality academic content to mobile devices is content format of third party materials that may not be device supported or user friendly (Mill, 2012). Instructors using mobile learning systems need to use varied content formats to suit their learner's devices. It is one thing to push content to a system and another for it to make sense to the learner. Learner's preferences and behavior is critical in the process of learning. One thing that affects learner's emotion is the sense of vision. Thomas Lisa (2011) argues that the trend in use of mobile device to access social media makes content "Hot now" if it is visual. The online correspondence and the YouTube videos and messaging on face book and other social media has made clients be emotionally motivated to access content.

"*If a picture is worth a thousand words, a thousand pictures evoke a million emotions. Photographs tell a story and illustrate an experience more profoundly than words alone. Real-time, text-based communication is an increasingly normal part of daily life as mobile devices and social networks proliferate" (Thomas, L.C., 2011).*

Eric et al. (2009) in their article *Bringing the Classroom to the Web: Effects of Using New Technologies to Capture and Deliver Lectures* argue that delivery of content in multimedia format make a leaner to apply cognitive processes to make sense of that content. Mayer in 2001 and 2002 confirms this argument by suggesting that multimedia learning optimizes learning by reducing cognitive load in learner's memory. Meyer underscores that "*multimedia has a significant relationship with the Web since both use visual, auditory and text based communications*", the research that was going on that time encouraged many educational technologist to implement multimedia content onto mobile devices. Tanya 2011 in the analysis of challenges facing mobile devices highlighted that

"*There is no single solution to push richly interactive mobile content onto every possible phone"* (Tanya, 2011) unless it is a smart phone. It is therefore

necessary for any mobile learning system to provide varied content format for different device choice by the learner.

This research endeavored to analyze the content format and packaging that is popular by learners at undergraduate level. From the results, it is sufficient to conclude that when multimedia content is pushed through mobile devices in plain text, video, graphics and animations formats, it influences the intended learning outcomes. Therefore, the direct path hypotheses that stated:- H3: Content Format and packaging influences the intended learning outcome is accepted. This conclusion is in tandem with other researchers as discussed above. When an instructor intends to use mobile learning to support teaching and learning, the choice of content format is critical. The use of plain text coupled with video clips, graphics and animations do motivate the learners significantly for optimal achievement of intended learning outcome.

Factor 4: Learner Attention

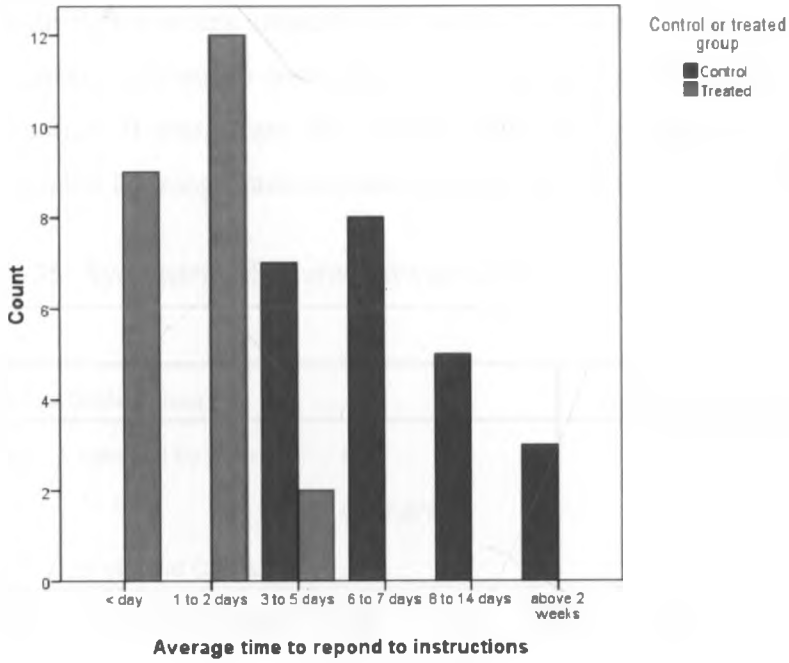
The direct path hypothesis for learner attention stated:
H4: The Learner Attention (L.A) has a significant influence to achieving the intended Learning Outcome (I.L.O);
H4a: The effect of L.A on intended Learning Outcome (I.L.O)is moderated by Age;

The learner attention was measured by taking the average time taken in responding to instruction via quizzes or assignments and to discussion forum. Data was collected from both treatment and control group. The average time was recorded and classified in days. The intervals chosen were less than a day, one to two, three to five, six to seven, eight to fourteen and above fourteen days (two weeks).

Figure 20 shows a descriptive view of responses and it is clear that the treatment group took less time to respond on average than the control group. Learners in the treatment group respond in less than a day while majority do it between 1 to 2 days. In the control group, the earliest to respond is in 3 to 5 days while majority responded between 6 to 7 days. All those that respond

after a week are in the control group. It is evident from the distribution that mobile learning provides learners with ease and flexibility to respond to tasks given quickly.

Figure 20: Average time to respond to Instruction



From the table of chi square test results, table 34, it is clear that there is a relationship between faster response and performance. The asymptotic values of control group (p=.079) and for the treatment group (p=.122). It indicates that there exists a relationship between instruction responses and performance for both control group and treatment group.

Table 34: Chi-Square Tests results for Response to Instructions

Chi-Square Tests				
Control or treated group		Value	df	Asymp. Sig. (2-sided)
Control	Pearson Chi-Square	55.549[a]	42	.079
	Likelihood Ratio	49.943	42	.187
	Linear-by-Linear Association	14.403	1	.000
	N of Valid Cases	23		
Treated	Pearson Chi-Square	43.764[b]	34	.122
	Likelihood Ratio	39.500	34	.238
	Linear-by-Linear Association	16.741	1	.000
	N of Valid Cases	23		

Table 35 shows the symmetric measure for both groups indicating the relationships are very strong. It confirms that the learner with quick response perform well than those that take a longer time to respond. The Cramer's V value for treatment group was .975 and control group .897. The values are close to 1.000 implying a very strong relationship. It is therefore right to conclude that learners subjected to mobile learning software (treated group) have faster response to instructions and also performed better in their final examination. It also means that learner attention has a significant influence to the intended learning outcomes hence accepting the direct hypothesis.

Table 35: Symmetric Measures between groups

Control or treated group			Value	Approx. Sig.
Control	Nominal by Nominal	Phi	1.554	.079
		Cramer's V	.897	.079
	N of Valid Cases		23	
Treated	Nominal by Nominal	Phi	1.379	.122
		Cramer's V	.975	.122
	N of Valid Cases		23	

Moderators for learner attention

From figure 21, majority of the young between 18 years and 22 years responded in less than two days while those in the age of 23 to 25 responded within a week. The most aged between 26 and 30 years responded in a weeks' time.

From table 36, the Tests between-Subjects Effects table has the asymptotic significance for age at .029 with F value (F=5.132). It means the effect size is too small and not significant to influence learner attention. From the same table the F value for the Attention (F=12.958) with (p=.000) confirms that the learner attention has a very big effect size on learner performance. The results therefore indicate that age has no effect on learner attention and the rejection of the hypothesis H4a: The effect of L.A is moderated by Age. This is partly contrary to Maylor & Levie (1998) who concluded in their experiment age had significant effect on attention. Their experiment compared ages (19 to 30) and

(65 to 79). On the other hand if Maylor and Levie assumed the age group (19 to 30) had the same attention span then this experiment results would concur with their assumption and justified to conclude the age had no significant effect on learner attention.

Figure 21: A Bar Chat for Average Response Time against Age

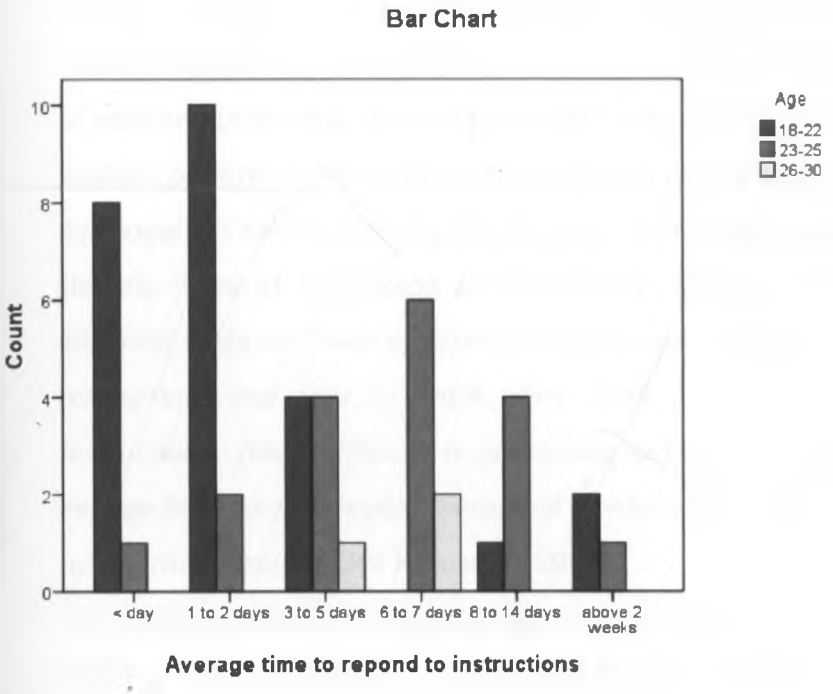


Table 36: Tests of Between-Subjects Effects on response to Instructions

Dependent Variable:Final score

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	3643.057[a]	6	607.176	10.802	.000
Intercept	8869.507	1	8869.507	157.787	.000
Age	288.475	1	288.475	5.132	.029
LAttension	3642.039	5	728.408	12.958	.000
Error	2192.269	39	56.212		
Total	178591.000	46			
Corrected Total	5835.326	45			

a. R Squared = .624 (Adjusted R Squared = .567)

Discussions on Learner Attention

Before any meaningful teaching and learning can take place in a class, the instructor must gain leaner attention (Frymier, A.B. & Shulman, G.M., 1995). According to John Keller(2010), learners get motivated and put effort in pursuit of a learning goal when an instructor uses motivational tactics. The tactic must aim at supporting instructional goals. The results obtained in this research shows that mobile learning gives learner attention and arouses their curiosity and interest to learn hence agrees with both Frymier and Keller. The mobile learning system created attention of the learner by providing a variety of response paths, e.g. discussion forums, assignments and quizzes. Attentive learners perform well in their examinations as proved by this research and the developers of mobile learning objects must ensure the learning object provides flexible ways of responding to instructions. Failure of the learner to pay attention leads to "*making errors in class work; cannot follow through on instructions and fails to finish class work due to failure to understand instructions; finds difficulty in organizing tasks and activities; is reluctant to engage in tasks that require sustained mental effort; and is easily distracted by external stimuli*" (Dev Kumar B., 2013).

The results have also shown that age does not affect attention. When mobile learning system is used for teaching and learning, learner's attention does not get affected by age. All learners will respond faster irrespective of their age.

Factor 5: Learner Feedback

The direct path hypothesis for learner feedback stated as follows:

H5: The Learner Feedback (L.F) has a significant influence to achieving the intended Learning Outcome (I.L.O);

H5a: The effect of L.F on intended Learning Outcome (I.L.O) is moderated by cost of bandwidth;

H5b: The effect of L.F on intended Learning Outcome (I.L.O) is moderated by Delivery mode;

Learner feedback is the response to enquiry or discussion or submission of answered test/assignment. In this research experiment, feedback was measured

by taking the total sum of all active responses to discussions, submitted tests/assignments and all responses to enquiry by the instructor. All assignments and tests given were 4 and 12 discussion threads. However, there were also responses done due to learner enquiries. The minimum total responses were expected to be 16 in number.

From the chi square test table 37, the control group shows a significant influence of learner feedback and final score performance with Pearson's Chi Square value (p=.045). Comparing this with the treatment group with value (p=.319). It implies that learner feedback influenced performance significantly in the control group while it did not influence performance significantly for the treatment group. This means the average feedback given by learners in the control group linearly had direct reflection on their performance, comparing this with the treated group, many learners even those with low performance had high feedback. The asymptotic significance linear by linear association has a p value (p= .000) for treatment group and (p=.104) for control group. This implies that learner feedback has a significant influence on learning outcomes and feedback is highly improved by mobile learning.

Table 37: Chi-Square Tests on Learner Feedback

Control or treated group		Value	df	Asymp. Sig. (2-sided)
Control	Pearson Chi-Square	41.818[a]	28	.045
	Likelihood Ratio	33.180	28	.229
	Linear-by-Linear Association	2.644	1	.104
	N of Valid Cases	23		
Treated	Pearson Chi-Square	55.200[b]	51	.319
	Likelihood Ratio	50.680	51	.486
	Linear-by-Linear Association	12.586	1	.000
	N of Valid Cases	23		

a. 45 cells (100.0%) have expected count less than 5. The minimum expected count is .04.

b. 72 cells (100.0%) have expected count less than 5. The minimum expected count is .13.

From table 38, the univariate analysis results shows the test of subject effects and that learner feedback had no significant influence on final score perfomance (p=.209) which is greater than (p>.05), the effect size (F=1.590, eta=.209) being too low. The interractions of learner feedback and cost of band width has no influence on final score. It has effect size (F=.024, eta=.001) too low and an asymptotic significance (p=.877) greater (p>.05). This implies that the cost of band width had no effect on moderating the way learners gave their feedback. It means those learners that used mobile learning devices used the institutional WiFi, finding it not expensive or if they incurred cost they found it affordable.

The interaction between Learner feedback and delivery mode provides a low effect size (F=1.911 (F<10), p=.120 (p>.05) and eta=.323 (far less than 1.00). The p>.05 is indicative that the null hypothesis is accepted that there is no significant effect that delivery mode has on learner feedback to achieving the intended learning outcome.

