USABILITY EVALUATION OF EDUCATIONAL TABLET, A CASE STUDY OF
OSUN TECHNOLOGY ENHANCED LEARNING SYSTEM, NIGERIA

Ph.D. Thesis Proposal Seminar

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CHAPTER ONE

INTRODUCTION

Background to the Study

Education in the world today is on a superhighway and its vehicle is the Information and Communication Technology (hereafter ICT). Nigeria as a developing country and a member of global community cannot afford to be left behind on this important contemporary global journey. A major effort at keeping up with the rest of the world in this modern era is evident in the National Policy on Education where the Federal government recognizes the importance of being in tune with the modern world even in education.

Nigeria in her National Policy on Education affirmed the need to make education one which will meet the needs of individual citizens and society at large in consonance with the realities of our immediate environment and modern world (FRN, 2004). This, by inference, means that Nigeria educational system will not be blinded to the development in the modern world and also that efforts will be channeled towards bringing whatever positive innovations (Technology) in the modern world in education into Nigerian environment for the benefit of individual participants and the general society.

It has been argued that development of any nation is dependent on her level of educational advancement and as it today, no country can claim to be educationally advanced unless it embraces technology for her educational activities in order to aid
her citizens’ smooth transition from the information society into the emerging global knowledge economy with the focus more on how people use knowledge rather than technology (Olagunju, 2003; Nancy, 2008). Since the emergence of ICT into the modern world, its relevance is found in almost all facets of human life; education, health, entertainment, sports etc.

The present era is regarded as the “Knowledge age” (Yusuf, 2005), where information is available anytime, anywhere and to whoever has the appropriate medium to access, share or distribute as applicable. This fact cannot be ignored in this part of the world because, development in any nation has been argued to be dependent on its level of educational advancement and as it is today; no country can claim to be educationally advanced except it embraces technology for its educational activities (Olagunju, 2003; Nancy, 2008).

Learning is becoming more complex, especially in a developing nation like Nigeria as a result of high volume of information the learners are expected to process and cope with at all levels of our educational system (Koole & Ally n.d.). Therefore, every serious country whose aim is to compete favourably in today’s knowledge economy should rethink her process of educating her young ones, has submitted by Lane (2012) “To teach our children in the way we were taught, prepares them for the past not the future” (p. 59).

This fact was not lost on formulators of Nigeria Educational Policy and as such Nigeria does not lack in deliberate policy to catch-in on the opportunity offered by technology to effectively cope with the changing world. As rightly put in the
philosophy and goals of Nigeria educational policy that “modern educational techniques shall be increasingly used and improved upon at all levels of the educational system” to bring about the desired educational outcomes (FRN, 2004).

The introduction of ICT into teaching and learning situations was never an accident as canvassed by Melhuish and Fallon (2010) that, education has a well-established history of taking devices not originally intended for educational purposes, and attempting to appropriate them for educational gain, therefore, its introduction was a calculated attempt at making learners learn more in less time, anywhere, anytime without reducing quality (Tijani, 2009). Roblyer and Edwards, (2000) in Samak (2006) proposed five reasons for technology use in education: (1) motivation, (2) distinctive instructional abilities, (3) higher productivity of teachers, (4) essential skills for the Information Age, and (5) support for new teaching techniques.

The volume of information available to learners in the world today can only be imagined and in an effort to improve on the volume, means, how and when the learners are exposed to this enormous information, necessitated the world newest found love with ICT in education to fill the obvious gap created by the fact that no single teacher can supply all the required up-to-date and complete information in his/her subject area to the students (Iyeke, 2011).

Several researches have been conducted on the potency of ICT in teaching learning situations across various modes; CAI, video, PowerPoint, radio, internet, web quest, etc. and results have shown that it is a veritable tool, when appropriately used in bringing about improved learning performance across levels of education and
in various subject areas (Yusuf, 1997; Egunjobi, 2003; Ibode 2004; Aduwa-Ogiegbaen & Iyamu 2005; Tijani, 2009; Adeyemo, (2010); Omiola, 2011). Others have looked at ICT for other purposes other than teaching-learning and it has also been found to be efficient and bring about enhanced educational administrative processes (Palmén, 2011; Krubu, & Osawaru, 2011; Zambuk & Ya’u Gital, 2012; Adebayo, 2012).

ICT has been explained by many authors in various forms (Zuochen & Dragana, 2008; Ajayi & Ekundayo, 2009; Adeyemo, 2010; Esharenana & Emperor 2010; Iyeke, 2011) but the consensus is that, ICT comprises of modern technological products (software and hardware) that are used to collect, gather, store, process and transmit information from one point to the other. Therefore, ICT can be define as all modern technological products (software and hardware) that can be used to access, collect, gather, store, process and transmit learning contents from one point to the other by the learners and teachers.

ICT has reduced the human world which hitherto appeared big into a global village, information sharing and gathering are now done in matter of seconds. Knowledge is becoming obsolete as soon as they are acquired, learnt and shared (Anaza, 2011). It has destroyed and still destroying all known geographical barriers; local, national and international in information system, closing up the physical space and making the world more shrinking information-wise by making information available to anybody, anywhere and at any time (Olagunju, 2003).
ICT when appropriately used in various modes and across various subjects especially in controlled settings (Şahin-kizil, 2011) has been found to be a potent tool in bringing about an improved learning outcome and enhanced participants attitudes (Cavas, Cavas, Karaoglan & Kisla, 2009).

Temi (2003) while commenting on the importance of ICT in education argued that, without ICT support for students and staff, the preparedness and survival of trainees amidst enormous information challenges will be elusive. In other to solve these problems of large volume of available information, large class size, inadequate learning resource which could lead to poor learning environment and students inability to participate actively in the teaching and learning processes, integration of ICT should therefore be encouraged (Olagunju, 2003).

The benefits of ICT in education are enormous. These benefits spread across all education activity such as students’ registration, payment of fees, checking of results, etc. Nyenwe and Ishikaku (2013) highlighted the benefits of ICT integration into education to include:

i. ICT improves access to and promotes equity in education by providing educational opportunities to a greater number of people.

ii. ICT enhances the quality of teaching and learning by providing access to a greater variety of educational resources and by enabling participatory pedagogies.

iii. ICT improves management of education through more efficient administrative process, including human resource management, monitory, evaluation and resources sharing.
As earlier discussed, ICT is a collection of many resources (Hardware and software) for the purpose of transmitting and processing instructional and learning materials from one point to the other. The materials that make up the ICT family includes; the computer; Radio; Television; audio-visual projectors; digital camera and other hardware products. Software includes all resources upon which the hardware can function for effective delivery of content. The Tablet which is the main focus of this study is a member of the hardware components of the computer family and is one of the devices used in Mobile or m-learning (Fischer, Smolnik & Galletta, 2013).

Many great minds across the world believe our current 18th century way of educating is broken and in this information age, tablets is believed to be a significant creative breakthrough that will help the students learn better and teachers across the world do their jobs better (Johnston, 2012).

The tablet computing has been around for many years and has come in a number of guises, from PDA's and handheld devices to touchscreen laptops, Tablet PC's, Slates and most recently 'Post-PC' Tablets. Early tablet computers were predominantly versions of existing hardware and operating systems adapted to recognise an additional input device, usually a stylus or 'pen' or simply a physical touch or press. In early 2002 Microsoft released Windows XP Tablet edition, supporting a new generation of laptops that had touch sensitive screens that could rotate and flatten against the body of the laptop. This created a surface that could be used for direct input and often supported new functionality such as handwriting.
recognition. However, they failed to gain widespread acceptance and traditional laptops and PCs remained the primary computing device of choice (LearnPad, 2013).

Fundamentally, tablet computing had taken a new form, based on the growing popularity of 'Smartphones' and the functionality that these devices, and in turn their operating systems, provided. In essence, the tablet computers emerging were larger, more functional versions of the smartphones that preceded them. Tablets have endowed users with a new paradigm of interaction and functional versatility that goes beyond the use of "traditional" computing (Fernandes, 2013).

Tablet PC is a portable device with touch screen being the primary input device; it has other characteristics such as small shape and size compare to the normal laptop computers. It is powered by variety of operating systems; it is capable of wireless connection to internet and local area network. A tablet PC is generally defined as a portable computer larger than a mobile phone with a flat touchscreen as its dominant external feature. It is operated mainly by touching the screen with the use of either a stylus or one’s fingers. Typing words on current models can also be done with the use of a virtual keyboard. Some models may be connected to a keyboard through a wireless connection or via a USB port (eCycleBest, 2013).

Tablet technology is a 21st century invention member of the computer family that comes with a view to improving on the shortcomings of the laptop computers such as incomplete portability as mentioned by (Henrik & Martin, 2012). Some of the users’ complaints against the laptop computers include the use of computer
peripherals like the keyboards and pointing devices. In their submission, Henrik & Martin (2012) described the laptop computer as a portable device with a hefty weight; obviously referring to its use of computer peripherals and a large battery to sustain its energy use.

Since the reinvented tablet (iPad) by Apple hit the market, Tablet usage has increased in the last 2 years, as reported by Henrik and Martin (2012), United States witnessed a rapid increase from 10 percent adult users in December 2011 to 19 in January 2012. By August 2012, the figure as increased to 25 percent and tablet ownership is expected to hit 760 million globally (PewInternet, 2012 in Henrik & Martin, 2012). This clearly shows the Tablet technology as the most used technology in recent times all over the world with its potential to open up the world’s rich store of information to willing minds and expert instruction (Logan, 2013).

Describing the tablet as a laptop computer with extra abilities, Vrtis (2010) highlighted other tablet features to include; use of keyboard (optional), displayed using all of the functions of a basic laptop. He also sees the tablet as a convertible device which allows the user to input information/command to it through a device known as the stylus. This screen can also be turned around and folded to mirror the image of a notebook. By interacting with the screen, users can write directly upon the screen and simulate a pen and paper experience.

What makes the tablets popular are the integrated nature, touch screen interface, portability and, increasingly, the lower cost as consumer products, but now
it is also having an impact in the educational sector, this popularity within education appear to be growing rapidly and indeed large scale (Kukulska-Hulme, 2007).

The tablet comes in various forms as highlighted by Calar (2010) and they include: Slate tablet, Convertible tablet, Hybrid tablet pc, Booklet, Rugged tablet pc.

It is no longer debatable that we live in explosively innovative times of mobile devices and applications including tablet computing. The Tablet revolution didn’t just happen overnight, although most modern users believe that tablets were invented when Apple, under the leadership of Steve Jobs, launched the iPad in 2010. But Unknown to many, tablets had already been around for decades, with the evolutionary roots of their development dating as far back as the 1800s. (Holleran, 2013; eCycleBest, 2013). Attempts to build a tablet-like computer from this time were largely unsuccessful, yet every lesson learned on the way led to today’s much celebrated tablet (O’neill, 2012).

Elisha Gay’s 1888 Teleautograph was the first to be issued a patent attributed to the development of tablet computing, he was the one who developed an electrical stylus that would capture handwriting. In 1915 and 1942 respectively, other US patents were granted for inventions that recognized handwritten characters based on handwriting motion, despite these issued patents, a first demonstration of a tablet using a handwriting text recognition device to input data rather than a keyboard didn’t happen until 1956. (Holleran, 2013; eCycleBest, 2013).
With the tablet demonstration though coming late after second and third patents were issued, one would think the development and eventual commercialization would have been rapid but this is not so owing to the fact that, the idea of a personal computer, much less a writing pad-like computer, was mostly on the minds of scientists, fiction writers and engineers of that period. (Holleran, 2013). With the three inventions that were patented in 1888, 1915 and 1942 respectively, the seeds of what would become a full-fledged industry more than a century later were planted (eCycleBest, 2013).


A tablet computer system is a new form of technology that has recently been integrated into the teaching and learning situations, and it has been described as a great step forward for brilliant educators around the world (Johnston, 2012). Its trials are currently being run globally in schools and educational centres, which explains absence of many empirical studies on its potentials and drawbacks to students in school environments (Kukulska-Hulme, 2007; Vrtis, 2010).

Tablet computers provide a unique opportunity to create a truly portable learning experience. Lightweight with a long battery life, they offer possibilities not previously
seen with other 'mobile' computing solutions. It lends itself to better use of technology within teaching. For example, quick access to reference material during a lesson, previously difficult to achieve with existing ICT, can bring key advantages and enhance learning.

Using tablets in less typical scenarios, such as field trips, workshops or physical education lessons offers opportunities for research, evidence gathering and presentation. Bringing devices such as these into the classroom and everyday life for students is in itself a learning experience. Couple this with the resources a tablet computer can deliver, such as text and reference books, audio and video resources, internet research, document preparation and review, and specific eLearning applications and activities, what we then have is a truly versatile learning tool (LearnPad, 2013).

It is lighter weight, smaller size compare to a regular laptop with the ease of note taking capability among others, have endeared it with almost all sectors including education. Apart from its size and portability, It also does not required the point and click with mouse that is common with older technology in education.

In a recent study supervised by Marques in 2012-2013, it was reported that using digital tablets for classroom learning activities improves students understanding of topics, increases their digital skills, creativity, independent learning and motivation. This is the opinion of 87% of the teachers who took part the study involving educational uses of digital tablets. The study highlights further the advantages of using digital tablets in education to include, access to sources of
information on internet, and the tablet's portability and multifunctionality, providing resources for different learning activities.

Furthermore, the researchers reported that digital tablets lead teachers to apply student-centered methodologies, help them to deal with diversity among pupils (by personalising content and practice activities), spread digital skills within the family and facilitate the use of collaborative information-sharing environments. The researchers reported that 87% of teachers involved in the study claimed that tablets contribute to the improvement of pupils' learning in general. Over 90% of the teachers stated that tablet facilitates independent learning (as they provide interaction and tools), help develop pupils' digital skills, improve comprehension through images, simulations and video, encourages creativity by helping to find and organise information and discuss ideas, and increase pupils' involvement and motivation.