Table 38: Tests of Between-Subjects Effects on Learner Feedback

Dependent Variable:Final score

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[b]
Corrected Model	4649.854[a]	21	221.422	4.483	.000	.797	94.137	.999
Intercept	84564.421	1	84564.421	1.712E3	.000	.986	1712.015	1.000
LFEEDBACK	314.072	4	78.518	1.590	.209	.209	6.358	.415
preferedmode	1048.409	4	262.102	5.306	.003	.469	21.225	.935
CostBW	692.874	2	346.437	7.014	.004	.369	14.027	.892
LFEEDBACK * preferedmode	566.367	6	94.395	1.911	.120	.323	11.466	.586
LFEEDBACK * CostBW	1.200	1	1.200	.024	.877	.001	.024	.053
preferedmode * CostBW	9.000	1	9.000	.182	.673	.008	.182	.069
LFEEDBACK * preferedmode * CostBW	.000	0	.	.	.	.000	.000	.
Error	1185.472	24	49.395					
Total	178591.000	46						
Corrected Total	5835.326	45						

a. R Squared = .797 (Adjusted R Squared = .619)

b. Computed using alpha = .05

From the results discussed above, it is sufficient to deduce that Mobile learning system improves the learner feedback and that learner feedback significantly influences the intended learning outcome. It follows therefore the acceptance of the hypothesis: H5: The Learner Feedback (L.F) has a significant influence to achieving the intended Learning Outcome (I.L.O); and the rejection of: H5a: The effect of L.F is moderated by cost of bandwidth; and H5b: The effect of L.F is moderated by Delivery mode.

Discussions on Learner Feedback

Many scholars have written on learner feedback (Juwah C., et.al, 2004; Nicol D., 2005; Sadler R., Davies L. & Buckridge M., 2014) and all agree that

learner feedback contribute to good learning outcomes. David Nicol (2005), underscores the seven principles of good formative feedback that support self-regulation and summarizes by saying *"if students are to be prepared for learning throughout life they must be provided with opportunities to develop the capacity to regulate their own learning as they progress through higher education"*. The learner is expected to be actively involved in the process of learning and feedback is one way.

Learner's feedback influences the learning outcomes whether the technology tools are used or not, however, from the results given by this research, the use of mobile learning system greatly improves learner feedback. While the learner had the choice of giving feedback via multiple delivery modes, the delivery mode had no moderating effect to influence the expected learning outcome.

The learners found it affordable to use mobile learning devices due to the provision of Wi-Fi by the learning institution. The provision of Wi-Fi reduced costs significantly giving the learners ability to access content and give feedback to the instructor at affordable cost or no cost at all.

Factor 6: Learner Context Awareness (L.C.A)

The direct path hypothesis for learner context awareness stated as follows:

H6: The Context Awareness (C.A) has a significant influence to achieving the intended Learning Outcome (I.L.O).

H6a: The effect of C.A is moderated by delivery mode.

According to Vivian and Townsend, (2006), "*context awareness just means having information about the immediate situation—the people, roles, activities, times, places, devices, and software that define the situation*". For the sake of this research, Context Awareness has the definition of the learner consciousness when using mobile learning environment. The learner consciousness to use the mobile system was determined by taking the ratio between individual mode access logs and the total access logs of the learner (Economide A.A., 2008). From the configurations of the learning environment, some services such as voice recognition (IVR) was not available off campus; the learners could use other services like mobile web, USSD and the Android Mobile application. The switching of mode of delivery was

evident from learners especially the non-resident learners. All learners had no problem in use of the mobile devices and required no training; they were computer science learners with background in programming. The android application was saved as APK file downloadable and self-installing to the mobile devices. All that was required is for the learner to enter their personal details to be able to connect to server. The IVR module required the learners to download a soft phone through which they could configure and start interacting with the server. All the modules had instructional manuals where the learner would refer. Due to the ease and understanding of the environment, the learners had no excuse to access any content or to communicate. In order to find out if the differentiated environment as was populated by the four modes of delivery, an analysis of usage differentiated with the IVR module that was only accessible within the campus (Wi-Fi presence). The lowest scale access was 0 that had never accessed, 1 that had 1 to 10 accesses, 2 that had 11 to 50 accesses, 3 that had 51 to 100 accesses, 4 that had 1001 to 200 accesses and finally 5 that had above 200 accesses.

From table 39 of Pearson correlation, there is a negative relation between IVR and Android Application and mobile Web usage. At 95% confidence level the relation is significant enough for the researcher to conclude that the learner is context aware to use alternative delivery mode. The alternative delivery mode is Mobile Web. The two also show significant effect on final score with (Pearson index=.442 and .411, p values (p=.035, p=.051) respectively.
USSD mode of delivery is least preferred showing a very weak relationship that are not significant enough. The IVR mode of delivery has also a weak relationship with final score.

Table 39: Pearson's Correlations between Delivery Modes and Final Score

Pearson Correlations					
Delivery mode	Interactive Voice	Android application	USSD	Mobile Web	Final score
Interactive Voice	1	-.528**	-.255	.046	.350
Android application	-.528**	1	-.376	-.680**	-.442*
USSD	-.255	-.376	1	.122	-.199
Mobile Web	.046	-.680**	.122	1	.411
Final score	.350	-.442*	-.199		1
**. Correlation is significant at the 0.01 level (2-tailed).					
*. Correlation is significant at the 0.05 level (2-tailed).					

Table 40: Peaerson Correlations Sig. (2-tailed) between Delivery Modes and Final Score

Delivery mode	Interactive Voice	Android application	USSD	Mobile Web	Final score
Interactive Voice		.010	.240	.837	.101
Android application	.010		.077	.000	.035
USSD	.240	.077		.579	.363
Mobile Web	.837	.000	.579		.051
Final score	.101	.035	.363	.051	
**. Correlation is significant at the 0.01 level (2-tailed).					
*. Correlation is significant at the 0.05 level (2-tailed).					

From the univariate analysis results shown on table 41 , the test between subject effects show that only mobile web has significant effect on final score with (F=6.217, p=.041). The effect size of all the other modes of delivery have less effect. USSD mode has the least effect size with (F=.311 and p=.594).

Table 41: Tests of Between-Subjects Effects

Dependent Variable:Final score

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	2113.379[a]	15	140.892	2.219	.145	.826
Intercept	187.436	1	187.436	2.952	.129	.297
DM_MOBWEB	394.719	1	394.719	6.217	.041	.470
DM_ANDRO_APP	137.032	1	137.032	2.158	.185	.236
DM_USSD	19.774	1	19.774	.311	.594	.043
DM_IVR	1203.697	12	100.308	1.580	.279	.730
Error	444.447	7	63.492			
Total	97022.000	23				
Corrected Total	2557.826	22				

a. R Squared = .826 (Adjusted R Squared = .454)

From the results on table 41 and as discussed above, there is evidence that learners prefer mobile web. More than 70% of the learners own smart phones and tablets explaining the preference. The learners are context aware of the alternative modes as is shown by the correlations between IVR and popular modes of delivery like mobile web and Android application.

It is therefore sufficient to conclude that Learner context awareness influences the intended learning outcome. It is also true that the modes of delivery affect the context awareness of the learner when achieving the intended learning outcome.

This research therefore accepts the direct hypothesis: H6: The Context Awareness (C.A) has a significant influence to achieving the intended Learning Outcome (I.L.O); and the moderating hypothesis: H6a: The effect of C.A is moderated by delivery mode.

5.3.3 The New Mobile Learning Instructional Design and Delivery model

The following is the general mathematical model that was established to aid establishment of the final model.

$$y = f(x1, x2, \ldots . x10, p1, p2, p3, p4, p5, p6, p7, p8, p9, p10, p11, \ldots . p17)$$

Where

y = The Intended Learning Outcome, $x1$
= Learner Entry Behaviour(LEB)

$x2$ = Content Relevance and Serving(CR/S),

$x3$ = Content Format and Packaging(CF/P)

$x4$ = Learner Attention (LA), $x5$ = Larner Feedback (LF)

$x6$ = Learner Context Awareness (CA), $x7$ = Age (A) , $x8$=Gender (G)

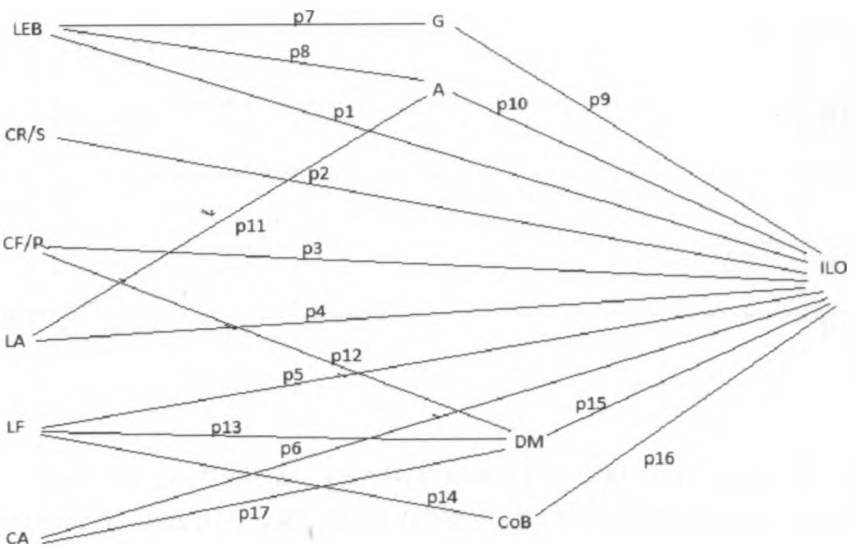
$x9$ = Delivery Mode(DM), $x10$ = Cost of Band Width (CoB)

p1, p2, ... p17 are parameters that describe the model relationships.

Using Multivariate analysis, the values of relationships are evaluated and determined to show final model.

Conceptual model form direct path hypothesis

Figure 22: Direct Path Model



Using the correlational coefficient values, the Model equation is as follows

Equation 1: ILO = p1*(LEB) + p2*(CR/S) + p3*(CF/P) + p4*(LA) + p5*(LF) + p6*(CA) + p9*(G) + p10*(A) + p15*(DM) + p16*(CoB)

Equation 2: A = p8*(LEB)+p11*(LA)

Equation 3: G = p7*(LEB)

Equation 4: DM = p12*(CF/P) + p13*(LF) + p17*(CA)

Equation 5: CoB = p14*(LF)

From the analysis the p values are obtained from Pearson's values from the univariate analysis.

Below are the Pearson's data values for each relationship obtained from tables 19, 20, 21, 24, 28, 29, 30, 31, 32, 33, 35, 36, 37 and 38.

Table 42: Pearson's Data Values for each Relationship and their Moderator effects

Factor	I.L.O	Gender	Age	CoB	DM
L.E.B	P1=.062	P7=.123	P8=.293	-	-
C.P/S	P2=.821	-	-	-	-
C.F/P	P3=.671	-	-	-	P12=.886
L.A	P4=.975	-	P11=.029	-	-
L.F	P5=.971	-	-	P14=.369	P13=.323
L.C.A	P6=.680	-	-	-	P17=.826

We obtain the coefficients, p9=.078 and p10=.009 from table 23, p15=.282 from table 33 and p16=.001 from table 38 by the relationships of final scores and moderators.

Replacing these values in the four equations above, we get the following:

ILO = p1*(LEB) + p2*(CR/S) + p3*(CF/P) + p4*(LA) + p5*(LF)+ p6*(CA) + p9*(G) + p10*(A) + p15*(DM) + p16*(CoB)

= .062*(LEB) + .821*(CR/S) + .671*(CF/P) + .975*(LA) + .971*(LF) + .680*(CA) + .078*(G) + .009*(A) + .282*(DM) + .001*(CoB)

A = p8*(LEB)+p11*(LA) = **.293***(LEB)+.029*(LA)

G = p7*(LEB) = .123*(L.E.B)

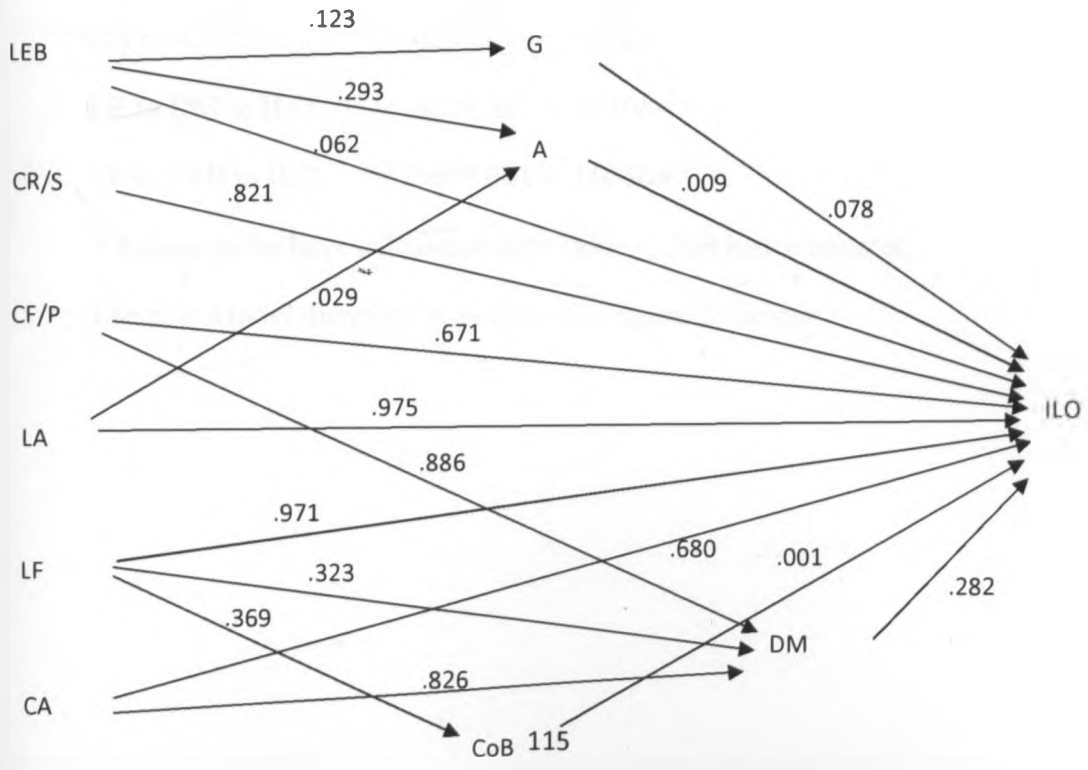
DM = p12*(CF/P) + p13*(LF) + p17*(CA)
= .886*(CF/P) + .323*(LF) + .826*(CA)

CoB = p14*(LF) = .369*(LF)

Finally, **ILO** = .062*(LEB) + .821*(CR/S) + .671*(CF/P) + .975*(LA) + .971*(LF) + .680*(CA) + .078***(.123*(L.E.B))** + .926*(.293***(LEB)+.029*(LA))** + .282***(.886*(CF/P) + .323*(LF) + .826*(CA)**) + .001***(.369*(LF)**)

This resulted to the model with values figure 23.