Contributing to the impact of Tablet in education in a 1–to-1 situation, Logan (2013) reported two recent researches involving students’ use of the tablet by Belbell and Cooney center. Bebell’s study involves a study of tablets for early literacy with kindergartners in Auburn, Maine. Students who learned with the tablets scored higher on early literacy assessments than the students in the control group, particularly in their ability to recognize sounds and represent sounds as letters. After using Martha Speaks, 5- to 7-year-olds’ vocabulary scores for a selection of words included in the app increased more than 20 percent
In another study on tablet computer assisted instruction carried out by Kenar, Balci and Gokal (2013) involving 56 students (27 in experimental and 29 in control groups. The results of the study showed that the tablet computer assisted instruction had positive impacts on students’ attitudes toward technology and technology usage in the courses; however, it had both negative and positive impacts toward science and technology courses in different aspects.

The tablet comes with various advantages; one of which is the freedom given to both teachers and students in teaching-learning situations. With correct applications to the appropriate subjects on the tablet, learners will be free to study at their different paces with same teacher within the same classroom environment. With this scenario, the teacher then becomes free to relate with different group of students based on their ability (Johnston, 2012).

Tablet Pc has also been found to reduce the students’ attrition rate from the STEM. Calar (2010) found that in the first semester of her studies, 98 % of participants were ready to continue with STM compare to 93 % at the non- Tablet pc classes. At the end of the 1st year course, 74 % of the students were ready to stay in STM compare to 49 % in non-tablet classes. At the end of sophomore year, the difference between the groups is even greater, 63 % still in Science, Technology, Engineering and Mathematics (STEM) compare with 33% in the non- Tablet pc classes. Apart from reduction in attrition rate, Tablet Pc may also be extremely beneficial adjunct to pedagogical approaches used by instructors in the field that are graphical-laden e.g. non-roman alphabet foreign language course (Arabic), fine arts
and courses which features of images are important e.g. physiology, histology and anatomy may benefit from the use of Tablet Pc to reduce the technical challenges faced by both faculty and students in preparing notes and ancillary materials for classes.

Calar (2010) further listed some of the advantages of Tablet pc over other technology in education to include:

- It is much easier to take note
- It is also possible for the students to write on the teacher presented slides during and after classes.
- Networked Tablet Pcs provide additional opportunities for interactive problem-solving and peer critiquing.
- Networked Pc which allows for peer-critiquing also encourages classroom participation among students.

Truly, the tablet technology has many advantages in our day to day and learning activities as highlighted above, but it has its own down side too. One significant disadvantage observed by Logan (2013), is that over 90% of the teachers involved in her study believe that these devices increase class-preparation time, especially time spent searching for and creating resources for the pupils.

Also, there is the issue of the Tablets not having large capacity to store content and applications without the feature of internet connectivity which also relies on
consistent access to robust and stable access points. This may constitute a big
hindrance to its use in many schools especially in Africa with her present low
broadband of internet connectivity. As stated by Marés (2012), that in reality, having
wireless Internet connectivity at schools, with enough broadband to connect the
tables of all students is a utopia in most countries especially Africa.

Tablets are not especially suitable to produce content with considerable amount
of text or precision drawing. Although it is possible to create and edit texts, like one
does with a word processing application in mobile or desktop computers, typing on
touchscreen can be time consuming and frustrating. They are not efficient either to
edit video multimedia or manage images, despite the existence of specific
applications to this end.

Tablets are fragile, and their touchscreen can easily become damaged. Also,
their small size and portability mean that the tablets are handled more, further
increasing the risk of an accident. In some cases, a tablet's screen hinge is designed
to rotate around two axes, which can easily break, if handled incorrectly.

The tablet configurations currently available in the market do not include
hardware update or enhancement options. Therefore, it’s obsolesce rate might be
higher compared to devices which critical components can be updated on a regular
basis. Although some models are more flexible than others at the time of installing
open applications, their architectures are limited. For example, it is necessary to have
a user authenticated and registered in platforms outside of the school system to
have privileges to install and update applications and contents.
Other technical downsides of the tablet as explained by Siegenthaler et.al (2012) include higher power consumption by the reflective screens on LCD tablets and the glass-like display surface makes it hard to read in bright light.

Finally, being new to the market, tablets cost more than a lot of conventional netbooks and their longer battery life requires that students make a habit of connecting their tablets to the power supply at home every day (Mares, 2012).

Usability is one of the focuses of the fields of Human Factors Psychology and Human-Computer Interaction. As the name suggests, usability has to do with bridging the gap between people and machines. Usability assesses the quality of users’ interaction with the system’s environment. It is considered to be one of the most important characteristics when targeting systems that will be used by widespread audiences, such as university students, without direct training and support (Henrik & Martin, 2012; Ali, 2013).

Usability is an important attribute that assists the developers in the design and development processes to produce a software or a device with a compelling user interface that is easy to use and thus allowing for users to achieve specific task oriented goals with effectiveness, efficiency and satisfaction.

There is a clear diversity as to what Usability as a concept is, for example, the end-users, the managers and software developers all see usability differently. For each of these audiences, usability is defined from a different viewpoint: For the end-user, software usability is essential because it is a determinant of performance: an application, which features good usability, will allow the user to perform the
expected task faster and more efficiently (Ardito, Costabile, Lanzilotti, Levia
di, Roselli & Rossano 2006).

For managers, usability is a major decision point in selecting a product, as this
decision will have a direct influence on the learnability of the chosen system, and
hence on the productivity of those who use it.

For software developers, usability describes the internal attributes of a system,
including issues like design quality, documentation maintainability.

The diversity of viewpoints, and their related usability requirements, has led to
different perspectives on usability in the various ISO models that have been
developed over the years by different groups of usability experts. Unfortunately,
each group of experts built its model without input from the other groups. This led to
the use of different terms and labels for the same usability characteristics, or
different terms for similar characteristics, without full consistency across these
standards; the situation in the literature in general is similar (Abran, Khelifi, Suryn &
Seffah, 2003).

Despite this diversity, one common denominator among experts is that usability
is context specific. As explained by Brooke (2013), there is no specific property of an
artifact that you can call usability; rather, something which is usable is something
which is appropriate to its context, where the context includes the task that is being
done, the background and the experience of the user who is doing it, and the
environment in which it is being done.
Abran et al. (2003) in supporting the above assertion explained that the challenge with definition of usability is that it is very difficult to specify what its characteristics and its attributes should be in particular because, the nature of the characteristics and required attributes depend on the context in which the product is used. They went further by presenting the following definitions of usability as given by different ISOs to support their argument.

“The capability of the software product to be understood learned, used and attractive to the user, when used under specified conditions.” (ISO/IEC 9126-1, 2000)

“The extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use.” (ISO9241-11, 1998)

“The ease with which a user can learn to operate, prepares inputs for, and interprets outputs of a system or component.” (IEEE Std.610.12-1990)

Having established divergent experts’ opinions on a single acceptable definition of usability, it is important to consider some usability definitions as given by their proponents.

Ali (2013) sees usability as the ease of use, learnability, understandability, attractiveness, and user satisfaction of a human-made object. These objects include software applications, tools, websites, processes, book, tool, machine, or anything a user interacts with.
In his description of usability, Nielsen (2012) submitted that Usability is defined by 5 quality components:

- **Learnability**: How easy is it for users to accomplish basic tasks the first time they encounter the design?
- **Efficiency**: Once users have learned the design, how quickly can they perform tasks?
- **Memorability**: When users return to the design after a period of not using it, how easily can they reestablish proficiency?
- **Errors**: How many errors do users make, how severe are these errors, and how easily can they recover from the errors?
- **Satisfaction**: How pleasant is it to use the design?

It matters little that something is easy if it's not what you want. It's also no good if the system can hypothetically do what you want, but you can't make it happen because the user interface is too difficult use or understand.

Technology innovations abound in learning, education, and training, but the need for evaluation of such technology remains important. Usability is a basic parameter for the evaluation of e-learning technologies and systems. It ensures quality of technology devices and puts the users and their real needs in the center technology development. Therefore, evaluation of usability and its integration or contribution to learning process is worthwhile (Zaharias, 2004).
Tools, devices or software (as diverse as a mobile phones, the interface of a website, or a word processor) must be evaluated before their release to the market from different points of view such as their technical properties or their usability. Jeffels (2011) while making a case for usability evaluation studies in technology states that “if the basics of usable design are ignored all users can be disabled by the inappropriate use of technology”. He advocates that “technology should be an enabler not a barrier” and that “campaigning for usability should simplify life for everyone.

Usability evaluation is an important part of the overall user interface design process, which ideally consists of iterative cycles of designing, prototyping, and evaluating. It allows assessing whether the product under evaluation is efficient enough (Are the users able to carry out their task while expending reasonable resources such as time, cognitive or physical demand), effective enough (Can the user complete the tasks they are supposed to perform with the tool?, is their performance complete and accurate?) and sufficiently satisfactory for the users (What is the users’ attitude towards the system? Do they experience discomfort?). Usability evaluation is itself a process that entails many activities depending on the method employed. Common activities include:

- **Capture** - collecting usability data, such as task completion time, errors, guideline violations, and subjective ratings;

- **Analysis** - interpreting usability data to identify problems in the interface; and
• Critique - suggesting solutions or improvements to mitigate problems (Ivory, 2001).

The importance of usability evaluation cannot be over emphasized especially with digital learning devices. From the user's perspective, usability is important because it can make the difference between performing a learning task accurately and completely or not, and enjoying the process or being frustrated while using it. To the developer, usability is important because it can mean the difference between the success and failure of a designed or developed system. From a management point of view, software with poor usability can reduce the productivity of the workforce to a level of performance worse than without the system.

In all cases, lack of usability can cost time and effort and can greatly determine the success or failure of a system. Given a choice, people tend to use systems or devices that are more user-friendly.

Nielsen (2012) is of the opinion that usability evaluation is a necessary condition for survival of a website. He explains that, if a website is difficult to use, people will leave. If the homepage fails to clearly state what a company offers and what users can do on the site, people will leave. If users get lost on a website, they will leave. If a website's information is hard to read or doesn't answer users' key questions, they will leave. There's no such thing as a user reading a website manual or otherwise spending much time trying to figure out an interface. There are plenty of other websites available; leaving is the first line of defense when users encounter
a difficulty. This is also true for an e-learning device, when a user especially young student feels frustrated while using any device, the next thing on his mind is to leave. This is common to a first timer who is having his/ her first encounter with a learning system or device.

Importantly, the usability evaluation of learning applications is slightly different from any other product primarily because, it is not enough to evaluate how usable e-learning software or device is, but also for how learnable the content is. Content learn-ability is what drives product success and acceptance in the educational/learning domain (Brooke, 2013). Usability experts agreed that eLearning system usability basically involves two aspects: technical usability and pedagogical usability. Technical usability involves ensuring a trouble-free interaction with the system while pedagogical usability aims at supporting the learning process and that both aspects of usability are intertwined and tap the user’s cognitive resources (Jeffels, 2011).

Jeffels (2011) use the term "pedagogical usability" to denote whether the tools, content, interface and the tasks of the web-based learning environments support various learners to learn in various learning contexts according to selected pedagogical objectives.

When a technology device has usability problems, it may be difficult or even harmful to operate. A system interface or a website with usability problems may lower user productivity, or drive users away. To improve usability, the product
developers must understand the users’ needs; the context in which they use the product; and how they interact with it. This is where usability evaluation methods come into play.

There are a variety of usability evaluation methods. Certain methods use data from users, while others rely on usability experts. There are usability evaluation methods for all stages of design and development, from product definition to final design modifications. When choosing a method, it is important to consider cost, time constraints, and appropriateness. This is because usability evaluation methods differ along many dimensions, such as resource requirements, costs, results, and applicability (i.e., at what stages of the interface development process (Ivory, 2001).

Usability evaluation methods (UEMs) are methods used to evaluate the usability of a product design, and identify the problem areas. The primary goal of usability is to have products developed to maximize the users’ ease of use and satisfaction (Tsai, 2006).

Nelsen (1995) in Tsai (2006) categorized UEMs into four basic groups:

1. Automatically – here usability measures are computed by running a user interface specification through special software.

2. Empirically – here usability is assessed by testing the interface with real users or experts.

3. Formally – here usability measures are calculated by exact models and formulas.
4. Informally – here usability measures are obtained based on rules of thumb and the general skill and experience of the evaluators. Of the four groups, empirical methods are the most often used.


From the literature, it has been established that no single usability evaluation method is capable of finding usability problems of an e-learning device or software. Different usability evaluation methods uncover different usability problems; therefore, it is often recommended for evaluators to use multiple assessment methods. For example, during a usability test, questionnaire may also be given to participants to provide subjective input; thus, enabling evaluators to gather quantitative and qualitative data (Ivory, 2013).
From the foregoing, the present study would employ heuristics and survey evaluation methods to evaluate the OTELS currently being distributed to students in Osun state in order to determine whether it conform with eLearning usability issues of efficiency, effectiveness and user satisfaction.

**Heuristic Evaluation**

A heuristic is a guideline or general principle or rule of thumb that can guide a design decision or be used to critique a decision that has already been made. Heuristic evaluation is a usability method for finding and assessing usability problems in a user interface design as part of an iterative design process. The general idea behind it is that several evaluators independently evaluate a system using recognized usability principles (the "heuristics") to come up with potential usability problems and then categorize and rate them. It is essential to have several evaluators involved in the process, this is because, it is impossible for one person to find all usability problems. It has been shown that when there are multiple evaluators, each will be able to find different usability problems, thus the effectiveness of the problem can be improved by having a group of evaluators (Tsai, 2006).

The evaluators are asked to inspect the system individually in their most preferred way and then compare and combine the problems they found to form a comprehensive list with reference to the usability principles the design violated. The identified problems can then be rated to allocate the resources needed to fix them, and to see if additional usability efforts are needed.
The evaluation can be carried out at any stage of the design, development or deployment. If it is carried out earlier in the design or development stages, it will afford the developers the opportunity to revise and redesign as the case may be. If it is done after the device or the system has been released or deployed, it will help the developer make the necessary adjustment for the subsequent version.

The ten heuristics as developed by Jakob Nielsen is the most commonly used in the industry and they are so called because they are more in the nature of rules of thumb than specific usability guidelines (Tsai, 2006).

- Visibility of system status
- Match between system and the real world
- User control and freedom
- Consistency and standards
- Error prevention
- Recognition rather than recall
- Flexibility and efficiency of use
- Aesthetic and minimalist design
- Help users recognize, diagnose, and recover from errors
- Help and documentation

Thus, by determining which guidelines are violated, the usability of a device can be determined (Wikipedia, 2013). It should however be noted that, the heuristics are meant to help the evaluators to find usability problem, but not to restrict them to find only the problem justifiable by the heuristics as such any other usability issues not captured in the guidelines should be raised by the evaluators.
Some of the advantages of heuristic evaluation include:

- It has been found to be highly effective in finding usability problems.
- It can be carried out within a short period of time with limited resources.
- It is a flexible method in that it does not require much planning, once the real product or its prototype is ready and the evaluators are assembled, the evaluation can be carried out.

The downsides of the method are:

Even though non-experts can carry out the usability evaluation using the Heuristics method, its effectiveness depends largely on the experience and skills of the evaluators. As stated by Tsai (2006), a bad evaluator is more likely to miss the problems that a better evaluator did not pick up thereby lowering the chances of detecting more problems during evaluation.

Also, the fact that evaluators are allowed the flexibility of carrying out the evaluation as they so wished without any procedure or guidelines may lower the credibility of the process.

The structure of the method limits the findings to the violation of heuristics, the result does not provide direct suggestion on how to improve the evaluated design, or lead to breakthroughs in the evaluated design (Tsai, 2006).
Statement of the Problem

Several studies have been conducted on ICT potency and results have shown that it is a veritable tool, when appropriately used. It brings about improved learning performance across levels of education and in various subject areas (Yusuf, 1997; Egunjobi, 2002; Kareem, 2003; Ibode, 2004; Tijani, 2009; Omiola, 2011). Others have looked at ICT for other purposes other than teaching-learning and it has also been found to be efficient and bring about enhanced educational administrative processes (Palmén, 2011; Krubu, & Osawaru, 2011; Zambuk & Ya’u Gital, 2012; Adebayo, 2012).

The tablet which as a member of the hardware components of the computer family (Fischer, Smolnik & Galletta, 2013) is defined as a portable computer larger than a mobile phone with a flat touchscreen as its dominant external feature. It is operated mainly by touching the screen with the use of either a stylus or one’s fingers. Typing words on current models can also be done with the use of a virtual keyboard (eCycleBest, 2013).

Since the reinvented tablet by apple was released, its usage has increased in the last 2 years, as reported by Henrik and Martin (2012), United States witnessed a rapid increase from 10% adult users in December 2011 to 19% in January 2012. By August 2012, adult Americans who are tablet users have increased to 25% and this figure is expected to keep increasing with a projection that tablet ownership will hit 760 million globally (Henrik & Martin, 2012). The tablets described as a great forward
for brilliant educators (Johnston 2012) is gradually finding its ways into the teaching and learning situations all over the world (Vrtis, 2010).

Although tablet integration into education is still at its trial stage in most countries of the world including Nigeria (Kukulska-Hulme, 2007) many studies have demonstrated its capacity to bring out improved students’ academic performance and attitude to learning (Marques, 2013; LearnPad, 2013; Kenar et al., 2013; Calar, 2010).

Despite the growing acceptance of tablets for educational purposes, there have not been many studies on it is usability (Granić & Ćukušić, 2011) and without a good usability study done on an e-learning application or device, it may be difficult or even harmful to operate (Tsai, 2006). However, studies have shown that the major contributor to high dropout rate in e-learning is poor design and usability (Luckin, Bligh, Manches, Ainsworth, Crook & Noss, 2012).

Akinola and Temilola (2012) conducted a study titled Usability Study of Some Selected Functional Websites in Nigeria with objectives to ascertain the extent to which the load time, web content, navigation and colour usage of the websites differ, and to evaluate user perception of the performances of the websites under study. Usability checklist was used to rate the usability of websites involved in the study. The research findings show that usability index of the websites involved ranges between 65% and 84%, which is below the standard 90% recommended level. Due to inadequate usability index of the tested websites, the researcher concluded that none of the websites attained good web usability.
In another study titled Improving the Usability of E-Book Readers involving 10 participants, Siegenthaler, Wurtz and Groner (2010) investigated two requirements of e-reader design. They tested five electronic reading devices and one classic paper book combining eye tracking with usability testing methods. It was reported that e-reader with e-ink technology provided more legibility compare to classic books; all participants reported normal or corrected to normal vision and had no previous experience with e-readers. Also, there was a significant difference between the different brands of e-book readers.

Schmid and Bergamin (2012) conducted a research involving 12 University Students titled, The Effects of Touch Screen Technology on the Usability of E-reading Devices. Three different types of devices were compared: two e-readers with e-ink display and one tablet PC with a backlit. Participants completed different use case scenarios for each device and then completed a questionnaire. The results show that e-reading devices with touch screens correlate with better navigation ratings.

As evidenced from the foregoing, usability evaluation is a must for any technological products especially e-learning device before they are released to the public (Jeffels, 2011). Not many usability evaluation studies have been done especially on E-Learning devices like Tablets (Ardito et al., 2006). Few of the usability studies carried out within Nigeria are not on e-learning devices or systems. As at today, The Osun Technology Enhanced Learning System (OTELS) as a stand-alone educational tablet remains new to the world and no usability evaluation study is known to have been carried out on it either in Nigeria or elsewhere in the world.
Thus, this study seeks to conduct usability evaluation on the Tablet of knowledge (Opon-imo) in Osun state, Nigeria using the Heuristics and Survey evaluation methods to determine: (a) whether the learning software conform with the heuristics guidelines, (b) areas where improvements are required, (c) whether students are satisfied with the tablets as a learning tool and (d) whether the students are satisfied with the find the e-learning software, find it easy to use, attractive and learnable.

**Purpose of the Study**

The purpose of this study is to conduct usability evaluation on Tablet of Knowledge (Opon-imo) in Osun state, Nigeria using Heuristics evaluation guidelines and Students’ Usability Evaluation Questionnaire. Specifically, the study seeks to determine:

(i) Whether the learning software conform with the heuristics guidelines,

(ii) Areas where improvements are required,

(iii) Whether students are satisfied with the tablets as a learning tool,

(iv) Whether the students find the e-learning software easy to use,

(v) Whether the students find the e-learning software attractive,

(vi) Whether the students find the software learnable
Research Questions

The study will provide answers to the following research questions:

(1) Did the OTELS conform to the heuristics guidelines?

(2) Which heuristics guideline or guidelines were violated?

(3) Which aspect of the OTELS software requires improvement?

(4) Are students satisfied with the tablets as a learning tool?

(5) Do the students find the OTELS software easy to use?

(6) Do the students find the OTELS software attractive?

(7) Do the students find the OTELS software learnable?

Scope of the Study

This study seeks to conduct usability evaluation on the Tablet of knowledge (Opon-imo) in Osun state, Nigeria using the Heuristics guidelines and Students’ Usability Evaluation Questionnaire to determine: (a) whether the learning software conform with the heuristics guidelines, (b) areas where improvements are required, (c) whether students are satisfied with the tablets as a learning tool and (d) whether the students are satisfied with the e-learning software, find it easy to use, attractive and learnable.
The geographical scope of the study is Osun state. The State government recently commenced the distribution of Tablet of knowledge (Opon-Imo) to all Senior Secondary School students and teachers in the state for classroom instructional activities. Politically, the State is divided into Osun West, Osun East and Osun Central senatorial districts. The State is further sub-divided into 30 Local Government Areas with an area office in Modakeke, Ile-ife.

Research samples would be restricted to 8 Usability experts and 600 High school students who had received their tablets. As at December, 2013, only 6,850 students have been given the tablet (Opon-imo Project office, Osogbo). The selection of these categories of samples is based on their relevance to the study as dictated by the usability evaluation methods.

Clarification of Terms

**Educational tablet:** Computer device with touchscreen that are bigger than intelligent phones and contains teaching and learning software or applications.

**Usability:** The efficiency, effectiveness and satisfaction attributes of the OTELS.

**Evaluation:** This involves the process of assessing the OTELS to ascertain its conformity with the three basic usability elements of e-learning system.
**Tablet of Knowledge (Opon-imo):** Is a touchscreen computer device with educational software that contains learning contents for High School students in Osun.

**Osun Technology Enhanced Learning System:** Is learning software which contains the learning environments on which the Tablet of Knowledge runs.

**Heuristics:** Developed by Jakob Nielsen and Rolf Molich, it is a guideline or general principle or rule of thumb that can guide a design decision or be used to critique a decision that has already been made on technology devices or system.

**Students’ satisfaction:** is how well the students found the tablet useful to their learning.

**Learnability:** The ease with which students accomplish basic tasks the first time they interact with or use the software without any help.

**Significance of the study**

It is expected that at the completion of this research, usability experts and researchers, educational software developers, students and governments all over the world will benefit from the findings.

The number of usability evaluation of educational devices or system is scanty; the findings of this study would therefore contribute to the existing literature from which experts and researchers can have access to empirical evidences.
It is equally believed that, the expected findings of this study would be of benefit to the developers of the software under study which may necessitate possible modifications to the existing software or development of a different one.

If the students find any part of the Tablet of knowledge unsatisfactory, through the findings of this study, modifications can be done to it to meet the expectations of the current student generation.

Finally, through the findings of this study, Osun state government who is the project initiator may benefit from experts evaluation and students feedback which may serve as template for a possible review in the project. Other governments either within or outside Nigeria who are considering replicating similar project may also benefit from the findings of the study.
CHAPTER TWO

REVIEW OF RELATED LITERATURE

This chapter presents a review of the relevant literature to this study.

The following areas were covered.

1. Theoretical Background
2. Concept and Methods of Usability
3. Empirical Studies on Usability Evaluation
4. Information and Communication Technology and Education
5. Barriers to ICT in Education
6. Concept of Mobile Learning and Education
7. The Evolution and Impact of Tablet in Education
8. Osun Technology Enhanced learning System (OTELS)
9. Appraisal of Reviewed Literature
Theoretical Background

The mind, described as a mysterious science is continually being studied by theorist to know how it understands and interprets information. Some of these theorists focus on the cognitive components of learning while others focus on behavioral influences. With the advancement in technology however, theories are constantly changing (Koch, 2012).

As submitted by Ebert (2012), the secondary school classroom is shifting towards implementing ever increasing amounts of educational technology into curricula and to do so meaningfully and to ensure successful learning, it is necessary to reflect upon learning theories (Ebert, 2012).

A cursory look into the history of learning theories will reveal ever changing and evolving field (Ford & Lott, 2012). Learning theories falls under three categories namely; Behaviorism, Cognitive and Constructivism. Ebert (2012) asserted that much of what happens in today’s technological secondary classroom derive its base from both the Behaviorist and constructivist theories. He argued further that these broad theories have many implications for the technological secondary classroom. The current study finds relevance in the Constructivist theories.

As opinioned by Hein (1991), the latest catchword in educational circles today is “constructivism”, supporting this view Ford and Lott (2012), stated that within the field of education currently, constructivist has taken the limelight as the focus of
researchers has turned to how knowledge is constructed. Even as constructivism has continued to be main focus of learning theorists, the tools used in education have also become increasingly powerful. These educational tools as explained by the researchers relate to one another under the umbrellas we term technology (Ford & Lott, 2012).

According to Jones and Brader-Araje (2002), the meaning of constructivism varies according to one's perspective and position. They asserted that within educational contexts, there are philosophical meanings of constructivism, as well as personal constructivism as described by Piaget (1967), social constructivism outlined by Vygotsky (1978), radical constructivism advocated by von Glasersfeld (1995), constructivist epistemologies, and educational constructivism (Mathews, 1998).

Jones and Brader-Araje (2002) presented opinions of several authors on constructivism thus;

"Knowledge, no matter how it be defined, is in the heads of persons, and that the thinking subject has no alternative but to construct what he or she knows on the basis of his or her own experience." (Glasersfeld, 1995)

"The doctrine itself holds that 'language users must individually construct the meaning of words, phrases, sentences and texts.'" (Suchting, 1998, p. 61-62; Glasersfeld, 1989, p. 132)

"Constructivists allege that it is we who constitute or construct, on the basis of our theorizing or experience, the allegedly unobservable items postulated in our theories." (Nola, 1998, p. 32) "The central principles of this approach are that
learners can only make sense of new situations in terms of their existing understanding. Learning involves an active process in which learners construct meaning by linking new ideas with their existing knowledge." (Naylor & Keogh, 1999, p.93)

"Constructivists of different persuasion (hold a) commitment to the idea that the development of understanding requires active engagement on the part of the learner."

As observed by Jones and Brader-Araje (2002), the common thread of constructivism that runs across all these definitions is the idea that development of understanding requires the learner to actively engage in meaning-making. It is the argument of constructivists that knowledge is not passively received but built up by the cognizing subject. Thus, constructivists shift the focus from knowledge as a product to knowing as a process.

In another vein, Glasersfeld (1989) in a study titled Constructivism in Education submitted that, Constructivism is a theory of knowledge with roots in philosophy, psychology, and cybernetics. They explained that that the theory asserts two main principles whose application has far-reaching consequences for the study of cognitive development and learning as well as for the practice of teaching, psychotherapy, and interpersonal management in general. The two principles as listed by the researchers are:

(1) Knowledge is not passively received but actively built up by the cognizing subject;
(2) The function of cognition is adaptive and serves the organization of the experiential world, not the discovery of ontological reality.