Figure 23: Conceptual Framework with Path Weights



According to Gary L. Tompkin (1978), a path coefficient with absolute value less than .200 ($p<.200$) is regarded a weak path and can be eliminated.

In order to evaluate the path strength, we take the product of their coefficients (Tompkin G.L, 1978).

The following paths therefore are accepted:

Direct paths:

CR/S to ILO; CF/P to ILO; LA to ILO; LF to ILO; CA to ILO;

Accepted calculated path:

CF/P to DM to ILO = .886*.282 = .2499

CA to DM to ILO = .826*.282 = .2329

Both have path value > .200 hence paths accepted.

The following paths are therefore rejected:

Direct paths: LEB to ILO;

Calculated paths:

LEB to A to ILO = .293*.009 = .002637

LEB to G to ILO = .123*.078 = .009594

LA to A to ILO = .029*.009 = .000261

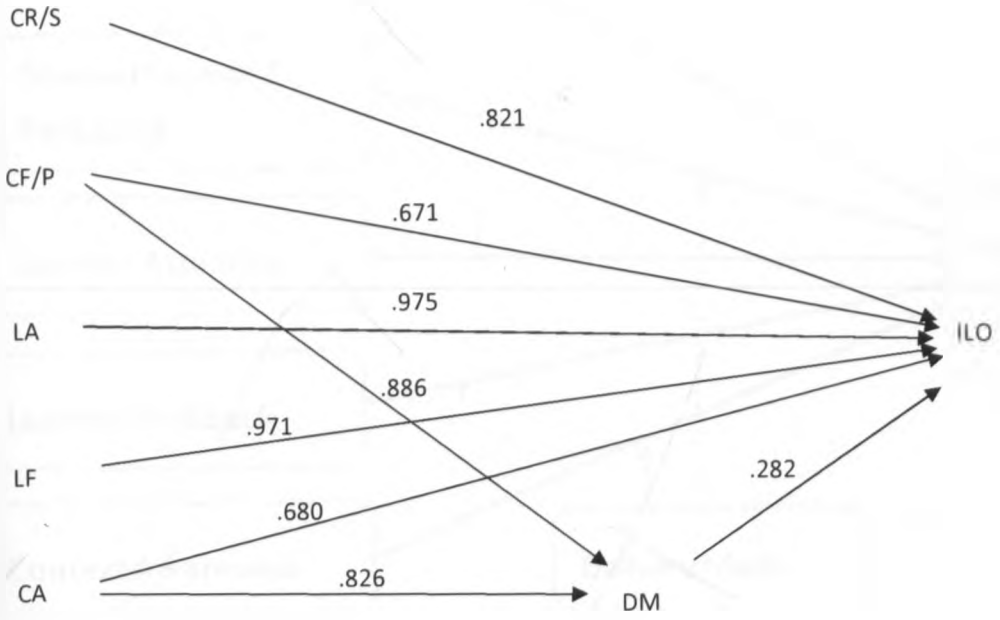
LF to DM to ILO = .323*.282 = .091086

LF to CoB to ILO = .369*.001 = .000369

All these paths have calculated path value < .200 hence rejected.

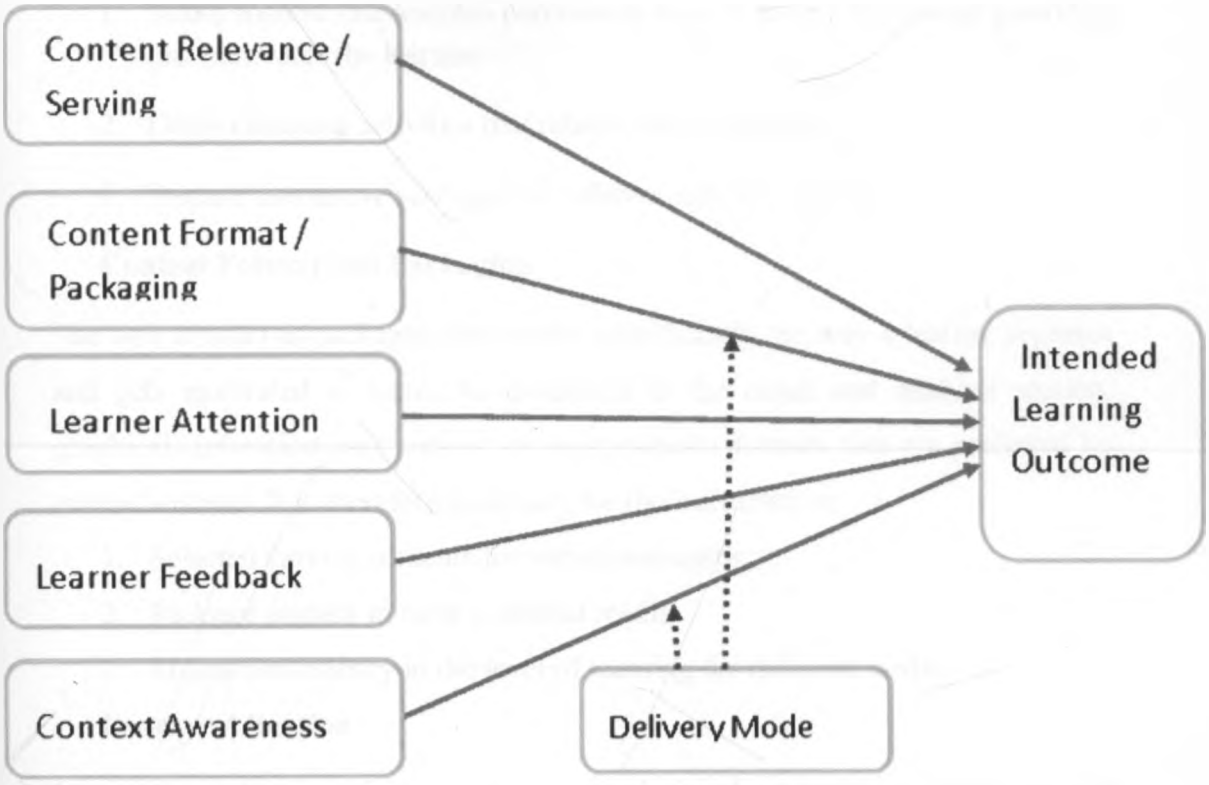
The new Model therefore is as shown in figure 26 below:

Figure 24: Revised Conceptual Framework with Weights



5.3.3.1 Discussion on the final Framework

Figure 25: Revised Instructional Design and Delivery Model for Mobile Learning



Source: Researcher

Content relevance and Serving

From figure 25, the instructor must make the learning content relevant to the subject matter. A learner attaches relevance to content if:

1. The content relates well with the subject of discussion;
2. Motivates the learner to understand the subject of discussion;
3. The content offer adequate materials to enable the learner to answer questions given in an assignment;
4. It directs the learner to discover new knowledge;

Unlike other models of instructional designs, the way content is served to the learner determines relevance. Mobile learners are motivated by content that is in video or graphical formats hence served in modes that support such formats. Majority of learners have smart devices that can stream videos and rich multimedia content. It is therefore, the responsibility of the instructor to prepare content that learners deem relevant. The learner must relate content to the

learning activities. An instructional content must be clear to direct the learning activity. The instructor must therefore:

1. Select content that learners perceive as easy to follow and design a serving that motivates the learners.
2. Design learning activities that relates well to content;
3. Prepare alternative servings for different delivery modes.

Content Format and Packaging

The way content is packaged determines significantly the way a learner accesses and gets motivated to learn. As discussed in the result and analysis section, graphical, animations and videos are most popular formats that are preferred by mobile learners. It is therefore necessary for the instructor to:

1. Selected various contents for varied packaging;
2. Package content in most preferred media
3. Ensure consistency in the level of learning for different media.

Learner Attention

Instructor must ensure the learners are actively involved and their attention is not lost. A learner will show attention by the rate of feedback. A learner who is bored is not motivated to learn. Therefore the instructor need to:

1. Provide short exercises that learners can respond to quickly with answers;
2. Ensure that the instructive level of difficulty is incremental;
3. Learning activities are interesting to the learner.

If the activities are well designed, they captures the attention of the learner and the learning outcomes are highly achieved.

Context Awareness

The learners learn better when they are aware of the levels of difficulty in accessing and posting of content. Many times the learner has a preferred mode and content format and medium of access. It is therefore necessary for the instructor to explain the various content formats and mediums used on the learning content. It is therefore necessary for the instructor to:

1. Provide a learner's guide;
2. Provide supportive instructions along content or hints that learners can refer to;

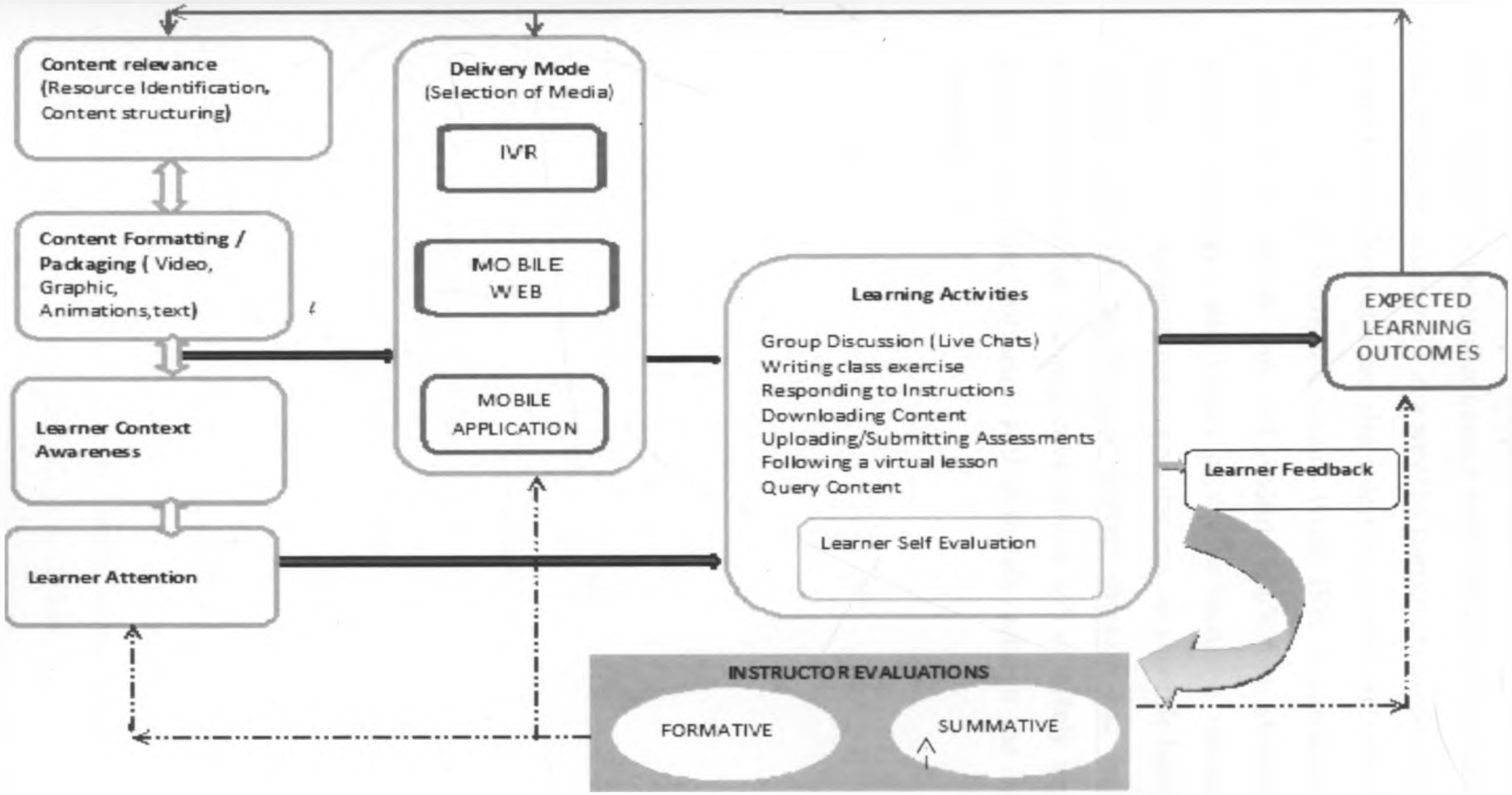
3. Respond to all questions;
4. Provide a link to answers of all frequently asked questions.

Learner Feedback

Learner feedback is as important as instructor's feedback. Learners will respond depending on the way they get response from their instructor. It is therefore necessary for the instructor to:

1. Provide requests that the learner need to be responded to;
2. Respond to all requests done by the learners in a timely manner;
3. Motivate the learner when they give a response by timely feed forward response.

Figure 26: *The Mobile Learning Instructional Design & Delivery Model*



Instructors can use the instructional design and delivery model by preparing relevant content for learning and packaging it in a way it can be delivered. The model informs of activities that can keep both the learner and the instructor more engaged as the learner interact with content and instructor. The instructor should design assessment in a way the learner can assess themselves and also others that the instructor can also assess the learner. Activities like group work can do well in discussion forum. While IVR is interactive enough, other channels like mobile web and Android application should be available to increase flexibility and variety of choice based on varied location of the leaner. A well designed instruction that run on a mobile learning system with multiple channels can increase learner attention and feedback. A well-orchestrated mobile learning environment will definitely improve quality of learning and the instructor will definitely achieve the intended learning outcome.