To Kharade and Thakkar (2012), the term constructivism refers to a set of learning theories as an epistemological alternative to objectivist theories of knowledge. In their opinions, Constructivist epistemology rejects the notion of knowledge transmission and emphasizes the active role of learners who construct their own knowledge by connecting their past experiences and knowledge with new ideas and concepts. The constructivist principle gives rise to such learning approaches as learner-centered learning that place an emphasis on linking learning to learners' experiences and accepting multiple perspectives and thereby promoting their active engagement in the process of learning.

Glasersfeld (1989) presenting an historical view of constructivism stated that the first explicit formulation of a constructivist theory of knowledge was proposed by Giambattista Vico in his little-known Latin treatise *De antiquissima Italorum sapientia* (1710). He coined the phrase “verum est ipsum factum” and explained that to know something means to know what parts it is made of and how they have been put together. Vico was reported to explain that, Objective, ontological reality, therefore, may be known to God, who constructed it, but not to a human who has access only to subjective experience. “God,” Vico wrote, “is the artificer of nature, man the god of artifacts” and that "The human mind can know only what the human mind has made" Jones and Brader-Araje (2002).
In another instance, Ebert (2012); Ford and Lott (2012) are of the view that the early roots of Constructivism are from the educational theories of John Dewey and Jean Piaget. While Dewey set the foundation for constructivism by finding inquiry to be a key part of learning, Jean Piaget on the other hand explained constructivism idea through his theories of the four childhood stages of development. These theories according to Ebert (2012) are founded on the belief that “the child, at first directly assimilating the external environment to his own activity, later, in order to extend this assimilation, forms an increasing number of schemata which are both more mobile and better able to intercoordinate”. The contributions of both theorists constitute the beginning of the constructivist learning process with both focusing on how learning is processed and structured.

**Forms of Constructivism**

According to Light (2008), there are two main forms of constructivism namely: the Psychological constructivism and Social constructivism.

Psychological constructivism: also known as Personal constructivism or Cognitive constructivism is influenced most strongly by the Ideas of Piaget. Rather than learning being a process of just adding on new knowledge, psychological constructivism sees learning as being a process of the learner constructing unique knowledge through the interaction of his or her previous experience and knowledge and new experiences. This is with an assumption that knowledge is not merely received or taken in but is actively interpreted by the learner through exploration and
discovery. Psychological constructivism emphasizes the intrapersonal dimensions of learning and personal meaning making. It sees the construction of knowledge as involving the activation and reorganization of existing knowledge to make a unique understanding of the world. It suggests that thinking and learning are not restricted to the mind but to the body and its senses (Light, 2008).

Social constructivism on the other hand is strongly influenced by the ideas of Vygotsky which sees cognition occurring beyond the body. To a social constructivist, cognition is seen not as an individual process but instead as a collective process spread across the individual’s world, the understandings and capabilities that emerge from social interaction with a group is greater than those that are possible at an intrapersonal level. Social constructivist approaches to teaching thus emphasize social interaction and dialogue, such as when children work in groups to share ideas and solve mathematical problems collectively (Light, 2008; Ford & Lott (2012).

**Constructivism and ICT**

According to Kharade and Thakkar (2012) considering emerging technology in the 21st century, the implication of constructivist theory is often supported by the use of modern ICT tools. ICT is believed to support constructivist learning because of its capability to provide learning environments for collaboration and social interaction, in which learners construct knowledge in the target language on their own "by engaging in meaningful activities. Contemporary pedagogical theories suggest that collaborative learning which is based on the Constructivist paradigm is
the most effective means of facilitating teaching and learning in digital environments. The constructivist pedagogical strategies help to create Learning environments promoting active engagement of the learners and provide content relevant experiences by utilizing ICTs and resources to support unique learning goals and knowledge construction.

The strengths of constructivism lie in its emphasis on learning as a process of personal understanding and the development of meaning where learning is viewed as the construction of meaning rather than as the memorization of facts. Learning approaches using contemporary ICTs provide many opportunities for constructivist learning through their student centered environments based on their context. The current trend in e-Learning is to provide cognitive tools, which can be adapted for intellectual partnerships among teachers and students and facilitate critical thinking and higher-order learn (Kharade & Thakkar, 2012).

**Concept and Methods of Usability**

Usabilityfirst (2013) defines Usability as a measure of the interactive user experience associated with a user interface, such a website or software application. On the other hand, Usability.gov (2013) refers to usability as the quality of a user's experience when interacting with products or systems, including websites, software, devices, or applications. Usability is about effectiveness, efficiency and the overall satisfaction of the user.
Ali (2013) sees Usability as the ease of use, learnability, understandability, attractiveness, and user satisfaction of a human-made object which include software applications, tools, websites, processes, or anything that a user interacts with.

According to the International Standards Organization/International Electrotechnical Commission (ISO/IEC) 9126, usability includes the attractiveness, operability, understandability, learnability, and usability compliance sub-characteristics. Usability is known as a qualitative attribute that determines how easy the user interface can be utilized. It assesses the quality of users’ interaction with the system’s environment. Usability is considered to be one of the most important characteristics when targeting systems that will be used by widespread audiences, such as university students, without direct training and support (Ali, 2013).

Usability is the ease of use and learnability of a human-made object. The object of use can be a software application, website, book, tool, machine, process, or anything a human interacts with. Usability includes methods of measuring usability, such as needs analysis and the study of the principles behind an object's perceived efficiency or elegance. In human-computer interaction and computer science, usability studies the elegance and clarity with which the interaction with a computer program or a web site (web usability) is designed. Usability differs from user satisfaction and user experience because usability also considers usefulness (Wikipedia).
Nielsen (2012) sees Usability as a quality attribute that assesses how easy user interfaces is to use. He explained that the word "usability" also refers to methods for improving ease-of-use during the design process and can be defined by 5 quality components:

**Learnability:** How easy is it for users to accomplish basic tasks the first time they encounter the design?

**Efficiency:** Once users have learned the design, how quickly can they perform tasks?

**Memorability:** When users return to the design after a period of not using it, how easily can they reestablish proficiency?

**Errors:** How many errors do users make, how severe are these errors, and how easily can they recover from the errors?

**Satisfaction:** How pleasant is it to use the design?

In his opinion, Nielsen believes there are many other component of usability among which is Utility. Utility he mentioned refers to the design's functionality which answers question such as; does the device or software do what users need?

To Nielsen, usability and utility are equally important and together they determine whether something is useful. Usefulness he argued is the combination of Utility (whether it provides the features you need) and usability (how easy & pleasant these features are to use). Brooke (2013) while explaining usability relying
on ISO 9241, part 11 (ISO, 1998) submitted that there is no specific property of an artifact that you can call usability; rather, something which is usable is something which is appropriate to its context, where the context includes the task that is being done, the background and experience of the user who is doing it, and the environment in which it is being done (Ali, 2013; Usability.gov, 2013).

He explained further that ISO 9241-11 breaks the measurement of usability down into three separate components that must be defined relative to the context of use:

**Effectiveness:** Whether people can actually complete their tasks and achieve their goals.

**Efficiency:** The extent to which they expend resource in achieving their goals.

**Satisfaction:** The level of comfort they experience in achieving those goals.

Thus, a system that lets people complete their tasks, but at the expense of considerable expenditure of time and effort and which was felt to be very unsatisfactory by all concerned, could not really be said to be usable. (By the same measure, however, a system which people enjoyed using but which didn’t allow them to complete any tasks and on which they spent a lot of unproductive time could equally be argued not to be very usable).

Based on these different dimensions of usability, comparing two different systems which operate in different contexts in terms of usability will be difficult, how,
for example, can one compare a software development environment with a web-based banking system? The types of tasks that people use them for are so different that comparing them is always going to be a case of comparing apples with oranges (Brooke, 2013).

Brooke (2013) noted that Effectiveness in particular will always need to be defined in terms of the tasks the system is being used for; that one cannot really make a comparison between, say, using a development environment to build a web-page allowing a user to check their bank balance, to actually using that web-page to do the check as an end user.

To Brooke, measures of efficiency may have more in common across different application areas and are often expressed in terms of resource expenditure (time in particular) or unproductive activity such as making and correcting errors. But he noted again that, even here ways of measuring efficiency may differ radically between different applications and technologies, even when they are being used ostensibly for the same purpose.

On the issue of satisfaction, however there is more chance that one will be able to make comparisons across systems. As submitted by Brooke, If there is an area in which it is possible to make more generalised assessments of usability, which could bear cross-system comparison, it is the area of subjective assessments of usability.
Usability.gov (2013) took the discussion a step further by extending the usability components from three as listed by Brooke (2013) to five and with some new components.

**Intuitive design:** A nearly effortless understanding of the architecture and navigation of the site.

**Ease of learning:** How fast a user who has never seen the user interface before can accomplish basic tasks?

**Efficiency of use:** How fast can experience user accomplish tasks?

**Memorability:** After visiting the site, if a user can remember enough to use it effectively in future visits

**Error frequency and severity:** How often users make errors while using the system, how serious the errors are, and how users recover from the errors and

**Subjective satisfaction:** If the user likes using the system.

**Importance of Usability Evaluation**

Technology innovations abound in learning, education, and training, but the need for evaluation of such technology remains. Usability is a basic parameter for the evaluation of e-learning technologies and systems. Usability means quality and puts the users and their real needs in the center. Therefore investigation of usability and its integration or contribution to learning process is worthwhile (Zaharias, 2004).
Brooke (2013) believes usability is important because it can make the difference between user accurately and completely performing a task or not. It may also determine if the user will enjoy the process or will be frustrated. To the developer or designer, Brooke explains that usability is important because it can mean the difference between the success and failure of a system.

From a management point of view, software with poor usability can reduce the productivity of the workforce to a level of performance worse than without the system. In all cases, lack of usability can cost time and effort and can greatly determine the success or failure of a system. Given a choice, people tend to buy systems that are more user-friendly (Brooke, 2013).

Adhering to Usability principle for web designers is also important and a necessary condition for survival of the website. In that, if a website is difficult to use, users will leave. Since there is no such thing as website manual the users can fall back on to get information on how the interface works, also competition among software is fierce so it is important to get it right from the beginning (Nielsen, 2012).

While commenting on why usability evaluation should be carried out, Ali (2013) lamented that there are several factors influencing the usability of mobile devices in education, therefore, it is important to observe the usability requirements for users who will be utilizing these systems. This, the researcher concluded will ensure the acceptability, and high level of usability of those systems.
Also, applying in the design and development processes, it is vital to consider user interface design principles and to implement them; this can be useful for users to increase their performances while interacting with the system. A user-friendly user interface and usable mobile applications will definitely enhance the learning process.

Furthermore, mobile applications, specifically smartphones, must be designed and developed in a professional manner. It is important to meet usability needs of those applications in terms of satisfying the needs of end-users since user interface plays the most important role for each individual’s interaction between the user and his/her smartphone application.

Thus, mobile applications must be easy to use, learnable, understandable, and attractive as well as providing an enjoyable experience for users (Ali, 2013).

Federici and Borsci (2010) explained that Usability is evaluated by the quality of communication (interaction) between a technological product (system) and a user (the one who uses that technological product). The unit of measurement is the user's behaviour (satisfaction, comfort, time spent in performing an action, etc.) in a specific context of use (natural and virtual environment as well as the physical environment where communication between user and technological product takes place.

**Brief History of Usability**

1950-1963: During this period, the researchers explained that usability evaluation in the human computer interface was not required because the creators of the interface were also the users of their creations. They explained further that, since the end of the 1950s, technological and computer tools were created with specific functions determined by the different ideal interaction models elaborated by programmers which are mainly to get better calculation performances or better machine functions, with a focus on the management and control of technology.

Users of technology at this time had to adapt to the formal rules of the product as introduced by the designers, whether it was a calculator, an appliance or industrial machinery. The operator/user could control the technology with a panel meant to be used only for two operations: the correction of the machine's functions (i.e. debugging) and the input of command lines into the system. The interaction of Human-machine at this time was built up following the ideas of the Command Line Interface (CLI). The consumer/user was forced to learn the commands and input them using a keyboard. The interface was substantially textual and, usually, the interaction was limited to inserting data into the system.

The early 1960s witnessed high demand for a new interaction model. This new need as the researchers noted, was made possible by the introduction of new hardware elements and by a redefinition of the industrial operators. Gradually, the operators of industrial technological products could no longer be considered mere objects, embedded in the assemblage process; instead, they were beginning to be considered as subjects with rights, as well as consumers of the production process. It
is this historical step that marked the passage from operators to user era. These new perspectives developed the need to improve the conditions of interactive exchange. There was less physical involvement from people; instead, users interacted with machinery, which asked for instructions and transmitted information about the development process. The ergonomic attention moved from the muscular to the perceptive load.

Starting from this era, user’s interaction with technology grows; they were now sitting in front of radar screens, dashboards or command panels and were involved in new interactions with technology. As a consequence, their cognitive workloads were much heavier: attention decreased, while detention time regarding signal and answer times increased. In this new scenario, the reduction of error numbers during the interaction with the system (especially in a work environment) became a major issue for HCI researchers and practitioners.

With the progressive automation of the work process, a larger element of information, procedures, strategies and solutions was developed through machines. In this way, operators were released of the workload that was now being undertaken by the machine. This allowed for the possibility to focus their abilities on complex cognitive tasks. As a consequence, in the 1960s, ergonomic studies switched their attention from the physical structure of the work environment to its psychological and cognitive aspects.
1963 to 1984 eras: The researchers reported that the first interactive graphic user interface, Sketchpad was developed in 1963, at the Massachusetts Institute of Technology (MIT). This system they explained consisted of the direct manipulation of some graphic objects through an optic pen with which the user could create and move the graphic elements, receive graphic feedback and modify the interface setup. The idea of direct manipulation helped to overcome the CLI, opening new scenarios for HCI. In 1983, Shneiderman, defined the main features of direct interface manipulation in graphic interface, these principles were further developed by Hutchins and others in 1985. They started from the idea that interaction quality must be linked to the affordances concept. Affordances are to be understood as all the latent "action possibilities" in the environment that are objectively measurable and independent from the subjects' ability to recognize them; even though affordances are not dependent on the subjects' recognition, they are still related to the actors and their skills. Gibson's affordance concept was developed to explain subjects' interactions in physical environments. Hutchinson, Holland and Norman (1985) extended its range to virtual environments also considering, along with physical capabilities, other aspects related to the human-computer interaction, such as: actors' goals, plans, values, beliefs and past experiences.

An interface, as a place of functions and variables, is designed for operating a system, starting from the user inputs (click/query); in a simple virtual environment (i.e. interface), the user should be able to immediately develop messages or recall useful knowledge from the machine's memory. The user, during interaction with a
graphic interface like Sketchpad, must work with multiple aspects of knowledge, such as action, objects and manifold levels of syntactic knowledge. Thanks to Shneiderman's work at the Palo Alto Research Centre and to the subsequent formalization of the Graphical User Interface (GUI), the first window systems were developed in the second half of the 1980s.

1984 until now: This period as described by Federici and Borsci (2010) is the personal computer and Internet era. In 1984, at MIT, client/server architecture was produced in order to work flexibly on an interactive windows information system. It was named X Window System. In 1985, the GUI system became available to regular consumers when the first version of MS-Windows was released. Finally, during the 1990s, the WIMP (Windows, Icons, Menus and Pointer) type of interface became the most operative system until today.

The transformations in hardware and software over the last thirty years have promoted the development of graphic elements and have imposed the use of an interaction code, which is based on symbolic and spatial elements and not only on a linear language. Indeed, in the WIMP interface, the information organized in the virtual space, is spread both by the succession and by the order of content (i.e. the drop-down menus, the toolbars and the textual guides). At the same time, the information follows the rules of temporality, irreversibility, horizontality, uniformity, causality and fragmentation of the written language. In fact, users interact with information both through graphic content and through organization of space and
form (i.e. the concept of a desktop, the icons, the radial menus and the interaction through the mouse, etc.).

Thereby, users must extend their cognitive faculties from their logical-analytical, linear and sequential abilities to figurative, spatial, gestaltic and circulars abilities. While in the CLI, both the designer and user are bound by the same communicative code, which is logical and analytical (i.e. typed text), in the WIMP, the information is also communicated through graphic-spatial codes. The WIMP communicative code no longer coincides with the system code. The information relevance of an icon, for example, is not only linked to its content and functions, but also to its position on the screen or to the environment during the interface. The information content of CLI was entirely lacking of graphic context and the facilitation for the users' interactions could be reduced to few ergonomic rules (size of the screen, size and shape of the fonts, brightness, etc.).

On the other hand, in the WIMP model, the content is linked to the graphic-spatial context, so introducing the user to greater possibilities for the interpretation of content and environment (position, clarity of the symbol, graphic effects, etc.). With WIMP interfaces, in order to guarantee the functionality of the environment, the developers' function is no longer limited to the verification of the syntactic correctness of the code. In this way, the users' interpretative analysis of the code becomes part of the design process itself.
The historical transition from CLI to the GUI and the diffusion of personal computers raised usability and accessibility problems, and as a consequence, researchers developed new evaluation methodologies in order to develop friendly systems that were able to support performance and the spread of information on the World Wide Web. The evaluation of these products, and in particular the evaluation of the interaction with users, became an important way to develop the technology. In fact, from the 1980s, the first kind of usability test, known as "laboratory usability testing", quickly became the primary usability evaluation method for examining a new or modified interface.

Developers considered laboratory testing as a way to minimize costs of service calls, to increase sales through the design of a more competitive product (by minimizing risk) and creating a historical record of usability benchmarks for future releases. In addition to the users' subjective evaluations, laboratory testing measures speed, accuracy and errors of users' performances. Methods for collecting data beyond user performance included: verbal protocols, critical incident reporting and user satisfaction ratings. More recently, in the 1990s, developers explored other evaluation methods in an attempt to decrease further the costs and time required for traditional usability testing. In addition, since usability testing tended to occur late in the design process, developers were motivated to search for new methods that could be used with the prototypes developed in the early design process.

Some of the most popular expert-based UEMs include guidelines for the evaluators based on the rules of the interaction design. Examples include guidelines
for the software of the United State Air force, heuristic evaluation, cognitive walkthroughs, usability walkthroughs, formal usability inspections and heuristic walkthroughs. Practitioners are far from settled on a uniform UEM, and researchers are far from agreeing on a standard for evaluating and comparing UEMs.

**Usability Evaluation Methods**

Research in the field of human-computer interaction (HCI) has provided numerous principles and guidelines that can steer designers into making good decisions. Although applying good design guidelines alone is a good start, it is no substitute for system usability evaluation (Granić1 & Ćukušić 2011). There are a variety of usability evaluation methods. Certain methods use data from users, while others rely on usability experts. There are usability evaluation methods for all stages of design and development, from product definition to final design modifications.

According to Bernérus and Zhang (2010) Usability evaluation methods can be categorised into two categories and these are Analytical and Empirical evaluation methods. Analytical usability methods are carried out by usability experts, who put themselves in the targeted end-users position. Based on the experts expertise and usability heuristics, the expert validates the software, this process does not involved the users at all, they however suggested that, analytical evaluation methods fits best early in the system development process. The researchers listed the following “Guidelines”, “GOMS” or “Heuristic Evaluation” as part of analytical method.
**Analytical Usability Evaluation Methods**

This category contains of three evaluation methods which include: design guidelines, formal-analytical technique and inspection methods, these methods involve experts only.

**Design guidelines:** This are set of instructions that should be followed in order to develop a user friendly interface or system. These methods are further sub-divided into five categories: design rules, ergonomic algorithms, style guide, standards and collection of guidelines with each having respective characterisation.

Design rules contain short instructions in such way that no further interpretation is required. Ergonomic algorithms collect design requirements in a rigid manner that describes how the design process has to be carried out under certain conditions.

Style guides contains rules and standards in order to provide a model graphical user interface design, the actual content is then later inserted. Standards, for example DIN EN ISO 9241 are defined by national or international organizations to generalize design of interfaces. Collections of guidelines offer a number of different guidelines for different types of user interfaces (Bernérus & Zhang (2010).

Formal-analytical techniques are also carried out by usability experts only, the techniques can be divided into two subgroups. The first, task analytical methods focuses on the task within the system. These tasks are broken down into small sub-tasks in order to distinguish potential problems in each one of them. The outcome of this method is data on execution times or sequences. GOMS (Goals, Operators,
Methods, and Selection Rules) are one such technique and it provides time intervals in which a user should need in order to solve a task. This time includes both cognitive and physical actions. This can be useful if there are two designs to choose from as it would be easy to compare them and see what design is most efficient since time of task completion is the main focus. The second formal-analytical technique is “expert guidelines”, which focuses on the ergonomics of the software (Bernérus & Zhang 2010).

The last of the Analytical methods, the inspection methods can also be divided into two sub-categories, (1) design principles such as heuristic evaluation and (2) design task analysis such as cognitive walkthrough (Bernérus & Zhang 2010).

In heuristic evaluation, the usability experts put themselves in the position of the user and conduct the evaluation of the interface independently of any collaboration. In this method, expert evaluators are separated by time and location and when the evaluation is over; reports are collated and merged to an overall assessment of the system. The evaluation is done according to the usability heuristics guidelines. The Cognitive walkthrough on the other hand is more focused on tasks the users are to perform. It’s a review process, where experts evaluate the design using criteria appropriate to the design issues.

The second category of the usability methods are regarded as empirical evaluation methods; these methods require user representative to test the software. This category according to Bernérus and Zhang (2010) mainly consists of usability
tests and questionnaires. They argued that these empirical evaluation methods are better applied later on in a development process or when the system is already deployed for use. The goal at this stage then becomes determination of the overall usability of the system involved. However, whichever category an evaluator may choose to employ, it is important to know that these categories should not replace each other, rather they should complement each other (Bernérus & Zhang 2010).

**Empirical Usability Evaluation Methods**

In this method, the intended end-users are involved and can consist of Usability Tests or Questionnaires. It does not matter if the system has been deployed for use or not, what is important is the users’ involvement. Usability Test can be in several forms including video feedback or screen recording, log files & input protocols, thinking aloud protocol and attention-tracking (mouse tracking) & eye-tracking.

**Video feedback:** this involves filming the user while interacting with the system, the main purpose of which is to observe the user while use the interface without any intrusion. The users’ actions can then be analysed by an investigator and possibly the filmed user together.

**Log files:** In this method, user actions are recorded and documented in a file which can then be analysed by the investigator to see the exact time and sequence of the user actions.
The think aloud protocol: This requires the user to verbally express his or her reactions and say what s/he is doing during the evaluation process. The users are trained on how to voice their thoughts while interacting with the system.

Attention tracking: User uses the mouse to pint and click in the area or section he find the most noticeable, making the mouse both tool and pointer of focus and attention. This makes it not so good for interactive tasks and it diverts the mouse from its intended use.

Eye Tracking: In this method, users’ eyes and views are tracked and recorded while interacting with the system. This is later analysed to see what was most distracting to the users, where the attention were most and how long the user remained on certain sections.

Questionnaires can be used to collect quantitative data and can consist of different types of questions, multiple choice questions and a rate scale as well as open ended questions (Bernérus & Zhang, 2010).

Other Usability Evaluation Methods

Other usability evaluation methods as listed by Bernérus and Zhang (2010) include: Systematic usability evaluation (SUE) which is a combination of both analytical and empirical evaluation methods. The SUE utilizes the evaluation patterns, called “abstract tasks” (ATs), which is a detailed description of what tasks the
evaluators must perform during inspection. MiLE is a SUE framework for web applications. It is a scenario-driven inspection technique which uses user profiles, scenarios, user goals and usability attribute. I.e., in MiLE the user requirements, their goals and scenarios are the basis for the evaluation. This is tested through both inspection methods: to verify the feasibility of the scenarios or tasks, as well as heuristics: to verify the compliance of the system using a set of usability principles.

“MiLE+” is a fruition of both SUE and MiLE, i.e., version two of MiLE. MiLE+’s goal is to be easier to use, especially by novice users than its predecessor is. Additionally it aims to be more systematic and structured.

Tsai (2006) presenting a report of the survey study titled, A survey of empirical usability evaluation methods GSLIS quoted Nelsen (1995) to have categorized Usability evaluation methods in to four basic groups which are:

1. Automatically – in which usability measures are computed by running a user interface specification through special software.

2. Empirically – in which usability is assessed by testing the interface with real users or experts.

3. Formally – in which usability measures are calculated by exact models and formulas.

4. Informally – in which usability measures are obtained based on rules of thumb and the general skill and experience of the evaluators. He further subdivided the empirical usability evaluation methods into two; User study and system inspection.
Relying on the authors views as presented above, usability evaluation methods can be categorized into two major groups; those that involve actual device or system users and those that rely solely on the experts’ judgments and involvements. Methods involving the user are however believed to be more acceptable to usability researchers. Making a case for the use of usability methods, Tsai (2006) submitted that the best way to learn about usability of devices or systems is to ask the users themselves suggesting that he who wears the shoe knows where it pinches. Below are some of the usability evaluation methods.

**Survey**

Survey is one of the Inquiry methods of usability evaluation used to gather additional data from a large population within a short period of time after a system/device/interface has been released. This is useful to the producer or developer for improving the system or the interface for future release. It could be used as a stand-alone method or with other methods to obtain additional user information.

Surveys come in various length, detail, and format. They could be done over the telephone, in person, over the mail or email, and generate quantitative information. Surveys available for different kinds of information collection; it could be used to collect participant’s attitudes toward individual products, or to measure a selected aspect of usability. The design of a good survey requires skill and time. The
questions need to be correlated to what the evaluators want to find out; able to provide reliable results; and have certain validity to the study (Tsai, 2006).

One caveat about this method is that it measures anything user preferences, not product usability (Tsai, 2006). In essence, survey questions explore how the users feel about a product – were the instructions easy to read, were the system easy to operate, or would they use the product again; not how they really performed on it.

Another problem with surveys is that it is difficult to interpret the results. When a user rates an answer, what does it really reflects? Would one user’s scale or rating standards equal to another’s? Did the participants answer the questions according to how they truly feel, or by what they think the evaluators wish to see? What does it mean when participants say they are satisfied with a product? Does it mean they were able to efficiently complete a task, or that though the system failed them, they were not annoyed by it? Are these measures really quantifiable? What does the resulted statistics mean?

Despite these low sides of survey, survey is still identified as one of the most widely used methods because of its efficiency in reaching a large sample size quickly. One of the instruments used for data gathering in survey method is the questionnaire. A questionnaire in usability evaluations is a measurement tool designed to assess a user’s subjective satisfaction with an interface. It contains questions that are distributed to users for responses. Responses on a questionnaire are usually quantitative (e.g., ratings on a 5-point scale). One example is the
Questionnaire for User Interaction Satisfaction (QUIS) (Viller, 2009). QUIS contains questions to rate 27 system attributes on a 10-point scale, including overall system satisfaction, screen visibility, terminology, system information, learning factors, and system capabilities (Ivory, 2001).

**Focus group**

Focus group originated as a market research method, and has evolved into a technique also used to study human-computer interaction and human factors (Tsai, 2006). It is a data collecting technique where about 6 to 9 users are brought together to discuss issues relating to the system’s effectiveness and user satisfaction. A human factors engineer plays the role of a moderator, who takes notes of the happenings, leads the conversation into interesting tangents, encourages comments, prevents the discussion to be dominated by few of the participants, and all the while avoid having any effects on the session’s outcome.