CHAPTER 6: ACHIEVEMENTS, CONTRIBUTIONS, CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

The purpose of this chapter is to summarize the study on modeling instructional design model for mobile learning. The study has achieved valid results from experimental and practical points of view to explain the critical role mobile technology can contribute to teaching and learning processes. System developers for mobile learning systems and instructors can now confidently use the instructional design model to develop and apply it to achieve the expected results.

6.2 Overview of the research and achievements

The research started by identifying the problem and setting a strategy to aid solve the problem. There are few institutions in Kenya that use mobile learning systems and one objective set by this research was to identify an institution that was ready to adopt mobile learning. A survey was conducted to the sampled institution and a mobile readiness test was conducted. During the test, KENET e-readiness indicators was modified and used. The result has shown that the institution was ready to adopt a mobile learning system.

A team of developers were composed and various components of mobile systems developed. The components are mobile website, mobile application (android version), USSD part, Interactive Voice Recognition (IVR) part and a database. The database or content management system adopted was Moodle. The system was developed and deployed to run on the institutions sub-domain http://mobile-learn.anu.ac.ke . It was tested and after seeking all authorizations, the experiments started and data gathering was successfully achieved within three months of instructions to the learners.

The researcher set out to develop an instructional design model for mobile learning. In order to do so a conceptual framework was developed by the researcher's rigourous review of existing literature on instructional design models and existing software architectures on mobile technology. Upon understanding the models and constructs, the researcher developed a conceptual framework to guide this study. Hypotheses were formulated and moderating factors. Data was obtained from the experiments conducted. After

analysis of data, some hypothesis were rejected and others accepted to model the instructional design model. Using the hypothesis testing results, the instructional design and delivery model was modeled. The model will enable developers and instructors to demonstrate mobile technology adoption for purposes of teaching and learning and can bring out expected learning outcomes.

Upon modeling the instructional design model it was found that learner entry behavior does not influence the leaner perfomance hence it is not related to expected learning outcome (Ireri B.N, Omwenga E.I., 2014). Instead it bridges the learners varied learning entry behavior. The paper quoted was generated from these results and published in an international journal. The factors that greatly influence learning outcome when mobile learning is used were content relevance and serving, content formats and packaging, learner attention, feedback and context awareness. These factors are discussed in chapter 4.

6.3 Research Contribution

This research makes a contribution to the body of knowledge from theoretical, methodological and practical or instructional points of view.

6.3.1 Theoretical Contribution

Alot has been developed on mobile learning and all revolve around the learning theories. In the context of learning theories, the researcher has made contributions on modeling the instructional design by coming up with an instructional model for mobile learning. Acording to Dubin (1978), the process of theory development must answer four questions **What?; How? ;Why?; Who,where, and when?**

What. To explain the what question, Whetten (1989) provides a guide that the which factors i.e. variables and constructs explains social or idividual phenomenon of interest. Using the whetten guide, the instructional design model has the factors clearly explaining how the intended learning outcome of a learning process can be achieved while using a mobile learning system.

How. Whetten continues to explain that after identifying the factors, one must show how they are related operatonally. The modeling process for the instructional design did show how each factor is related.

Why. The reason for modelling instructional design model was to help mobile software developers and insructors ground their processes in sound instructional theories. The reason being that learning using mobile technology is a pedagogical process rather than a technological process. Some theories have premise that say mobile technology in class is disruptive. Instructors may be persuaded by such theories not to use mobile technology in class. The contribution made by this research dispell such fear and encourages instructors and others who may require to use mobile technology for puporses of teaching and learning. The theoretical contribution provides guide to such users on what steps to take in order to get maximum benefit while using mobile learning system for puporses of teaching and learning.

Who,where and when?. As stated, the reason being to guide the developer and instructor, the software developer develops with the learner in mind while the instructor prepares instructions with the learner in mind. The context and focus here is the learner. The software developer is guided to dsign software that directly aids the learner and the instructor for purposes of managing the learning process.

The framework developed is in tandem with other instructional design models with afew theoretical differences brought by the nature and uniqueness of mobile learning. Some of the differences are: while other model emphasizes on learner entry behavior as a key component to achieving learning outcomes, this research dispells such claims by claiming that as long as the learner has the prerequisites to join a course, mobile learning bridges any other entry behavior. The leaners will perform equally irrespective of any other entry behavior the learner may possess. This is because a well designed instruction on mobile platform is motivating to the learners to enable them meet the expected learning outcome (Ireri B.N & Omwenga E.I., 2014). This preposition is a major theoretical contribution.

6.3.2 Methodological Contribution

The methodology used in this study, provides some guidelines for researchers interested in this area or related areas; Specifically, researchers interested in mobile learning technologies or use of technology for teaching and learning,

review as a method of literature, assessment of readiness for mobile adoption, design of experimental studies, use of SPSS for data analysis as well as moderating effects.

The research process used in this study was systematic. It started with review of literature using review as a method. This method is more involving than just literature review. It is analytic and provides indepth of liturature being reviewed.

Before setting up the experiment, a mobile readiness test was caried out. The reseacher has provided the method of assessing mobile learning readiness by modifying factors used by KENET for e-readiness. This is a major contribution for implementor of mobile learning systems who may be interested in setting up one in their institutions of learning. They can use this method to evaluate how ready they are.

The researcher used experimental design method to validate the model. Researchers who may be interested in using experimental design method are clearly guided by this research on the steps to follow.

6.3.3 Practice: Teaching and Learning Contribution

By providing an instructional design and delivery model for mobile learning, instructors, teachers and lecturers from all walks of live who may intend to use mobile technology for puporses of teaching and learning have a guide as they plan their lessons and instructions to their learners. The contribution may be more valuable for those instructors with no pedagogical training as this is simple a nd straight forward. It does not need pedagogical interpretation.

6.3.4 Mobile Learning Application Software Development contribution

It is predicted that the next 1 billion new internet connections will be from mobile devices in the hands of young people in the developing world (UNESCO (YOUTHMOBILE), 2014) and over the next fifteen years, students will not just use mobile devices but will learn to program them to suit their preferences. Majority of these young people are college and university students in sub-Saharan Africa. The report compares Africa and Europe where the rise in mobile programming in education by students is high. Many institutions of higher learning are encouraging learners to bring their own

devices (BYOD) in their classes. According to UNESCO report on mobile app development, the model of BYOD is causing a major shift in education by allowing learners to access course materials through mobile devices. In Kenya, Broadband usage has increased from 1million in December 2013 to 1.5 million in March 2014 (CCA, 2014). This rise is attributed to cost reduction in mobile devices. Many of the new connections and subscriptions are by young people aged between 18 years and 22 years. This research confirms that 100% of university student's own a mobile phone and that learners are ready to use them for purposes of learning.

In lieu of this growing demand, this research has made a significant contribution to those that will be mobile application developers for learning and have no pedagogical training. They will use the model as a guide to what components to include in their applications in order to enable learners and instructors to achieve the intended learning outcomes.

6.3.4 Contribution to Technical Term's Definitions

The research has contributed to some definitions by making the factor measurable hence enabling computations on them for purposes of establishing their impacts on inteneded learning outcomes. The following terms were redefined: Learner Feedback, Learner attention.

6.4 Research Conclusion

In this section, the researcher presents a summary of the key findings as reported in this thesis.

6.4.1 Instructional design and Delivery Models

Models for instructional design provide procedural frameworks for the systematic preparation of teaching and learning. Instructional models give structure or a framework and meaning to an instructional design problem for the purposes of producing instruction. The main purpose is to maximize the value of instruction for the learner. Pedagogical needs come first before the choice of instructional technology to be used to support learning. This research has demonstrated the importance of an instructional design model especially to an emerging technology like mobile learning throughout the discussions.

The mobile penetration in developing countries of Africa is above 70% and the cost of the devices has significantly dropped. In the institutions of higher learning where learners between the age of 18 years and 35 years are found, 100% own a mobile device. More than 70% are smart devices capable of accessing and processing multimedia content. The learners in these institutions are ready to use these gadgets for purposes of learning. It is therefore recommended that instructors need to design instructions that fit the use of these devices without compromising the pedagogical requirements. The researcher established through review of literature that there are no instructional design models to guide both the developers of mobile learning applications and the instructors who need to use the mobile technologies for instructional purposes. The researcher has modeled one and is therefore recommended for such uses.

6.4.2 Mobile Readiness Evaluation

For smooth transitioning from traditional methods of instructing learners to use of mobile learning systems, the researcher has developed a simple method for evaluating readiness that is benchmarked with KENET model.

For easier use of the instructional design and delivery model developed by the researcher, a simple diagram and explanations have been provided for instructors with no pedagogical training. These simple steps are helpful when preparing to instruct learners on mobile learning system.

6.5 Limitations of the study

The research produced good results, however, there were some limitations.

1. The mobile learning environment required a well networked campus with wireless connectivity (WiFi) among other requirements. In the first session of data collection i.e. preliminary stage, the WiFi coverage was low, however an infrastructural upgrade was done by the university making it possible and easier to conduct the experiments in the final stage of data collection.
2. The mobile application was developed for adroid mobile gadgets. This limited other respondents who did not have android gadgets to use mobile web, USSD and IVR modes.

3. The IVR mode was only accessible on campus via WiFi connection. This was because pushing voice over internet would use higher bandwidth and no provisions to increase bandwidth were provided. This limited users who were non resdent to use IVR services off campus.

6.6 Recommendations

6.6.1 Recommendations to Instructors and Developers

1. Before any instituition embarks on mobile learning as a strategy for delivery of teaching and learning, it is necesary to carry out a survey to ensure that the learners and the institution is generally ready for it. The method used in this research for computing mobile learning readiness is simple and easy to use. It is therefore recomended for adoption. A software application tool for calculating indexes is recomended to reduce labourious computations involved during staging level.
2. Since instructors in higher learning institutions like university are individually responsible and control the courses they teach, it makes sense for them to be able to design or even redesign content, bearing in mind the intended learning outcome. More responsibility is for those that intend to support teaching and learning using the mobile learning technologies since this research confirms that they need to figure out the various servings of that content in order to promote deep learning. Video clips and chart rooms have been proven to yield better results for mobile learners amongst many servings used in this research.
3. When instructing the learners through mobile learning system, the institution should consider upgrading their infrastructure to provide a wireless communication e.g. Wi-Fi.
4. The developers of mobile learning system must provide multiple delivery modes for learners to use when giving their feedback.
5. The instructor should offer learners multiple delivery modes to allow flexibility when giving feedback.

6.6.2 Recommendations to Policy Makers/Implementers

1. Mobile learning is a reality now and appropriate policy needs to be put in place to support it.

2. This research recomends that mobile learning research should be funded to investigate whether pre-primary, primary and secondary schools can adopt mobile learning. This will save costs on infrastructure development for computer labs and computers (desktops) and leverage on mobile device penetration in the country.
3. Government through KENET should invest build a cloud where all institutions of higher learning can draw connectivity for learning. The mobile learning and delivery system would be hosted as a cloud. This will ensure quality of content and formats are controled.

6.6.3 Recommendations for further study

While this research has successively achieved its objectives a few gaps were identified that require further research:

1. There is no one single framework for developing all mobile applications modules (USSD, Mobile WEB, SMS, IVR and so on).
2. The construct for mobile Context Awareness need further research especially device context awareness for monitoring learner preferences.

REFERENCES

Adero, B. 2009. February, Nokia launches information service for farmers in Kenya. Viewed September , 2013, http://www.africanagricultureblog.com.

Andrea, B., Greig, K. & Brenda, M. 2005. A Proposed Theoretical Model for M-Learning Adoption in Developing Countries. Viewed November, 2014. http://www.mlearn.org.za/CD/BOA_p.14.pdf .

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

Bahar, B, et al. 2011. Dokuz Eylul University, *Turkish Online Journal of Educational Technology* , vol. 10 Issue 1.

Baker, M.B., Boggs, R., & Arabasz, P. 2003. Student and Faculty Perspectives on E-learning Support. *Educase center for Applied Research*, Research Bulletin, Volume 2003, Issue 16, pp 1-10.

Bandura & Walters 1963. *Social Learning and Personality Development.* New York: Holt, Rinehart & Winston.

Berry, R., Mobley, K., & Turk, K. 1994. Preparing to document an object-oriented project. Technical Communication, 4(4), 643-652.

Bogdan & Biklen, 1998. *Qualitative research for education: An introduction to theory and methods.* Boston: Allyn and Bacon.

Burkholder, P. 2014. Content means to a critical thinking end: Group quizzing in history surveys. The History Teacher, 47 (4), 551-578.

Braxton, S., Bronico, K., & Looms, K. 1995. Instructional design methodologies and techniques. The George Washington University in Washington, D.C.: Computer Science Department. Viewed May 2014 http://www.seas.gwu.edu/~sbraxton/ISD/isd_homepage.html

Castells,M., Fernandez-Ard´evol,M., Qui, J. & She, A. 2007. *Mobile Communication and Society;* MIT Press, Cambridge, Mass, USA.