Some practitioners believe that with well planning, proper guidelines and a good moderator, focus groups can gather valuable usability data. They believe that though it is not suited for comparative, competitive, or bench-marking studies, focus groups can be used to generate ideas, capture and validate user roles as well as tasks and workflows, and validate high level strategy. However, there are also some major drawbacks that led many practitioners to question its validity in gathering useful user data. Tsai (2006) quoting Rosenbaum et al. (2002) stated that “... the quality of the data obtained from usability focus groups is only as good as the quality of the
participant selection and the questions asked.” The effectiveness of a focus group relies heavily on the participants to share their opinions and the discussions they had.

Though the group setting may be more relaxed to the participants, it might lead to groupthink, where creativity and individual ideas are suppressed and members conform their opinions to what appears to be the consensus of the team. The conversation may lose its function to reflect general opinions by becoming biased, or self-censored by participants. And as hard as the moderators may try, they may inevitably influence the discussion; it could be from a subtle tone of the voice, or from the words they chose to say. There have also been incidents when participants seek approval from the moderators and try to give comments that would please them. Furthermore, the method only collects user thoughts; it does not offer an opportunity to see the user at work, or learn more about the context of work. With the shortcomings of focus group in mind, practitioners have altered the method to improve its performance (Tsai, 2006; Buxton and Greenberg 2008).

Buxton and Greenberg (2008) presented general procedures for conducting a focus groups study.

- Locate representative users (typically 6 to 9 per focus group) who are willing to participate.
- Select a moderator.
- Prepare a list of issues to be discussed and goals for the type of information to gather.

- Keep the discussion on track without inhibiting the free flow of ideas and comment.

- Ensure that all participants get to contribute to the discussion thereby avoiding a single participant’s opinion dominate the discussion.

- Have the discussion feel free-flowing and relatively unstructured to the participants, but try to follow a preplanned script.

- Write a summary of the prevailing mood and critical comments of the session, including representative quotes.

**Testing**

Usability testing refers to evaluating a product or service by testing it with representative users. Typically, during a test, participants will try to complete typical tasks while observers watch, listen and takes notes. The goal is to identify any usability problems, collect qualitative and quantitative data and determine the participant’s satisfaction with the product (usability.gov, 2013).

Usability testing is designed for evaluators to observe and record end users interaction with a product by asking a user to perform a task, thinking aloud, using a test system. Usability testing is rated “highest as an effective usability methodology to create greater strategic impact,” and is widely used in organizations (Tsai, 2006).
According to Coopers (2007) in Henrik and Martin (2012) Usability testing is most effective at determining the following five attributes: Naming – Are buttons or section labels understandable? Could there be alternative words than others that might make labeling more understandable? Organization – Is information categorized into meaningful groups? Is content properly placed in places where users might expect them to be in? First-time use and discoverability – Is it easy for new users to find common items without much effort? Are there clear instructions and are they necessary? Effectiveness – Is it easy and fast to complete specific tasks? Are there mistakes? Where & when? How often? Also, usability testing is usually done on assessing the usability only the first time it is being tested. It is often difficult to measure

Usability testing lets the design and development teams identify problems before they are coded. The earlier issues are identified and fixed, the less expensive the fixes will be in terms of both staff time and possible impact to the schedule. (Usability.gov, 2013).

According to Ivory (2001) usability testing methods include:

Thinking-aloud Protocol: This method requires participants to verbalize their thoughts, feelings, and opinions during a usability test. One goal of this approach is to enable the tester to get a better understanding of the participant’s mental model during interaction with the interface. Critical response and periodic report are two
variations of the protocol wherein the participant is vocal only during the execution of certain pre-determined tasks or at pre-determined intervals of time, respectively.

Buxton and Greenberg (2008) noted that the Thinking-aloud protocol method can be applied across the design, the code, the test and the deployment stages. It covers effectiveness and satisfaction involving at least 1 expert and for users and no quantity data is gathered.

There are two variations of thinking-aloud protocol technique and they are:

Critical response: in this technique, users are expected to be vocal during the execution of certain predetermined subtasks only.

Periodic report: This technique is used when the task is complex and makes it difficult for users to think aloud while performing the task at the same time. The user, therefore, verbalizes at predetermined intervals of time and describes what he/she is currently trying to achieve. The length of the interval depends upon the complexity of the task. This technique is time consuming, so it is recommended for subdivisions of a task (Buxton & Greenberg, 2008).

Thinking aloud allows testers to understand how the user approaches the interface and what considerations the user keeps in mind when using the interface. If the user expresses that the sequence of steps dictated by the product to accomplish their task goal is different from what they expected, perhaps the interface is convoluted (Buxton & Greenberg, 2008).
Question-asking Protocol: This method is an extension of the thinking-aloud protocol (Ivory, 2001) it covers the design, code, test and deployment stages and involves at least a usability expert and 4 users. It is suitable for usability issues such as effectiveness and user satisfaction. During the test, besides letting the test users to verbalize their thoughts as in the thinking aloud protocol, the testers prompt them by asking direct questions about the product, in order to understand their mental model of the system and the tasks, and where they have trouble in understanding and using the system (Buxton & Greenberg, 2008).

Coaching Method: The method covers usability issues such as effectiveness and user satisfaction. It allows participants to ask any system-related questions of an expert coach during usability testing. Usually, the tester acts as the expert coach, but it is possible to have a separate tester serving as a coach. The latter approach may allow the tester to gain additional usability insight through observing the interaction between the participant and coach. In cases where an expert user serves as the coach, this also enables the tester to analyze the expert user’s mental model of the system. The main goal of this method is to determine the information needs of users to provide better training and documentation in addition to possibly redesigning the interface to eliminate the need for questions in the first place. It is also possible for the tester to control the answers given to questions during testing to discover what types of answers help users the most (Buxton & Greenberg, 2008; Ivory, 2001)

Teaching Method: For this method, the participant interacts with the system first to develop expertise to subsequently teach a novice user about the system. The
A novice user serves as a student and does not actively engage in problem solving. The participant does the problem solving, explains to the novice user how the system works, and demonstrates a set of pre-determined tasks. This method enables testers to assess the ease of learning of an interface and used for the design, code, test, and deployment stages. It is good for measuring system’s effectiveness and users’ satisfaction involving. It mostly involves one expert evaluator and four users (Ivory, 2001; Buxton & Greenberg, 2008).

Shadowing Method: Shadowing is an alternative to the thinking-aloud protocol where an expert user sits next to the tester and explains the participant's behavior during the testing session. Evaluators use this method in situations where it is inappropriate for participants to think aloud or talk to the tester and it covers usability issues such as system’s effectiveness and efficiency. The method can be applied at the design, code, test and development stages involving at least one usability expert and four users (Ivory, 2001; Buxton & Greenberg, 2008).

Co-discovering method: This approach is similar to the type of collaboration that occurs naturally in other environments, such as at work, it allows two test users attempt to perform tasks together while being observed. They are to help each other in the same manner as they would if they were working together to accomplish a common goal using the product. They are encouraged to explain what they are thinking about while working on the tasks. Compared to thinking-aloud protocol, this technique makes it more natural for the test users to verbalize their thoughts during the test.
This technique can be used in the following development stages: design, code, test, and deployment. When using this method, Buxton and Greenberg (2008) opined that it is preferable to pair two users who know each other into one group so that they won't feel uncomfortable working together. Provide the test users with the product to be tested (or a prototype of its interface) and a scenario of tasks to perform. The method can be applied by one usability expert and at most 6 users. It covers usability issues such as effectiveness and user satisfaction. The data gathered here are qualitative in nature.

Performance Measurement: This technique is used to obtain quantitative data about test participants' performance when they perform the tasks during usability test. Generally, interaction between the participant and the tester are prohibited during the test so as to eliminate interaction effect that may affect the quantitative performance data. When using this technique, the test is better conducted in a formal usability laboratory so that data can be collected accurately and possible unexpected interference is minimized. Quantitative data is most useful in doing comparative testing, or testing against predefined benchmarks. To obtain dependable results, at least one usability expert and 5 user participants are needed, while 8 or more participants would be more desirable. The technique can be used in combination with retrospective testing, post-test interview or questionnaires so that both quantitative and qualitative data are obtained (Ivory, 2001).

Measurement studies form the foundation of usability testing, since evaluators can use the results to assess whether the usability goals have been met as well as
for competitive analysis. In the first case the evaluator would re-define an abstract performance goal, such as usability, into a specific usability attribute, such as efficiency of use. After specifying a specific usability attribute, the evaluator can quantify this attribute with a metric (e.g., time to complete a task, time spent recovering from errors, etc.) and devise a plan for measuring this metric in the interface and collecting the necessary performance data. Without automated tools, this collection is typically accomplished by taking notes or videotaping testing sessions and subsequently reviewing the videotape to compute performance measures (Ivory, 2001; Buxton & Greenberg, 2008).

Retrospective Testing: This method is a follow-up to any other videotaped testing session wherein the tester and participant review the videotape together. It covers usability issues such effectiveness, efficiency and user satisfaction and can be conducted with at least 1 expert and 4 users (Buxton & Greenberg, 2008). During this review, the tester asks the participant questions regarding her behavior during the test session. The goal of this review is to collect additional information from the usability test. Although such testing can be valuable, but it means that each test takes at least twice as long. Another obvious requirement for using this technique is that the user's interaction with the computer needs to be recorded and replayed which ultimately means additional test cost to the evaluator (Ivory, 2001; Buxton & Greenberg, 2008).
**Inspection methods**

System inspection methods examine the product, rather than studying the user interaction with the system or device. The methods involve having usability experts or product designers inspect the product in an ad hoc manner, or following a guideline. Because the users are not involved and a lower number of evaluation sessions needed, the inspection techniques in general can be executed more quickly and less expensive than user studies (Buxton & Greenberg, 2008).

**Expert review**

Ivory (2001) defined Expert review as an informal method used by one or more expert usability professionals to evaluate a user interface. The method relies on the insights experts are able to provide from their deeper knowledge in their respective fields other than the users’ experiences through interaction with the system or device. As effective as expert review may be, its main focus is to evaluate if the product design may impede user’s performance of a task; it does not yield insights into user’s conceptual use model (Tsai, 2006).

**Heuristic evaluation**

Heuristic evaluation is also an informal system inspection method where a small group of evaluators are presented with an interface design and asked to judge whether each of its elements follows a set of established usability principles (Nielsen, 1995). The outcome of this evaluation is typically a list of possible usability problems. After the evaluators independently evaluate the interface, the evaluators aggregate
their findings and associate severity ratings with each potential usability problem (Ivory, 2001).

According to Ivory (2001), HE is the most used informal inspection method mainly because it relies on a small set of usability criteria. It is also a cheap, fast, and easy to use usability evaluation method (Slone, 2009).

Heuristic evaluation can be performed by not less than six experts or non-experts for effectiveness and it covers usability issues such as effectiveness and efficiency (Buxton & Greenberg, 2008). It has been shown that when there are multiple evaluators, chances are that each will be able to find different usability problems. According to Ivory (2001), 4 or 5 evaluators are able to report near 70% of the usability problems. The 10 heuristics were developed as an improvement over the list of nine usability principles earlier developed by Nielsen & Molich in 1990 after a factor analysis of 249 usability problems.

According to Buxton and Greenberg (2008) when conducting the evaluation, individual evaluator should be allowed to inspect the interface or system alone. It is after all evaluators have completed their individual inspections that they are allowed to communicate and have their findings aggregated.

To aid the evaluators in discovering usability problems, a list of heuristics is provided to them which can be used to generate ideas while evaluating the system. Here is a sample list of heuristics:
Visibility of system status: The system should always keep users informed about what is going on, through appropriate feedback within reasonable time.

Match between system and the real world: The system should speak the users' language, with words, phrases, and concepts familiar to the user, rather than system-oriented terms. Follow real-world conventions, making information appear in natural and logical order.

User control and freedom: Users often choose system functions by mistake and will need a clearly marked "emergency exit" to leave the unwanted state without having to go through an extended dialogue. Support undo and redo.

Consistency and standards: Users should not have to wonder whether different words, situations, or actions mean the same thing. Follow platform conventions.

Error prevention: Even better than good error messages is a careful design which prevents a problem from occurring in the first place.

Recognition rather than recall: Make objects, actions and options visible. The user should not have to remember information from one part of the dialogue to another. Instructions for use of the system should be visible or easily retrievable whenever appropriate.

Flexibility and efficiency of use: Accelerators - unseen by the novice user - may often speed up the interaction for the expert user to such an extent that the system
can cater to both inexperienced and experienced users. Allow users to tailor frequent actions.

**Aesthetic and minimalist design:** Dialogues should not contain information which irrelevant or rarely needed. Every extra unit of information in a dialogue competes with the relevant units of information and diminishes their relative visibility.

**Help users recognize, diagnose, and recover from errors:** Error messages should be expressed in plain language (no codes), precisely indicate the problem, and constructively suggest a solution.

**Help and documentation:** Even though it is better if the system can be used without documentation, it may be necessary to provide help and documentation. Any such information should be easy to search, focused on the user’s task, list concrete steps to be carried out, and not be too large.

When conducting the evaluation, the evaluators are asked to inspect the system individually, in any way they like, and then compare and combine the problems they found to form a comprehensive list with reference to the usability principles the design violated. The identified problems can then be rated to allocate the resources needed to fix them and to see if additional usability efforts are needed (Ivory, 2001; Tsai, 2006).

The main advantage of heuristic evaluation is its ability to be done in a short period of time with limited resources. It is also very flexible and does not require advanced planning; it could be carried out as soon as the group of evaluators is
assembled and that there is a product or a prototype to evaluate. Heuristic evaluation has also proved to be highly effective in finding usability problems (Ivory, 2001).