CAK. 2012. Quarterly Sector Statistics Report 1 St Quarter July-Sept 2012. Retrieved on January 2014. http://www.ca.go.ke/index.php/statistics

CAK. 2013. Quarterly Sector Statistics Report 3 Rd Quarter Jan-Mar 2013. Retrieved on April, 2013. http://www.ca.go.ke/index.php/statistics

CAK. 2013. Quarterly Sector Statistics Report 4 Th Quarter Apr-June 2013. Retrieved on October 2013. http://www.ca.go.ke/index.php/statistics

CAK. 2013. Quarterly Sector Statistics Report 1 St Quarter July-Sept 2013. Retrieved on October 2013. http://www.ca.go.ke/index.php/statistics

CAK. 2013. Quarterly Sector Statistics Report 2 Nd Quarter Oct-Dec 2013. Retrieved on January 2014. http://www.ca.go.ke/index.php/statistics

CAK. 2014. Quarterly Sector Statistics Report 3 Rd Quarter Jan-Mar 2014. Retrieved on July, 2014. http://www.ca.go.ke/images/downloads/STATISTICS/Sector%20Statistics%20Report%20Q1%202014-2015.pdf

CAK. 2014. Quarterly Sector Statistics Report 4 Th Quarter Apr-June 2014. Retrieved on July, 2014. http://www.ca.go.ke/images/downloads/STATISTICS/Sector%20Statistics%20Report%20Q1%202014-2015.pdf

CAK. 2014. Quarterly Sector Statistics Report 1 St Quarter July-Sept 2014. Retrieved on January 2015. http://www.ca.go.ke/images/downloads/STATISTICS/Sector%20Statistics%20Report%20Q1%202014-2015.pdf

CAK. 2014. Quarterly Sector Statistics Report 2 Nd Quarter Oct-Dec 2014. Retrieved on January 2015. http://www.ca.go.ke/images/downloads/STATISTICS/Sector%20Statistics%20Report%20Q1%202014-2015.pdf

Chaudry, M.A., & Rahman, F. 2010. A critical Review of Instructional Design Process of Distance Learning System. *Turkish Online Journal of Distance Educatio – TOJDE.* Vol. 11, No. 3 .

Chizmar, J. F., & Walbert, M. S. 1999.' Web-based learning environments guided by principles of good teaching practice', *Journal of Economic Education*, Vol. 30, pp. 248-264.

Christensen, C, 1995. Disruptive Technologies: Catching the Wave, Harvard Business Review.

Christensen, C 1997. *Innovator's Dilemma: When New Technologies Cause Great Firms to Fail.* Harvard Business Press, Cambridge, Mass, USA.

CompSysTech'2004, Rousse, Bulgaria, 17-18 June 2004. Retrieved 31 Oct 2013 from http://ecet.ecs.ru.acad.bg/cst04/Docs/sIV/428.pdf

Deegan, R., & Rothwell, P. 2010. A classification of m-learning applications from a usability perspective. Journal of the Research Center forEducational Technology, 6(1), 16–27.

Desrosier, J. 2011.Rapid Prototyping Reconsidered.*The Journal of Continuing Higher Education*, vol. 59,pg.135–145.

Dev Kumar, B., 2013.' ADHD in the Classroom', *Journal of Currents in Teaching and Learning*, Vol.5, Nos.1&2, Fall 2012 - Spring 2013, Worcester State University, Worcester, Massachusetts, U.S.A.

Dichanz, H. 2001: E-learning, a linguistic, psychological and pedagogical analysis of a misleading term. Paper presented at the 20th ICDE World Conference in Düsseldorf 2001.

Dick, W. & Cary, L. 1990. *The Systematic Design of Instruction*, Third Edition, Harper Collins.

Dorin, H., Demmin, P. E., Gabel, D. 1990. *Chemistry: The study of matter.* (3rd ed.), Englewood Cliffs, NJ: Prentice Hall, Inc.

Dubin, R., 1978. Theory Development, New York: Free Press.

Economides, A. A. 2008. 'Context-aware mobile learning. The Open Knowledge Society, A Computer Science and Information Systems Manifesto, First World Summit, WSKS 2008, Athens, Greece, September 24-26, 2008 Proceedings'.

El-Hussein, M. O. M., & Cronje, J.C. 2010. Defining Mobile Learning in the Higher Education Landscape. *EducationalTechnology & Society*, 13 (3), 12–21.

Elias, T. 2010. 'Universal instructional design principles for Moodle', *International Review of Research in Open and Distance Learning, Vol.*11(2). Viewed February, 2014, http://www.irrodl.org/index.php/irrodl/article/view/869.

Elias, T. 2011. Athabasca University, Canada International, Review of Research in Open and Distance Learning, Vol. 12(2), viewed February, 2014, , http://www.irrodl.org/index.php/irrodl/article/view/869.

Ellis, T. J., & Levy, Y. 2008. 'Framework of problem-based research: A guide for novice researchers on the development of a research-worthy problem. Informing Science, *The International Journal of an Emerging Transdiscipline*, vol. 11,pp. 17-33. Viewed February, 2014, http://www.inform.nu/Articles/Vol11/ISJv11p017-033Ellis486.pdf .

Ellis, T. J., & Levy, Y. 2009.' Towards a guide for novice researchers on research methodology: Review and proposed methods, *Issues in Informing Science and Information Technology*, Vol. 6, pp. 323-337. Viewed February, 2014, http://iisit.org/Vol6/IISITv6p323-337Ellis663.pdf .

Eric, L. D., Helen E. B., & David G. 2009. 'Bringing the Classroom to the Web: Effects of Using New Technologies to Capture and Deliver Lectures', *Research in Higher Education*, Vol. 50, No. 4, pp. 377-393, Springer Article Stable URL: http://www.jstor.org/stable/29782929.

Erickson, 2007."Megatrends, The Role of Mobile Learning In European Education", viewed November 2014, http://www.ericsson.com/ericsson/corpinfo/programs ./

Fozdar, B.I. & Kumar, L.S. 2007. "Mobile Learning and Student Retention", *International Review of Research in Open and Distance Learning*, Vol. 8., No. 2.

Frymier, A.B. & Shulman, G.M. 1995.' Making Content Relevant to Students' *Communication Education*, p.83-92.

Frymier, A.B., & Shulman,G.M. (1995). "What'sin it for me?: Increasing content relevance to enhance students' motivation', *Communication Education*, Vol. 44, pp.40-50.

Gagne, R. M., Briggs, L. J., & Wagner, W. W. 1992. *Principles of instructional design*. New York: Harcourt Brace Jovanovich College Publishers.

Gall, M., Borg, W., & Gall, J. 2003. *Educational research: An introduction (6th ed.)*. New York: Longman.

Garson, D. 2008. Path Analysis, Lecture Notes. North Carolina State University, Raleigh, North Carolina. Retrived in November, 2014 from: http://hbanaszak.mjr.uw.edu.pl/TempTxt/Garson_2008_PathAnalysis.pdf

Georgiev, T., Georgieva, E. and Smrikarov, A. 2004. M-Learning - a New Stage of e-Learning, *International Conference on Computer Systems and Technologies*

Gerlach, V.S., & Ely, D.P. 1980. *Teaching & Media: A Systematic Approach (2nd ed.)*. Englewood Cliffs, NJ: Prentice-Hall Incorporated.

Githii, S.K., Kamau, J.N., Njau, M.M., Kagiira, A.K. 2013. Factor Influencing Mobile Number Portability (Mnp) In Kenya: The Case Of Africa Nazarene University. 1st Annual International Interdisciplinary Conference, AIIC 2013, 24-26 April, Azores, Portugal.

Gudo, C.O & Olel, M.A . 2011. Students' Admission Policies for Quality Assurance: Towards Quality Education in Kenyan Universities. *International Journal of Business and Social Science*, Vol 2. No 8 pp 177 –183.

Gudo, C.O., Olel, M. A. & Oanda I.O. 2011. University Expansion in Kenya and Issues of Quality Education: Challenges and Opportunities. *International Journal of Business and Social Science*, Vol. 2 No.20; pp. 203-214.

Gustafson, K.L., & Branch, R.M. 1997. Revisioning Models of Instructional Development. Educational Technology Research and Development, 45(3), 73-87.

Hair, J., Black, W., Babin, B., Anderson, R., & Tatham, R. (2006). Multivariate data analysis (6th ed.). Uppersaddle River, N.J.: Pearson Prentice Hall.

Hasan, H. 2003. 'Information systems development as a research method', *Australasian Journal of Information Systems, 11*(1), 4-12.

Hellstrom, J. 2009. " Mobile phones and good governance – challenges and the way forward", Stockholm University ITU (2008b), *Information Society Statistical Profiles 2009* – Africa, Viewed October 6, 2014, http://www.itu.int/dms_pub/itu-d/opb/ind/D-IND-RPM.AF-2009-PDF-E.pdf .

Ireri, B. N., & Omwenga, E. I. 2014. Mobile Learning: A Bridging Technology for varying Learner Entry Behavior. *Journal of Education and Practice*, *5*(31), 119-124.

Jonassen, D. H., Tessmer, M., & Hannum, W. H. 1999. *Task analysis methods for instructional design*. London: Lawrence Erlbaum Associates.

Jones, M.K., Li, Z., & Merrill, M.D. 1992. Rapid prototyping in automating instructional design. *Educational Technology Research and Development*, 40(4), 95-100.

Juwah, C., Macfarlane-Dick, D., Matthew, B.,Nicol, D., Ross, D & Smith, B. 2004. "Enhancing student learning through effective formative feedback", *The higher Education Academy*, Viewed November, 2014, http://wap.rdg.ac.uk/web/FILES/EngageinFeedback/Race_using_feedback_to_help_students_learn.pdf.

Karen, D., Ko ningsa,C., Saskia, B. & Jeroen, J.G. 2010. van *Merrie¨nboerb,c Educational Research* ,Vol. 52, No. 1, pp. 45–59.

Kashorda, M., & Waema, T. 2002. E-Readiness Survey of Kenyan Universities (2002) Report. Nairobi: Kenya Education Network.

Kashorda, M., & Waema, T. 2008. E-Readiness Survey of Kenyan Universities (2008) Report. Nairobi: Kenya Education Network.

Kashorda, M., & Waema, T. 2014. E-Readiness Survey of Kenyan Universities (2013) Report. Nairobi: Kenya Education Network.

Keegan, D. 2005. The incorporation of mobile learning into mainstream education and training, proceedings of the 4th World Conference on Mlearning, Cape Town, 25-28 October, Retrieved January , 2014. http://www.mlearn.org.za/CD/papers/keegan1.pdf

Keller, J. M. 2010. *Motivational design for learning and performance: The ARCS model approach*. New York: Springer.

Kendall, M.G. & Gibbons, J.D. 1990. *Rank Correlation Methods. 5th Edition.* New York, NY: Oxford University Press.

Kinyanjui, L., 2002. *Preparing a workforce for the evolving information economy: a Survey on ICT access and use in Kenya secondary schools* (research by Muriuki Mureithi), SchoolNet Kenya.

Kothari, C.K., 2004. *Research Methodology, Methods and techniques*, revised second edition, New AgeInternational publishers Ltd., New Delhi, India.

Krallmann, J. & Foelster, N. 2002. *Remote service systems for agricultural machinery*. Paper presented at ASAE Automation Technology for Off-Road Equipment, Chicago, Illinois.

Lee, W., Burks, T. & Schueller, J. 2002. "Silage yield monitoring system", The American Society of Agriculture Engineers, St. Joseph, Michigan.

Leedy, P. D., & Ormrod, J. E. 2010. *Practical research: Planning and design* (9th ed.). Upper Saddle River, NJ: Prentice Hall.

Leeser, M. J. (2004). Learner proficiency and focus on form during collaborative dialogue. *Language Teaching Research*, *8*(1), 55-81.

Levy, Y., & Ellis, T. J. 2006. " A systems approach to conduct an effective literature review in support of information systems research" *Informing Science: the International Journal of an Emerging Transdiscipline,* Vol. 9, pp. 181-212, Viewed febrauary 2011, http://www.inform.nu/Articles/Vol9/V9p181-212Levy99.pdf.

Lindblon – Ylanne, S., Trigwell, K., Nevgi, A., & Ashurin, P. 2004. Variation in approaches to teaching: the role of discipline and teaching context. Paper presented at the EARLISIG Higher Education Conference, June 21 – 24.

Liu, G. & Ying, Y. 2003. "Application of Bluetooth technology in greenhouse environment, monitor and control" *J. Zhejiang Univ., Agric. Life Sci.Vol. 29*, pp. 329–334.

Lueddeke, G.R. 2003. Professionalizing teaching practice in higher education: a study of disciplinary variation and 'teaching – scholarship'. *Studies is Higher Education,* 28, 213 – 228.

Manyasi, B (2010). OL & DE as a Means of Increasing Access to Higher Learning in Kenya. *A Journal of the KIM School of Management* Vol 1 pp 123 –130.

Mario,M et al. 2003. *Higher Education in Mozambique: A Case Study. Partnership for Higher Education in Africa.* Oxford: James Curray.

Maylor, E.A., & Levie, N., 1998. "The influence of perceptual Load on Age Differences in selected Attention" *Journal of Psychology and Aging*, Vol. 13. No. 4, pp. 563-573.

McGriff, S. 2001. Instructional Design Models. Available on-line at http://www.personal.psu.edu/faculty/s/j/sjm256/portfolio/kbase/IDD/ISDModels.html #kemp . Viewed February, 2013.

McKenzie J., 2003. Pedagogy Does Matters. *The Educational Technology Journal*, Vol. 13, No.1 September, 2003.

McKinion, J., Jenkins, J., Willers, J. & Read, J. 2003. *Developing a wirelessLANfor high-speed transfer of precision agriculture information*, Paper presented at the 4th European Conference on Precision Agriculture, Berlin.

Meier, J.D., et. al. 2008. Mobile Application Architecture Guide. Patterns & Practices. Microsoft Corporation.

Mertler, C. A., & Vannatta, R. A. 2009. *Advanced and multivariate statistical methods: Practical application and interpretation* (3rd ed.). Los Angeles, CA: Pyrczak Publishing.

Mills K. 2011. Mobilising Academic Content Online. Published on open university UK, viewed October, 2014, http://www.open.ac.uk/blogs/macon/about/keren-mills-project-manager/.

Mills N. 2011. "Situated Learning through Social Networking Communities" *The Development of Joint Enterprise, Mutual Engagement, and a Shared Repertoire. CALICO Journal*, Vol. 28(2).

Mutisya, K (2010 December 22). How the wrong policies turned public universities into cacophonous markets. Daily Nation, p.13.

Mwendia, S.N., Wagacha, P.W., & Oboko, R. 2014. 'Culture Aware M-Learning Classification Framework for African Countries', in Keengwe, J., Schnellert, G., & Kungu, K., *Cross-Cultural Online Learning in Higher Education and Corporate Training*. IGI Global, USA

Mwaura, H.N. 2010. Kenya Mobile penetration crosses 50 pct mark-govt. Retrieved October 2, 2010 from http://www.reuters.com .

Nagl, L., Schmitz, R.,Warren, S., Hildreth, T., Erickson, H. & Andresen, D. 2003. *Wearable sensor system for wireless state-of-health determination in cattle.* Paper presented at the 25th IEEE EMBS Conference, Cancun, Mexico.

Newson, R. 2014. Interpretation of Somers' D Under Four Simple Models.

Nicol, D.J. & Boyle, J.T. 2005. *Formative assessment and self-regulated learning: A model and seven principles of good feedback practice.* Studies in Higher Education. Viewed, November, 2014, http://www.psy.gla.ac.uk/~steve/rap/docs/nicol.dmd.pdf.

Novac, A. 2007. Rapid prototyping home page. Retrieved in November 2014 from http://home.utah.edu/~asn8200/rapid.html .

Nunamaker, J. F., Chen, M., & Purdin, T. D. M. 1991. "Systems development in information systems research", *Journal of Management Information Systems, Vol. 7*(3), pp. 89-101.

Odebero, S.O. 2010. Crisis in Financing and Management of Kenyan Higher Education: Implications for Planning Reform agenda. Paper presented at Educational Management Society of Kenya Conference held at Migori Teachers" College, 12th - 14th April 2010.

Ofori, R. & Charlton, J. P. 2002. A path model of factors influencing the academic performance of nursing students Aims. *Journal of Advanced Nursing. Vol.*38(5), pg.507–515.

O'Malley, C., Vavoula, G., Taylor, J., Sharples, M. & Lefrere P. 2003. "Guidelines for learning/teaching/tutoring in a mobile environment", *Mobilearn deliverable D 4.1.*, viewed November 2012, http://www.mobilearn.org/download/results/guidelines.pdf .

Omwenga EI. 2011. *Modelling a Computer-mediated Learning Infrastructure: Concepts, Principles and Implementation Requirements.* Berlin: Lambert Academic Publishing.

Omwenga, E., Waema, T., & Wagacha, P. 2004. "A model for introducing and implementing e-learning for delivery of educational content within the African context" *African Journal of Sciences and Technology*, Vol.5 (1), pp. 35-48.

Oyelami, O. M. 2008. Vol. 5, No.11 (Serial No.48) US-China Education Review, ISSN1548-6613, USA

Park, Y. 2011. A Pedagogical Framework for Mobile Learning: Categorizing Educational Applications of Mobile Technologies into Four Types. Retrieved August, 2015 from: http://www.irrodl.org/index.php/irrodl/article/view/791/1699

Patrick, N. A. 2010. The Art of Teaching: Best Practices from a Master Educator (Chantilly, VA: The Great Courses).

Perkins, M., Correal, N. & O'Dea, B. 2002. *Emergent wireless sensor network limitations: a plea for advancement in core technologies.* Paper presented at the IEEE International Conference on Sensors, Orlando, Florida.

Pessel, G. & Denzer, H. 2003. *Portable and mobile instrument for continuous stable climate measurement.* Paper presented at the 4th European Conference in Precision Agriculture and the 1st European Conference on Precision Livestock Farming, Berlin.

Piaget, J. 1992. *The Essential Piaget.* London: Routledge, Kegan & Paul.

Prostareff, L. L., & Neugi, A. 2007. The effect of pedagogical training on teaching in higher education. *Teaching and Teacher Education*, 23, 557 – 571.

Quinn, C. 2000. mLearning. Mobile, Wireless, In-Your-Pocket Learning. *Linezine.* Fall. Retrieved from http://www.linezine.com/2.1/features/cqmmwiyp.htm.

Rajasingham L. 2011. Corporation Education Research International . Hindawi Publishing .Volume 2011, Article ID 528495.

Reigeluth, C. M. & Frick, T. W. 1999. Formative research: Methodology for creating and improvingdesign theories. In C. M. Reigeluth (Ed.) Instructional-design theories and models (Volume II) A new paradigm of instructional theory (pp. 633 –652). Mahwah, NJ: Lawrence Erlbaum Associates.

Republic of Kenya, 2003. *Report of the Education Sector Review.* Nairobi. Government Printer.

Richey, R. C., & Klein, J. D. 2007. *Design and development research.* Mahwah, NJ: Lawrence Erlbaum Associates, Publishers.

Sadler R., Davies L. & Buckridge M., 2014. GIHE Good Practice Guide on Developing Effective Feedback for Learning. Retrieved November, 2014. From http://www.griffith.edu.au/__data/assets/pdf_file/0009/194877/Feedback_GPG_RSadler.pdf

Schiffman, S. S. 1995. Instructional systems design: Five views of the field. In G.J. Anglin (Ed.), *Instructional technology: Past, present and future.* (2nd ed., pp. 131-142)., Englewood, CO: Libraries Unlimited, Inc.

Shuttleworth, M. 2008. "Definition of Research". Explorable. Explorable.com. Retrieved August 2013.

Springer *Communications in Computer and Information Science (CCIS) 19,* pp. 213-220. ISBN: 978-3-540-97782-0

Stead, G. 2010. Moblearn: The mobile generation is learning. Retrieved from http://moblearn.blogspot.com/2010/06/can-my-m-learning-course-run-same-on.html

Storch, N. 2001. Comparing ESL learners' attention to grammar on three different classroom tasks. *RELC journal, 32*(2), 104-124.

Sygenta Foundation. (n.d.). Microinsurance for Farmers in Kenya - Kilimo Salama. Retrieved October 2, 2010 from http://www.syngentafoundation.org.

Tessmer, M. 1994. Formative evaluation alternatives. Performance Improvement Quarterly, 7(1), 3-18.

Thomas, L. C., 2011. "Social Eyes: Design for Double Rainbow." *Journal of Web Librarianship* 6:321–324, 2012. Copyright © Taylor & Francis Group, LLC ISSN: 1932-2909 print / 1932-2917 online DOI: 10.1080/19322909.2012.729388.

Traxler, J., & Kukulska –Hulme, A. 2005. *Mobile learning: A handbook for educators and trainers.* London: Routledge

Tripp, S., & Bichelmeyer, B. 1990. Rapid prototyping: An alternative ID strategy. *Educational Technology Research & Development, 38*(1).

Trivonova, A., Knapp, J., Ronchetti, M. &, Gamper, J. 2004. Mobile ELDIT: Challenges in the Transition from an e-Learning to an m-Learning System. University of Trento, Sommarive 14 -38050 Povo (Trento), Italy.

Trifonova A., Ronchetti M. 2003. A General Architecture for M-Learning.InProceedings of the Second International Conference on Multimedia and ICTs in Education (m-ICTE 2003), Badajoz, Spain

Trifonova A., Ronchetti M. 2003. Where is Mobile Learning Going? In Proceedings of E-Learn 2003 Conference, Phoenix, Arizona, USA
Udell C. 2013. 10 reasons why mobile learning is more secure than desktop learning. http://floatlearning.com/2013/06/10-reasons-why-mobile-learning-is-more-secure-than-desktop-learning/. Retrieved January, 2015.

UNESCO, 2002. *Information and communication technologies in teacher education, a planning guide*, [online] Available: http://www.unesco.org

UNESCO, 2004. *The need for a systematic approach.*
[online] Available: http://unescobkk.org/education/ict/v2

UNESCO, 2012. *Mobile learning support for teachers 2012 Africa and middle east* [online] Available: http://www.unesco.org.

UNESCO Report, 2014. Youth Mobile. http://en.unesco.org/youthmobile , retrieved October, 2014.

Vivian K., Liebhold M.,& Townsend A., 2006. *Many faces of Context Awareness: A Spectrum of Technologies, Applications, and Impact. Technology Horizons Program.* Retrieved in November, 2014, Retreived from:
http://www.iftf.org/uploads/media/SR-1014_Many_Faces_Context_Awareness.pdf .

Vogt, N.P., Gardner, D.C.& Haeffele, L.M. 2012. When to Use What Research Design. New York, Guilford Press.

Whetten D.A., 1989. What Constitutes a Theoretical Contribution? *Academy of Management Review*, Vol.14(4), No.4, 490-495.

Waithaka, T.M. 2009. Highlights of 2009 economic survey. Retrieved November 23, 2009 from **www.fke-kenya.org**

Williams, J. 1999. Learner-generated attention to form. *Language learning,49*(4), 583-625.

Williams, J. 2001. The effectiveness of spontaneous attention to form.*System*, *29*(3), 325-340.

APPENDIX 1: ACTIVITY CHART- GANTT CHAT

Modelling Instructional Design and Delivery Model for Mobile Learning
A PhD. Thesis by Bonface Ngari Supervised by Prof. Elijah Omwenga
School of Computing and Informatics - University of Nairobi

		2012		2013			2014			
	ACTIVITY	MAY-JULY	SEPT.-DEC	JAN-APRIL	MAY-AUGUST	SEPT.-DEC	JAN-APRIL	MAY-AUGUST	SEPT.-DEC	SEPT.-DEC
1	PROPOSAL WRITING	■	■	■						
2	PRELIMINARY DATA COLLECTION				■	■	■			
3	DATA ANALYSIS				■	■	■			
4	MOBILE LEARNING SYSTEM DEVELOPMENT			■	■	■				
5	SYTEMTESTING AND DEPLOYMENT					■	■			
6	EXPERIMENTS							■		
7	FINAL DATA COLLECTION							■	■	
8	DATA ANALYSISAND MODELLING							■	■	
9	THESIS WRITING AND SUBMISSION					■	■	■	■	■

APPENDIX 2: THE BUDGET

Sno	Activity	Resources	Qty	Start Date	Finish Date	cost per Item	Cost
1	Proposal Writing	Financial (Transport)	1			5,000.00	5,000.00
2	Defence	Financial (Transport)	1			5,000.00	5,000.00
3	Data Collection	Server	1			200,000.00	200,000.00
		Laptop	1			80,000.00	80,000.00
		3 Research Assistants	3			20,000.00	60,000.00
		mobile Phones	4			12,000.00	48,000.00
4	Data Analysis	SPSS Software	1			-	
5	Seminar		10			5,000.00	50,000.00
6	Modeling ID					-	
7	Publications		1			50,000.00	50,000.00
8	Conferences	Financial (Transport)	2			50,000.00	100,000.00
9	Mobile Apps. Development	3 Research Assistants	3			20,000.00	60,000.00
10	Server Apps. Development	1 Research Assistant	1			20,000.00	20,000.00
11	Configurations	1 Research Assistant	1			20,000.00	20,000.00
12	Connectivity Related Expenses	Financial	1			50,000.00	50,000.00
13	Testing	1 Research Assistant	1			20,000.00	20,000.00
14	Seminar	Financial (Transport)	10			5,000.00	50,000.00
15	Testing ID model/Platform	3 Research Assistants	3			20,000.00	60,000.00
16	Publications	Financial	1			50,000.00	50,000.00
17	Report writing	Financial	1			50,000.00	50,000.00
18	Conferences	Financial (Transport)	2			50,000.00	100,000.00
19	Final Defence	Financial (Transport)	1			5,000.00	5,000.00
20	Other Expenses	Financial					50,000.00
	TOTAL						**1,133,000.00**

APPENDIX 3: RESEARCH PERMIT AND AUTHOURISATION

A: NATIONAL COUNCIL FOR SCIENCE AND TECHNOLOGY AND INNOVATIONS (NACOSTI)

ORIGINAL

AC: 01761

OFFICIAL RECEIPT

Station ..... Date .....

RECEIVED from .....

Shillings .....

..... cents .....

on account of .....

.....

Vote Head .....

NACOSTI

Item .....

Cash

Cheque No. .....

USD	
Kshs	
AC No.	

Signature of Officer receiving remittance

NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY AND INNOVATION

Telephone: +254-20-2213471,
2241349, 310571, 2219420
Fax: +254-20-318245, 318249
Email: secretary@nacosti.go.ke
Website: www.nacosti.go.ke
When replying please quote

9th Floor, Utalii House
Uhuru Highway
P.O. Box 30623-00100
NAIROBI-KENYA

Ref: No

Date:

30th June, 2014

NACOSTI/P/14/3194/1270

Bonface Ngari Ireri
Africa Nazarene University
P.O.Box 53067-00200
NAIROBI.

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on ***"Modelling instructional design and delivery model for mobile learning,"*** I am pleased to inform you that you have been authorized to undertake research in **Nairobi County** for a period ending **31st December, 2014.**

You are advised to report to **the County Commissioner and the County Director of Education, Nairobi County** before embarking on the research project.

On completion of the research, you are expected to submit **two hard copies and one soft copy in pdf** of the research report/thesis to our office.

SAID HUSSEIN
FOR: SECRETARY/CEO

Copy to:

The County Commissioner
The County Director of Education
Nairobi County.

CONDITIONS

1. You must report to the County Commissioner and the County Education Officer of the area before embarking on your research. Failure to do that may lead to the cancellation of your permit
2. Government Officers will not be interviewed without prior appointment.
3. No questionnaire will be used unless it has been approved.
4. Excavation, filming and collection of biological specimens are subject to further permission from the relevant Government Ministries.
5. You are required to submit at least two(2) hard copies and one(1) soft copy of your final report.
6. The Government of Kenya reserves the right to modify the conditions of this permit including its cancellation without notice.

REPUBLIC OF KENYA

National Commission for Science, Technology and Innovation

RESEARCH CLEARANCE PERMIT

Serial No. A 2075

CONDITIONS: see back page

THIS IS TO CERTIFY THAT:
MR. BONFACE NGARI IRERI
of AFRICA NAZARENE UNIVERSITY, 19800-202 Nairobi,has been permitted to conduct research in *Nairobi County*

on the topic: *MODELLING INSTRUCTIONAL DESIGN AND DELIVERY MODEL FOR MOBILE LEARNING*

for the period ending:
31st December,2014

Permit No : NACOSTI/P/14/3194/1270
Date Of Issue : 30th June,2014
Fee Recieved :Ksh 2,000

.....
Applicant's Signature

.....
Secretary
National Commission for Science, Technology & Innovation

B: AFRICA NAZARENE UNIVERSITY

April 29th 2014
Mr. Ngari
Congratulations and
Best of luck per this
research Project. I
believe that the
outcome of it
will indeed be a tool
to improve our
learning.
You have my
Approval
L Marangu

From:
Bonface Ngari Ireri
Africa Nazarene University
CIT department
bngari@anu.ac.ke

To
The Vice Chancellor
Africa Nazarene University,
P.O Box 53067
Nairobi.