Despite the aforesaid advantages of the method, it effectiveness depends largely on the evaluators’ skill and experience. Though non-experts are able to perform the evaluation as well as experts, it is very likely that they would not be able to find as many usability problems as the experts. Also, the flexibility given to the evaluators, allowing them to inspect the system anyway they want also means a lack of support and structure to the inspection process (Law & Hvannberg, 2004 in Ivory, 2001). Again, the structure of this method limits the findings to the violation of heuristics, the result does not provide direct suggestion on how to improve the evaluated design, or lead to breakthroughs in the evaluated design (Ivory, 2001).

Ivory (2001) listed some usability evaluation methods which are variations of the Heuristics evaluation to include:

Perspective-based Inspection: Perspective-based inspection is a variation of heuristic evaluation. For this method, evaluators divide a list of usability issues into different perspectives and focus on only one perspective or subset of heuristics during an inspection session. A perspective is a point of view consisting of a list of inspection questions and a specific procedure for conducting the inspection. This approach improves the effectiveness of evaluators within each perspective as well as overall, in comparison to heuristic evaluation (Ivory, 2001).
Feature Inspection: This evaluation method is for the purpose of inspecting a feature set of a product and to analyze the availability, understandability, and other functionality aspects for each feature. Evaluators use a list of product features along with scenarios for such inspections. The evaluations primarily concern with evaluating the system against the set of features as contained in the list. This method can be applied by a single expert and it only evaluates effectiveness of a device or system (Buxton & Greenberg, 2008).

Formal Usability Inspection: Formal usability inspection is an adaptation of traditional software inspection to usability evaluation. The inspection procedure is fairly similar to heuristic evaluation and involves a diverse team of inspectors such as system developers, designers, documenters, trainers, technical support personnel, and possibly usability experts). The only difference is the formality associated with the inspection i.e. roles are assigned and a formal six-step process is followed.

Consistency Inspection: Evaluators use this method to determine a consistent interface appearance and functionality that they can then use to assess the consistency of interfaces across multiple products in a family.

Standards Inspection: In this inspection method an evaluator compares components of an interface to a list of industry standards to assess the interface's compliance with these standards. This inspection method is usually aimed at ensuring a product's market conformance.
Cognitive walkthrough

This is a method of evaluating the user interaction of a working prototype or final product. It is used to evaluate the system’s ease of learning and effectiveness. This method is useful to understand the user’s thought processes and decision making when interacting with a system, especially for first-time or infrequent users (Buxton & Greenberg, 2008).

According to Tsai (2006), Cognitive walkthrough is a theoretically structured usability evaluation process that focuses on a user’s cognitive activities, especially while performing a task. It can be carried out on finished products or paper prototype by individuals or groups, software developers or usability specialists. It is a method based on a theory of exploratory learning and corresponding interface design guidelines, cognitive walkthrough is a task-based methodology that centers an evaluator’s attention on the user’s goals and actions during a task, and on whether the system design supports or hinders the effective accomplishment of those goals.

To Ivory (2001) Cognitive walkthrough involves one or more evaluators exploring an interface, prototype, or paper mock-up by going through a pre-determined set of tasks and assessing the understandability and ease of learning for each task. During the walkthrough of a task, the evaluator(s) attempts to simulate a user’s problem-solving process while examining each action required. The evaluator attempts to construct a credible success story for each step of the task.
While the evaluation is ongoing, the design team then takes on the perspective of a user, work through the tasks, and fill out the forms. The forms play a major part of the process; they guide the evaluators’ actions and explorations with a series of questions regarding actions taken to complete a task. Each form asks the evaluators to identify the immediate goal of an action; inspect the atomic actions that precedes and follows, and if they were well supported; scrutinize user’s cognitive process; evaluate user’s action options; examine if the identified goal can be achieved and if there are other options; and finally, observe the appropriateness of system feedback. Since a form is required for each individual action, copies of it may be filled out dozens of times through a completed walkthrough (Tsai, 2006).

To eliminate the cumbersomeness of the documentation process involved in the cognitive walkthrough, a modified version called Jogthrough was developed by Rowley and Rhoades (1992) to expedite recording during the walkthrough session. In cognitive jogthrough, the session is videotaped and logging software is used to mark key events. Thus, the videotape can be reviewed afterwards to document the session (Ivory, 2001).

Pluralistic Walkthrough: This is a variation of the cognitive walkthrough inspection method wherein representative users, evaluators, and developers inspect the interface as a group to step through a set of tasks, discussing and evaluating the usability of a system. Group walkthroughs have the advantage of providing a diverse range of skills and perspectives to bear on usability problems (Ivory, 2001; Buxton & Greenberg, 2001). It is believed that as more people inspect the system or software
for problems, the higher the probability to find usability issues and the faster the usability issues are resolved.

Inquiry methods

Usability enquiry methods allows evaluators to obtain information about users' likes, dislikes, needs, and understanding of the system by talking to them, observing them using the system in real work (not for the purpose of usability testing), or letting them answer questions verbally or in written form. Inquiry methods include:

Field Observation: According to Ivory (2001) Field observation is similar to, but less structured than contextual inquiry. It is typically conducted for a released system and may involve one expert and minimum of two users, this method is appropriate to measure usability issues such as effectiveness and satisfaction. For this method, evaluators visit the representative users' workplace and observe them working with the system. This enables the evaluator to understand how users are using the system to accomplish their tasks as well as the mental model the users have of the system. During this visit, the evaluator may also interview users about their jobs and other aspects about the way they use the product (Buxton & Greenberg, 2008).

Contextual inquiry: Buxton & Greenberg (2008) defines contextual inquiry as a qualitative data-gathering and data-analysis methodology adapted from the fields of psychology, anthropology, and sociology. It is a field research method wherein usability evaluators go to the users' workplaces, observes them at work, and asks questions regarding the work content, process, or product usage. This process may
take weeks and in some cases months to complete depending on the user’s work life cycle. According to Ivory (2001), the method is based on three core principles:

1. Understanding the context in which a product is used is essential for its successful design;

2. The user is a partner in the design process; and

3. The usability design process must have a focus.

Several evaluators may observe different users at the same time. The data is gathered, compared and shared among product development team members after the observation. Contextual inquiry is different from an interview because instead of a question and answer session, the data gatherer and the user form a partnership to explore the issues together.

**Empirical Studies on Usability Evaluation**

Although several usability evaluation studies have been conducted in the field of technology and engineering, the field of educational technology has not recorded many especially as it concerns tablets technology. Below are the procedures and findings of such studies.

Akinola and Temilola (2012) conducted a study titled Usability Study of Some Selected Functional Websites in Nigeria with objectives to ascertain the extent to which the load time, web content, navigation and colour usage of the websites differ,
and to evaluate user perception of the performances of the websites under study. Twenty-five functional websites created by five selected software organizations were evaluated for usability. Usability checklist was used to rate the usability of websites involved in the study. The data collected were analyzed and interpreted using simple percentages. Analysis of Variance (ANOVA) was also used to compare the websites usability. The research findings show that usability index of the websites involved ranges between 65% and 84%, which is below the standard 90% recommended level. Due to inadequate usability index of the tested websites, the researcher concluded that none of the websites attained good web usability.

Suomalainen, Korpinen and Pääkkönen (2010) conducted a research titled, A Comparison of the Usability of a Laptop, Communicator, and Handheld Computer in Finland. Their main interest was to find out how user-friendly and ergonomically correct the devices under study are. The study involved 25 subjects who had 5 minutes each to perform typing or calculation tests with each device. While the subjects were performing the tasks, an observer monitored the subjects’ work posture and after the tasks were completed, the subjects completed questionnaires about the usability of each device they used. The researchers reported that Based on the subjects’ experiences, the handheld computer and laptop had better ergonomic characteristics than the communicator. It was concluded that subjects felt the highest amounts of stress in their neck while working on the laptop, felt stress on their backs while working on the communicator, and they felt stress in their eyes while working on the handheld computer. It was however observed that the Subjects
performed the typing tasks best using the laptop. The researchers suggested that companies developing mobile devices should consider ergonomic issues and the ergonomic differences between different types of mobile devices to further improve user satisfaction.

Pearson in a white paper supervised by Davis, Strain-Seymour and Gay (2013) conducted a study titled Testing on Tablets: A Usability Study Report on the Use of Tablets for K-12 Assessment Programs. The study involved 63 students and conducted for a period of three weeks across 16 school locations in four states of Maryland, Virginia, Florida, and Texas. The Researchers used a “think-aloud” protocol (concurrent verbalization) which allowed students to narrate their experiences as they moved through the test questions on the tablets. The main goals of the study include to:

1. Observe student interactions with tools, navigation, and question components on the tablets and identify specific areas where the interactions on tablets could present challenges

2. Understand the ergonomics of short-term tablets usage in order to identify any areas of concern around fatigue or strain

3. Observe the impact of differing screen sizes and device features across a limited range, using two different devices.

They reported that tablets frequency of use and use in an academic setting by the students was more variable. While some interactions generated frustration,
students were generally able to navigate within the testing software and interact with questions in a fluid manner. Most students were able to accomplish the test tasks even if they were not familiar with the specific testing software.

In another study titled Improving the Usability of E-Book Readers, Siegenthaler, Wurtz and Groner (2010) investigated two requirements of e-reader design. Ten participants, 5 male and 5 female were involved in the study. They tested five electronic reading devices (IREx Iliad, Sony PRS-505, BeBook, Ectaco jetBook® and Bookeen Cybook Gen) and one classic paper book combining eye tracking with usability testing methods. It was reported that e-reader with e-ink technology provided more legibility compare to classic books; all participants reported normal or corrected to normal vision and had no previous experience with e-readers. Also, there was a significant difference between the different brands of e-book readers. However, the researchers cautioned that the current e-reader generation has large deficit with respect to usability.

Schmid and Bergamin (2012) conducted a research titled, The Effects of Touch Screen Technology on the Usability of E-reading Devices. 12 university students were involved in the experiment with their mean age reported as 20-26. Three different types of devices were compared: two e-readers with e-ink display (the Sony PRS 600 with a touch screen and the Sony PRS 505 without a touch screen) and one tablets PC with a backlit LCD (Apple iPad with a multi-touch screen). Participants completed different use case scenarios for each device and then completed a questionnaire that asked them to rate the usability of the navigation, design, handiness, and handling of
each device. The results show that e-reading devices with touch screens correlate with better navigation ratings. Participants rated the navigation significantly better for the devices with a touch screen compared to a device without a touch screen. Overall results suggest that a touch screen allows for an easier and more intuitive interaction. Nonetheless, participants were not able to solve all tasks without problems, and significant differences were found between the devices. The researchers concluded that the devices evaluated needed to be improved upon in regards to usability aspects.

Bernérus and Zhag (2010) conducted a Literature review of usability evaluation of e-learning System titled A Peek at the Position of Pedagogical Aspects in Usability Evaluation of E-learning System from 2000-2010. He submitted that many studies have been made on usability evaluation methods in many specific areas, however not so much in E-Learning systems. The paper compared all of the studies reviewed to see how the “pedagogical aspects” or criteria has been treated when performing such evaluations, as well as present a summary of all the usability evaluation methods (UEMs) that have been used in the studies. York method was used for their literature review. In total 27 papers were analysed with a focus on four important pedagogical usability factors namely, learning content design, assessment, motivation to learn and learning/authoring supportive tools. It was however discovered that one third of the studies are not fully aware of the importance of pedagogical aspects in usability, in conclusion, usability evaluators were urged to be aware of the pedagogy usability when performing usability evaluation in the future.
Information and Communication Technology and Education

Information and communication technology (ICT) has become a key instrument to the developmental strive of most countries in these modern era to the extent that countries have to make necessary adjustments to cope in this present knowledge economy (Yusuf, 2005).

Education has been identified as a vital tool for any form of development, be it economic, social or political. It is a factor that determines the state of prosperity, sustenance of welfare and security of the people (Osakwe, 2012). Supporting this argument, Yusuf (2007) affirmed that “No nation can rise above the quality of its education”. Therefore, as canvassed by Rodecker and Oyestein (2013) that for any nation to truly boast of educational development, it should be able to boast of viable and functional Information and communication technology driven education at all levels including the secondary schools.

There is a growing argument in support of ICT in teaching and learning situations and as expressed by Biagi and Loi (2013) this support, is traceable to the recent improvements in technology such as the Tablet. This improvement they said are leading many observers to emphasize the need to invest in new technologies that will improve learning experiences for the younger generation.

Information and communication technology may be viewed in different ways which explains it definitions from different perspectives (Obakhume, 2011; Womboh, 2008; Osakwe, 2012).
As explained by Elisha (2006), everyone agrees that ICT is an acronym for Information and Communication Technology but beyond the acronym, “there is not a universally accepted definition of ICT”. This as he explained is because; the concepts, methods and applications involved in ICT are constantly evolving almost every day. He noted further that it is difficult to keep up with the changes as they happen with fast paces.

Bakhshi (2013) described ICT as basically an umbrella term that encompasses all communication technologies such as internet, wireless networks, cell phones, satellite communications, digital television etc. that provide access to information.

Womboh (2008) submitted that, Information and Communication Technology (ICT) is a composite term which embodies three important concepts; Information, Communication and Technology. These concepts he noted must be properly explained to understand the concept of ICT. He described information as processed data which aids decision making and as a commodity which could be sold and bought, while communication is seen as the transfer or exchange of information, ideas, thoughts and messages from a sender to a receiver involving a code and or language that is understood by both the sender and the receiver. Also, he sees Technology as the use of scientific knowledge to invent tools that assist human beings in their efforts to overcome environmental hazards and impediments to comfort which in this regard refers to things like the computer, telephone, cell phone, GSM handsets, television, radio, etc.
To Oye, Shallsuku and Lahad (2012), the term, information and communication technologies (ICT), refers to forms of technology that are used to transmit, store, create, share or exchange information. This definition of ICT the researchers argued includes such technologies as: radio, television, video, DVD, telephone (both fixed line and mobile phones), satellite systems, computer and network hardware and software; as well as the equipment and services associated with these technologies, such as videoconferencing and electronic.