Dear Prof. Leah Marangu,

RE: RESEARCH AUTHORISATION WITHIN THE UNIVERSITY

Following your encouragement for me to pursue a Ph.D. degree, time has come for me to conduct research to build my thesis claims. I wish to conduct my research in most ANU campuses especially main and Nairobi CBD. I will be giving a questionnaire, conduct interviews to students and lecturers after subjecting them to mobile learning software.
In order for me to accomplish this, I also request to be allowed to use university resources like server space and internet.
It is my hope that after completing this project, ANU community will be the first beneficiary of the recommendations that may arise from this project.

I wish to thank you in advance for all support and encouragements I have received from you.
Thank you and may almighty God bless ANU and you.

Yours Sincerely,

Bonface Ngari Ireri

C: SCHOOL OF COMPUTING AND INFORMATICS (UON) LETTER

UNIVERSITY OF NAIROBI
COLLEGE OF BIOLOGICAL AND PHYSICAL SCIENCES
SCHOOL OF COMPUTING AND INFORMATICS

Telephone 4447870/ 4444919/4445544
Telegrams: "Varsity" Nairobi

Email director-sci@uonbi.ac.ke

P. O Box 30197
00100 GPO
Nairobi, Kenya

Our Ref: UON/SCI/Ph.D)/2012

07 November 2012

To Whom It May Concern

Dear Sir/Madam

IRERI BONFACE NGARI – REG. NO. P80/P/83221/2012

The above named is a bona fide student pursuing a Ph.D degree at the School of Computing and Informatics, University of Nairobi. As part of the course, students are required to undertake a research project. Hence Mr Ireri is currently carrying out his research on the project entitled **"An Instructional Design and Delivery Model for Mobile Learning in Distance Learning Education".**

We would be grateful if you could assist Mr. Ireri as he gathers data for his research. If you have any queries about the exercise please do not hesitate to contact us.

Yours faithfully

PROF. W. OKELO-ODONGO
DIRECTOR
SCHOOL OF COMPUTING AND INFORMATICS

APPENDIX 4: QUESTIONNAIRE: PRE-LIMINARY SURVEY FOR M- READINESS

MOBILE LEARNING SURVEY

The Aim of this study is to identify the possibility and sustainability of implementing a mobile learning system in the University. The system will enable students to have access to class content anytime anywhere using mobile phones.

Thank you for taking time to fill this questionnaire. All information collected will be treated as private and confidential and used only for the purpose of this research.

Part 1 (Please tick or circle appropriately)

1. Age?
   - o Below 18
   - o 18 – 23
   - o 24 and above

2. Gender?
   - o Male
   - o Female

3. Faculty/School?
   - o EDUCATION
   - o PEACE
   - o LAW
   - o COMPUTER SCIENCE
   - o BUSINESS
   - o DRY LAND
   - o MASS COMM
   - o RELIGION

4. Program mode?
   - o DAY
   - o EVENING
   - o DISTANCE

5. Year of Study?
   - o 1st Year

- 2nd Year
- 3rd Year
- 4th Year

Part 2 (Please tick or circle appropriately)

6. What is the Make of your mobile phone?
   - Nokia
   - Samsung
   - Motorola
   - Sony Ericson
   - LG
   - IDEOS
   - Siemens
   - iPhone
   - Others(Please specify): _____

7. What is the model of the phone stated above? (E.g. 3210, C1235, etc)

   _____

8. Is your Mobile phone internet enabled?
   - Yes
   - No

9. Which mobile phone browser do you prefer to use?
   - Opera Mini
   - Firefox
   - Default phone browser
   - Other (Please specify):_____

10. Which operating system does your mobile phone run on?
    - Symbian
    - Android
    - iOS
    - I don't know
    - Other (Please specify): _____

11. Where do you most often use your mobile phone?
    - o At Home
    - o In School
    - o On transition/on the road
    - o Other (Please specify): _____

12. Given an option, would you prefer accessing e-learning resources on your phone (Mobile learning) or on your computer?
    - o Phone
    - o Computer

13. If your choice is **"Phone"** in the above question, tick the possible reasons that guided your choice
    - o Anytime, anywhere access to content
    - o More fun because of social network focus
    - o Enhanced interactions between students and instructors
    - o More personalized learning

14. What type (format) of learning content would you prefer to view on your mobile phone?
    - o Slides
    - o Formatted text
    - o PDF
    - o Animations
    - o Videos Audio

15. What features would you like to see in mobile learning system? (Please tick appropriately)
    - o Document reader
    - o Document editor
    - o Download/viewslides
    - o Submit assignment
    - o Chat forums
    - o Others specify _____

16. Are you comfortable installing software on your mobile phone?

- Completely uncomfortable
- Somewhat uncomfortable
- Not sure
- Somewhat comfortable
- Completely comfortable

17. Do you think accessing course material such as slides & quizzes through your mobile phone would be beneficial to your study process?
    - Don't think so
    - Somewhat don't think so
    - Not sure
    - Somewhat think so
    - Think so

18. Do you think using a mobile learning application would improve your overall performance in class?
    - No
    - Probably not
    - Not sure
    - Probably
    - Yes

19. Would you purchase a better mobile device if you thought it would improve your performance in class?
    - No
    - Probably not
    - Not sure
    - Probably
    - Yes

20. Which other device(s) do you own? (Tick all that apply)
    - Laptop
    - Desktop
    - Notebook
    - Tablet
    - None
    - Other specify_____

21. How do you access internet on the device(s) in above question outside the University? (Tick all that apply)

- Modem
- HOME LAN
- Friend/workplace/relatives place
- Cyber café
- Others specify _____

APPENDIX 5: SYSTEMS USER MANUAL

Mobile Learning: A Learners Guide

Bonface Ngari
Africa Nazarene University
and

Elijah Omwenga

University of Nairobi

May, 2014

Introduction

Mobile Learning can be defined as any sort of learning that take place when the learner is not at a fixed, predetermined location or learning that takes place anytime and anywhere when the learner takes advantage of the learning opportunities offered by mobile technologies.

This Mobile Learning, **learners guide** was written to aid students intending to use the mobile learning platform. The mobile learning delivery mod el has many channels of delivery of content to the learners. A learner can choose to use the mobile learning website (mobile web): mobile-learn.anu.ac.ke or USSD for mobilearn, Android application for mobilearn or Interactive Voice for mobilearn. Each of the application assists learners in different ways depending on mobile device they may own, bandwidth connectivity, and location of the learner or preference. The learners guide give instructions on how the device is to configured, the way to access various contents and the needed support for better functionality.

The guide is organized to cover all delivery channels with brief descriptions of what the channel is meant to achieve. Any user need not have any specializations on computer science or IT but basic computer skills for purposes of navigating the menus.

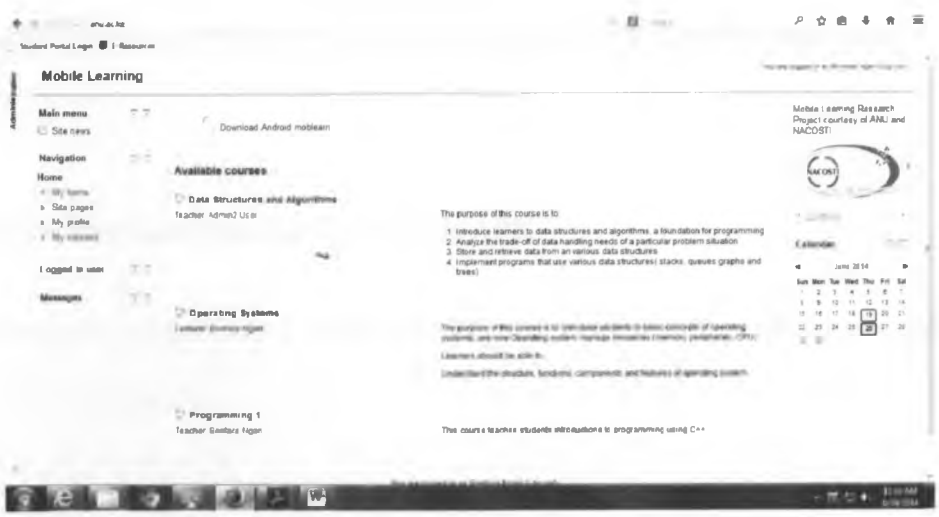
Reading the setup and configurations instructions given in each delivery channel, one is able to quickly start using the services.

Welcome and enjoy learning.

Mobile Learning via Mobile Web

If one has a smart phone or tablet or laptop or a feature phone that can access the internet this channel can be used to access various contents for purposes of learning. The url: to access is http://mobile-learn.anu.ac.ke . the following page appers:-

The user must be registered to the system or to a course unit offered on this mobile learning system. Once one login he/she is able to view courses they are registered in.



By selecting the course unit one can get the various contents, download the content or view to read. If one has an android enabled device one can download the application and install it on their devices. This gives one similar capabilities. The application is suitable especially for low bandwidth or for pages that take a lot of time to load.

Mobile Learning Android Application

Mobile Learning mobile application helps the students who are enrolled to a particular course to view all the course topics, quiz, and assignments and also there is a platform where the lecturer and the students can chat and share ideas with each other. The student and also the lecturer can also be able to update their profile information. Student will also be able to download some relevant tutorials from the application. The application also has a web view where the students can be able to access the m_learn site within the application and they can be able to login to the site.

NB: For one to use the Mobile Learning application you must be connected to the internet and also you should use you username to gain access to the Mobile Learning application.

Link for the Mobile Learning Android apk is APK

All the student and teachers can go to this link () and download the android apk and install the application to their phones.

Android Version

The Mobile Learning application is supported by android version 2.3 and above.

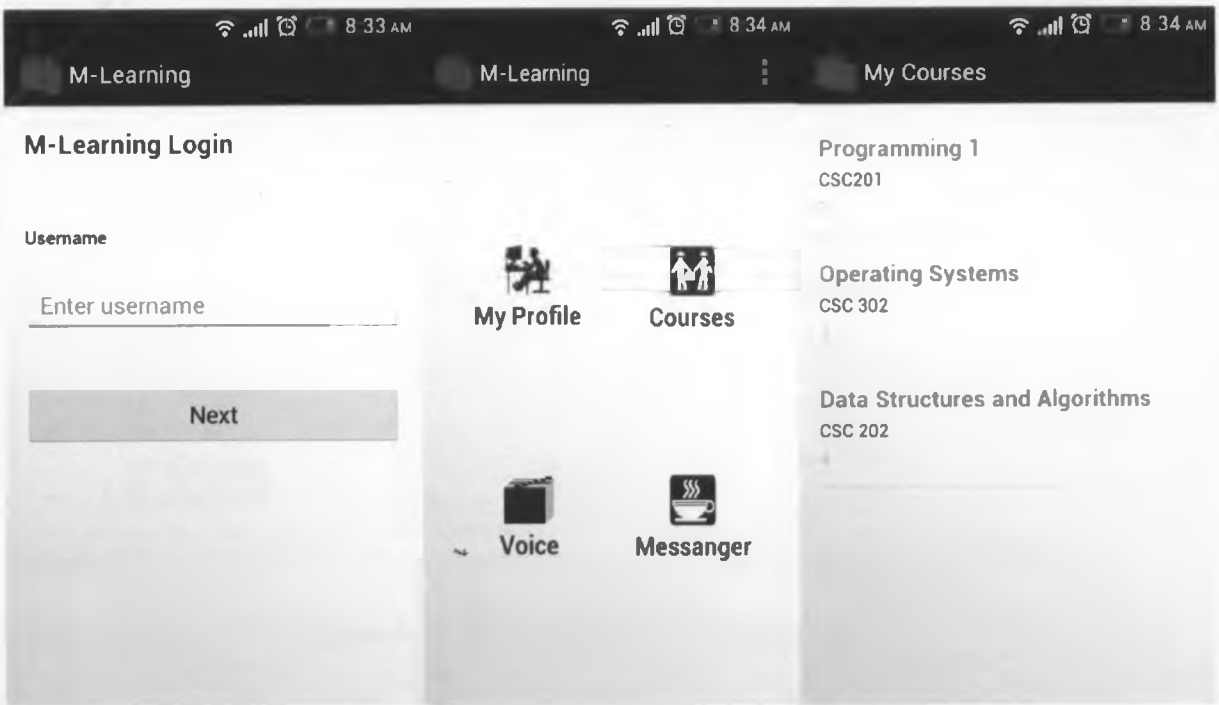
How to get to the mobile learning web site

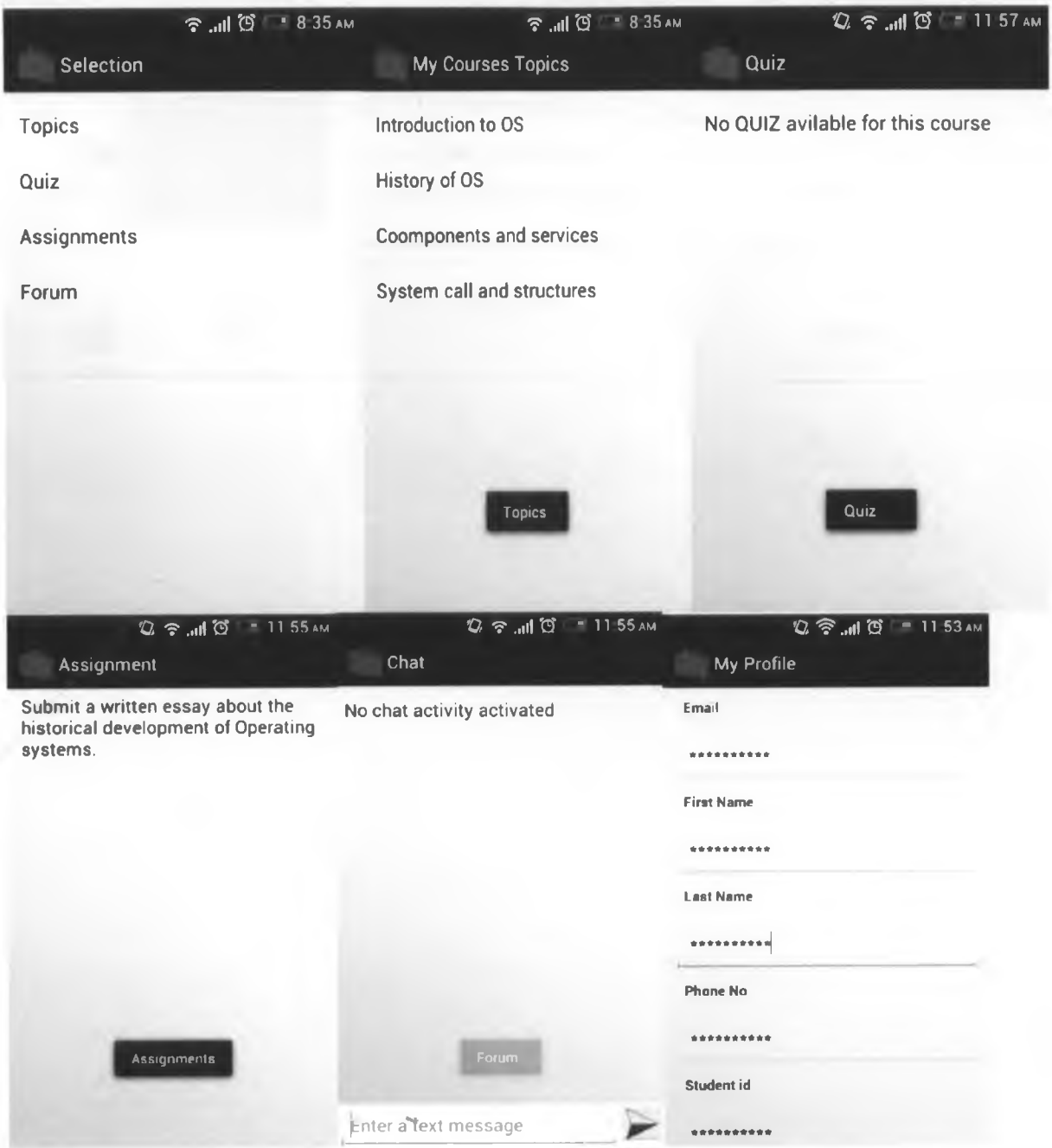
Go to this link (http://mobile-learn.anu.ac.ke)

How to user the Mobile Learning web site to load new information to be viewed in the mobile appliacation

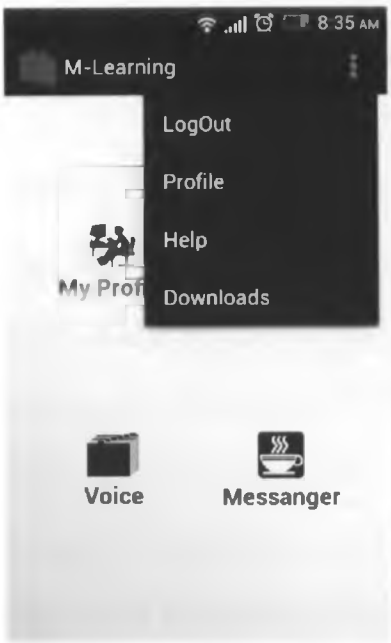
The instructor can be able to add a new topic, assignment, quiz and also chat. All this components can be viewed in the mobile application.

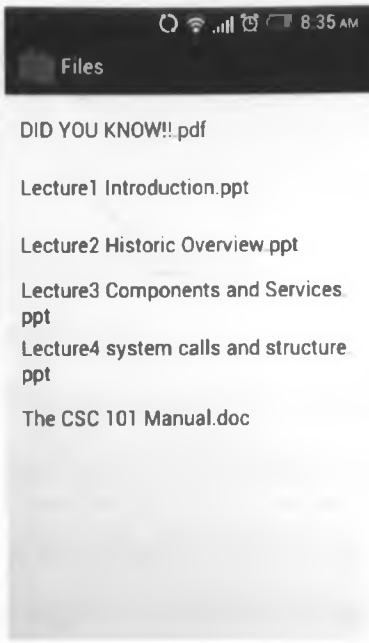
NB: For a student to be able to see the course he/she must be enrolled to that course by either the site admin or by the course instructor.





Click on your menu button to view all these options on your phone


8:35 AM
M-Learning
LogOut
Profile
Help
Downloads
My Profi
Voice
Messanger


8:35 AM
Files
DID YOU KNOW!!.pdf
Lecture1 Introduction.ppt
Lecture2 Historic Overview.ppt
Lecture3 Components and Services ppt
Lecture4 system calls and structure ppt
The CSC 101 Manual.doc


8:36 AM
Mobile Learning
Mobile Learning
You are not logged in
Home → Log in to the site
Log in
Username
Password
Log in
Remember username
Forgotten your username or password?
Cookies must be enabled in your browser

USSD System access

The content for USSD is limited to 240 characters.

Registered user access to the USSD menu

For any user to access the USSD menu, they must be registered with Mobile Learning. Then after logging in, find the link "Edit Profile", it should be within the "My Profile Settings" block. Locate the mobile phone field, type your phone number, and update your profile.

The format for mobile phone should be: country code – phone number e.g. a valid phone number would be: 254722123456; an invalid phone number would be: 0722100100 or 710555888.

USSD menu access via a browser

The USSD menu is accessible via the URL: http://mobile-learn.anu.ac.ke:8080/MobiLearn/callback

To test the correct menus, one has to put the expected parameters.

e.g. http://mobile-learn.anu.ac.ke:8080/MobiLearn/callback?session_id=35&service_code=555&msisdn=254724149679&ussd_string=1

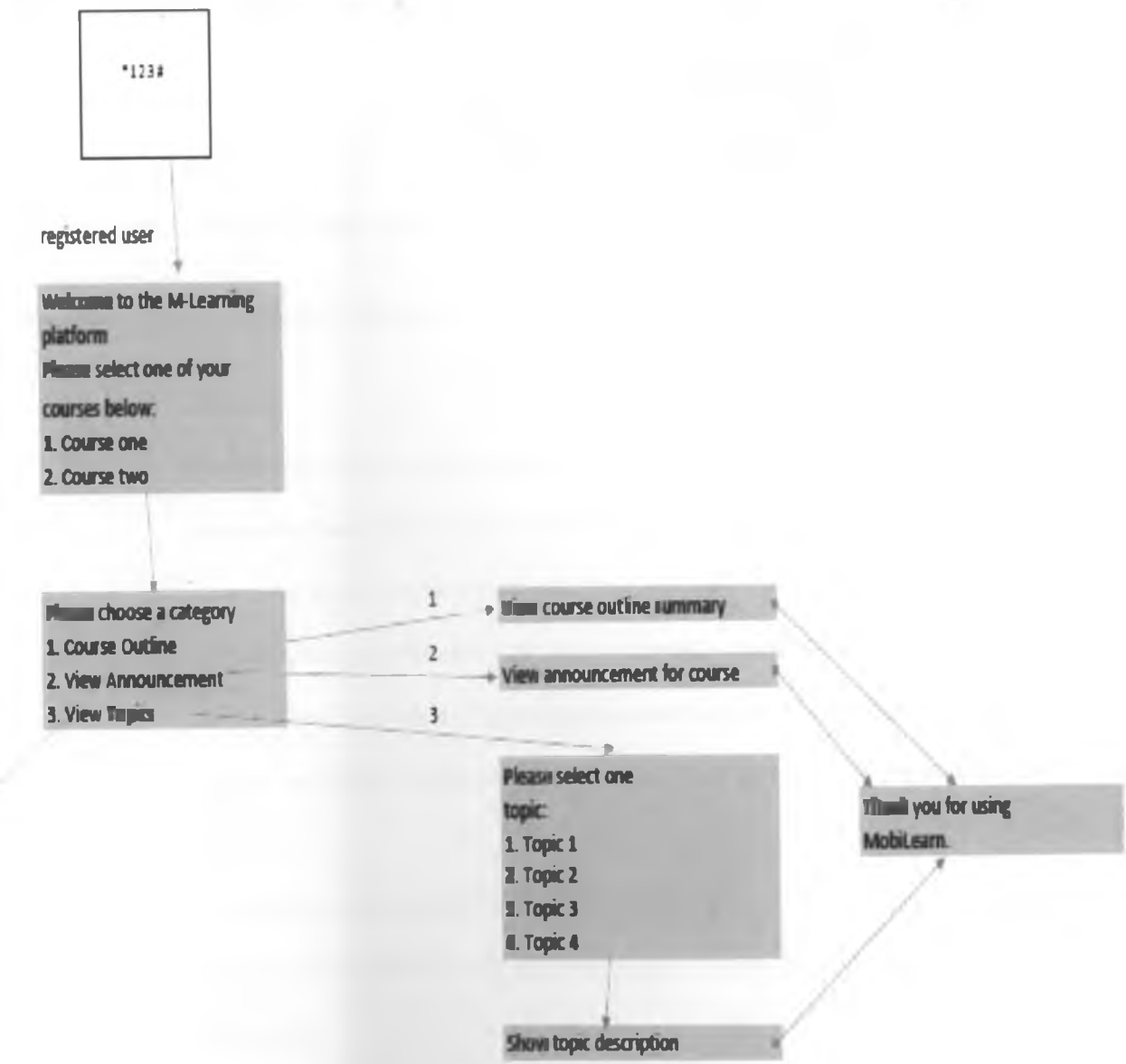
However, one need to login into Moodle and save in your profiles your own phone number. Then replace the msisdn with your phone number.

Alternatively, you can use the internal network ip address: 172.17.14.49

USSD menu access via GSM or Mobile service provider (e.g. Safaricom)

Dial *384*6543# then follow the instructions.

MobiLearn USSD Flow Diagram



Mobile Learning via Interractive Voice System

The voice system uses asterics to power the interractivity. One needs to be registered to the system and once this is done the system sends out an email on how to setup in order to access content and communicate with others in class.

e.g. you receive a message from itutor (interractive tutor) like the one below:-

Hello 1,

I would like to thank you for your interest in subscribing to our mobile learning. Follow the instructions below to start using the service.

1. You will need a soft phone client.

- If you are using a Windows computer - laptop or desktop - you can follow the link below to download a softphone - http://www.counterpath.com/x-lite-download.html

- If you are using Android smartphone or tablet, go to Google Play and search for SipDroid.

2. Registration for Softphone client.

Once you have installed your soft phone client, use the following registration information.

- userid = 6748

- userpass = 6748

- host = 192.168.0.172

3. You need to verify the registration is correct. Dial 0001 and follow the instructions.

4. If you fail to get audio instructions, contact: itutor.telecloud@gmail.com

Kind regards,

Mobile Learning Team.

Note:

1. To use this service one must have a soft phone installed. There are many soft phone downloadable (open source).
2. Every user who is registered has their own unique userid which is also their userpass. The host is same for all users:- *192.168.0.172*
3. This service can only be used while on the university LAN, Wi-Fi NOT out of this range.
4. If you know another user one can call them through their soft phone or can call to join a conference via voice call or video call.
5. To access content ensure your instructor has given you the five digit course ID.

Once all installations are done and setup is complete, dial 0001 (4 digit) to test and to get to the mobile learning MENU. Follow the instructions by providing your user identification (id) and course identification (C. ID).

APPENDIX 6: Sample Experiment design

LESSON 1

Topic: Introduction to Programming using C++ programming Language

Period: 3 hour lesson (Theory/ Practical lesson)

Introduction

This being the first topic, the learners are expected to have covered computer fundamentals where computational concepts and programming languages are introduced. In this topic the learner is introduced to a specific language and in this case is C++.

Learning outcomes:

By the end of this topic, the learner is expected to:

1. Explain the historical development of C++ and the structure of a C++ program;
2. Write his/her first C++ program by:
    i. Getting introduced to a C++ compiler environment;
    ii. Writing the popular "Hallo World" program
    iii. Running the first program

Learning Activities: LESSON 1

Control Group

Activity	Instructor Responsibility	Learner Responsibility	Observations
Introduction	1. Introduce the topic; 2. Clarify any questions asked.	Write notes and ask questions	
Navigating the compiler	Provide steps on a projected display	Follow the practical steps on the desktop computers (LAB)	
Writing the code	Code displayed as example ; Provide a task (class exercise) and evaluate	Follow steps of example and attempt the tasks	
Homework	Provide home work	Give Solutions in next lesson	

Evaluation criterion:

Recall (COGNITIVE)	Did the learner show knowledge on specific learning outcome?	
Practical Skills (PSYCHOMOTOR)	Did the learner construct and code, debug the code, run the code on a machine?	
Appreciative/ motivated (AFFECTIVE)	Does the learner request for more exercise? Do they feel comfortable, find it easy while engaging in class activities?	

Treatment Group

Activity	Instructor Responsibility	Learner Responsibility	Observations
Introduction	1. Introduce the topic; 2. Clarify any questions asked.		
Navigating the compiler	Provide steps on a projected display; Refer instructions on http://mobile-learn.anu.ac.ke website		
Writing the code	Code displayed as example ; Provide a task (class exercise) and evaluate		
Homework	Provide homework and refer same on http://mobile-learn.anu.ac.ke mobile website		

Evaluation criterion:

Recall (COGNITIVE)	Did the learner show knowledge on specific learning outcome?
Practical Skills (PSYCHOMOTOR)	Did the learner construct and code, debug the code, run the code on a machine?
Appreciative/ motivated (AFFECTIVE)	Does the learner request for more exercise? Do they feel comfortable, find it easy while engaging in class activities?