ICT has affected almost every sphere of our lives including education. Specifically, researches have proved globally that ICT can improve quality of research, leads to improved students’ learning and better teaching methods. It has been proved that an increase in student exposure to educational ICT through curriculum integration has a significant and positive impact on student achievement, especially in terms of "Knowledge Comprehension", "Practical skill" and "Presentation skill" in subject areas such as mathematics, science, and social study (Oye, Shallsuku, & Lahad, 2012; Obakhume, 2011).

Onasanya (2009) in Ayelaagbe (2013) categorised the benefits of ICT in instructional situations into two; those that are predominantly targeted at reducing cost and those that increase effectiveness. He listed ICT benefits that have to do with cost reduction to include: reduction of training time; reduction in the need for the usage of expensive or possible dangerous operational equipment; reduction on reliance on trained instructors and provision of rapid updates of instructional materials.
On the benefits that increase effectiveness in instructional situations, the researcher highlighted that: ICT makes the provision of quality instructions available on a large scale; make available quality training in remote locations; allows individualized learning and instruction and provides hands-on performance oriented instruction.

Commenting on the benefits of ICT in education, Bakhshi (2013) noted that, ICT, if used creatively, can make a big difference in the way teachers teach and students learn and can help students acquire 21st century skills like digital literacy, innovative thinking, creativity, sound reasoning and effective communication. Furthermore, the researcher submitted that ICT can help in enhancing the quality of education through blended learning by supplementing the traditional talk and chalk method of teaching. For open and distance learning with the philosophy of “Anyone, Anywhere and Anytime”, Bakhshi (2013) noted that ICT- enabled education can do unimaginable wonders which may invariably leads to creation of virtual institution of learning in the long run.

Osakwe (2012) is of the opinion that the introduction of ICT and electronic information network signifies a new dawn for researchers, academics and secondary school students. He explained further that ICT brings the following benefits into the secondary schools

- ICT helps to promote fundamental changes in teaching and learning methods thereby helping to overcome the barriers of time and place as technology introduces
new choices and opportunities for students and teachers through endless research and learning on the internet.

- ICT provides secondary school students with practical and functional knowledge of the computer, the internet and other associated gadgets that will have positive effect on future experience and make them more competent, rational and comfortable in this era of globalization.

- ICT helps students to react intelligently to future changes, expand information and live successfully in a changing world.

- ICT, through its multimedia facet, creates room for students to acquire new knowledge, fosters enquiry and exploration of facets, and adopt new approaches to teaching and learning.

- This conventional system helps to accelerate the learning process, increase teachers efficiency and effectiveness and provides remedial instruction and enrichment of material, thus guaranteeing higher quality standards in secondary schools.

- ICT facilitates students’ acquisition of skills and potentials for active participation in teaching/learning process and it also helps to enrich the curriculum by replacing the existing face-to-face instruction.

Nwokeocha (2013) is of the opinion that when ICT is used by teachers in curriculum and instruction, the following benefits are accruable:
• It accelerates and deepens students' basic skills in any schools subject especially reading, mathematics and the sciences;

• It challenges students to learn, be independent and hence be responsible;

• Helps update students' academic knowledge and instructional practices;

• Prepares the individual learner to economically survive and become productive in tomorrow's world of work which depends on ICT;

• Teachers are provided with efficient and effective tools to take care of students' individual differences;

• There are opportunities for close co-operation with colleagues in the same or even other fields though networking and internet services;

• Educators are challenged to new methods of acquiring knowledge through knowledge sharing and be ultimately connected to the world; and

• Unrestricted access of teacher and students to relevant information and developments in subject areas. Other experts' peers and policy making institutions can also be readily contacted.

**Barriers to ICT in Education**

Goktas, Yildirim and Yildirim (2009) defined Barrier as, the gap between an initial and end state. In other words, barriers are challenges which have to be overcome in
order to attain a goal. Eze and Nwangbo (2013) defined ICT barriers as challenges which could affect the use of ICT tools in secondary schools.

Eze and Nwangbo (2013) listed ICT barriers to include problems of curriculum and pedagogy, material resources and capacity building, language content and finance, rural nature of most schools, power failure, and lack of instructional materials, inability of policy makers to do pilot testing, need assessment, teaching strategies and evaluation techniques of using these tools. They concluded that for the implementation of ICT tools in the teaching and learning in the country, the aforementioned problems must be tackled.

In the same vein, Edith (2013) while commenting on Barriers to Effective Utilization of ICT Facilities in Tertiary Education in Nigeria submitted that, the full potentials of ICT have not been fully tapped by the country and listed some of the barriers to ICT integration to include, Low level of technology education, Inadequate technical supportive staff, Poor power supply, Low quality service, Low level of funding; Lack of government policy.

Ishikaku and Nyenwe (2013) also commented on the challenges of ICT integration into the Nigeria educational system, they categorized the challenges into 2; infrastructural and human capacity building challenges. They argued that before any ICT based programme should be implemented, the following infrastructural challenges must be solved,
i. Availability of appropriate rooms and building: this they constitute a big challenge to the integration of ICT in Nigeria, it is their opinion that even if the required ICT facilities are provided, without the needed physical space, not much can be achieved.

ii. Availability of power. As stated by Edith (2013), power supply is still a big problem in Nigeria, until this is properly tackled, integration of ICT within the country will remain as low as it presently. The researchers however suggested that alternative power supply should be looked into address the problem in the short-run.

iii. Choosing from different ICT types: selecting appropriate ICT resources constitute another impediment to ICT usage in Nigeria, the researcher therefore advised that before selecting any ICT resources for educational use, factors such as appropriateness, cost-effectiveness and sustainability must be considered (Ishikaku & Nyenwe, 2013).

The second part of the challenges of ICT integration in the country as explained by Ishikaku and Nyenwe (2013) is the Challenges to human capital building. They argued that for proper and successful ICT integration, the needed personnel such as the teachers, educational administrators, content developers and trained technical personnel must be competent.

Aduwa-Ogiegbaen and Iyamu (2005) In a study titled Using Information and Communication Technology in Secondary Schools in Nigeria: Problems and Prospects It identified challenges such as high cost of computer hardware and software; weak infrastructure; cost, lack of human skills, lack of relevant software and limited access
to the Internet, knowledge in ICT, and lack of relevant software appropriate and culturally suitable to Nigeria as the major stumbling block of the adoption of ICT in secondary education in Nigeria.

**Cost:** the researchers say is of great impediment to the integration of ICT into the educational sector in Nigeria. They argued that the cost of purchasing ICT tools such as computer and other materials remain high for the schools to bear. High cost of internet connectivity is also to be a challenge to the schools.

**Weak infrastructure:** the weak nature of infrastructural facility such as power supply is seen to be formidable impediment to the country’s ICT penetration. They argued that since ICT products such as the computer are developed to function with resources like power, and with the current power condition in the country, the present poor integration of ICT will continue.

**Lack of skills:** Nigeria, the researchers agued, lack in adequate human resources to be able to integrate ICT in to the teaching and learning situations. They submitted that technicians who will be responsible for installation, maintenance and repair of the facility are short supply. Also, teachers who are majorly concerned at implementation stage are poorly trained to be able to used ICT effectively (Aduwa-Ogiegbaen & Iyamu, 2005).

Lack of relevant software: software ultimately is required for most computer applications and programmes to work, this software are in short supply in the country. Majority of those that are available are unsuitable for the Nigeria’s cultural
and educational environment. Therefore, to boost the current low integration of ICT into the country’s educational practices, Nigeria must as a matter of priority encourage more local software developers.

**Limited access to the Internet:** internet penetration is said to be low in Nigeria, with just 0.6% of the populace having access to computer technology, not many can be said to access the web. Even with the epileptic service they provide, the internet providers still charge higher fee therefore pricing out many of the few who may want to have internet services. Nigeria must as a matter of urgency find a way to improve internet services in the country (Aduwa-Ogiegbaen & Iyamu, 2005).

In a research involving Nigeria Colleges of Education, Nsofor, Ala and Gambaki (2012) explained that effective implementation of ICT facilities and their utilization for instructional delivery faces serious barriers in Colleges, they listed the barriers to include; Inadequate funding, Inadequacy of ICT infrastructure, Inadequate electric power supply, lack of training and negative attitude and interest.

They explained that the greatest of all the problems is inadequacy of funds from the governments (Federal and State.) explaining the institutions over reliance on ETF as a major source of funds for their respective projects. On facilities, they reported that ICT facilities are not available in the Colleges and where available, they are inadequate and that most of the time, the available facilities are obsolete. They however advise the government to take proactive steps to address the situation warning that it may be difficult to achieve substantial integration of ICT into the
Instructional situations in the college except the highlighted barriers including power supply, reorientation, training and retraining of personnel are removed.

Above authors have highlighted some of the challenges facing ICT integration into the teaching and learning situations in Nigeria, though, some of these challenges are peculiar to the country, except they are properly addressed, a great deal of instructional and administrative work in Nigerian secondary school will still be done manually. As asserted by Aduwa-Ogiegbaen and Iyamu (2005), Nigeria is on the wrong side of the international digital divide already, as it has not made significant effort to integrate ICT into secondary school curriculum. To reverse the trend therefore requires a deliberate effort at addressing all the challenges as highlighted.

Internationally, the integration of ICT into the teaching and learning is not smooth-sailing, it also faces some barriers.

In a recent study carried out by Kipsoi, Chang’ach and Sang (2012) in Kenya titled Challenges Facing Adoption of Information and Communication Technology (ICT) In Educational Management in Schools in Kenya, reported that Africa as a region is lagging behind in adoption, use and innovation in the ICT sectors and that its people are missing out on a better education and well managed education systems and entities. This situation is however attributed to slow rate of adoption of technology despite its promise and potential for use in educational management in schools.
Kipsoi, Chang'ach and Sang (2012) identified the key barriers to using ICT in education as follows:

- Lack of access to appropriate ICT equipment
- Lack of time for training, exploration and preparation
- Lack of models of good practice in ICT
- Negative attitudes towards ICTs in education
- Computer anxiety and a lack of confidence
- Fear of change and a lack of personal change management skills
- Unreliable equipment
- Lack of technical, administrative and institutional support.

In the report, it further classified the barriers into the four factors namely a) resource-related factors b) factors associated with training, skills, knowledge and computer experience c) attitudinal and personality factors, and d) institutional and cultural factors.

In another instance, Kipsoi et al. (2012) through an extensive review of literature categorized the barriers in to school level or first order barriers which are those relating to the institutions and the manager-level or second barriers which are those relating to the individual.
Managerial-Level Barriers

(a) Lack of time, (b) Lack of self-confidence in using ICT (c) Negative experiences with ICT in the past, (d) Fear of embarrassment in front of pupils and colleagues, loss of status and an effective degrading of professional skills (e) Lack of the knowledge necessary to enable managers to resolve technical problems when they occur (f) Lack of personal change management skills (g) Lack of motivation to change long-standing pedagogical practices (h) Perception of ICTs as complicated and difficult to use

School-Level Barriers

(a) Lack of ICT equipment and the cost of acquiring, using and maintaining ICT resources (b) Obsolescence of software and hardware (c) Unreliability of equipment (d) Lack of technical support (e) Lack of administrative support (f) Lack of institutional support through leadership, planning and the involvement of teachers as well as managers in implementing change.

Khan, Hasan and Clement (2012) while contributing to the barriers against the integration of ICT in Africa submitted that the fact that many of the developing countries are not reaping the benefits offered by ICT in education is due to certain barriers, they went further to give the barriers as first order barriers which include lack of equipment, unreliability of equipment, lack of technical support and other resource-related issues and Second-order barriers which also include both school level factors, such as organizational culture and teacher level factors, such as beliefs
about teaching and technology and openness to change. In their discussion of the barriers, they highlighted barriers such as: ICT Supported Infrastructure and Lack of resources, Insufficient Funds, Government vision and plan School Vision and plan, Political Factors, Corruption Social and Cultural Factors (Gender, language, skills etc) Teachers' Attitudes and Beliefs about ICT, Lack of Knowledge and Skill, Lack of Time.

**Lack of time:** in their study, they reported lack of time as one of the biggest constraints to the integration of ICT into the teaching-learning situation. Teachers they said need time to learn how to use the hardware and software, time to plan, and time to collaborate with other teachers. Teachers also need time to develop and incorporate technology into their curriculum.

**Lack of knowledge and skill:** Teachers’ lack of knowledge and skills is one of the main hindrances to the use of ICT in education both for the developed and underdeveloped countries, Integrating technology in the curriculum the researchers agreed requires knowledge of the subject area, an understanding of how students learn and some level of technical expertise.

**Teachers' Attitudes and Beliefs about ICT:** if teachers want to successfully use technology in their classes, they need to possess positive attitudes to the use of technology. Such attitudes are developed when teachers are sufficiently comfortable with technology and are knowledgeable about its use.

**ICT Supported Infrastructure and Lack of Resources:** The development of the ICT infrastructure in a country is dependent on the availability of a reliable
electricity supply. Implementing ICT demands other resources, such as computers, printers, multimedia projectors, scanners etc. Without adequate infrastructural facilities, not much of ICT integration can be achieved at all levels.

**Political Factors:** This remains most notable of the barriers according to the researchers, the use of ICT in education in developing countries seems to be the political will of the people in the corridors of power. The allocation of sufficient funds for the educational sector and ICT does not seem to be very attractive to the leaders, hence the low level of support across the countries.

**Concept of Mobile learning and Education**

For a close observer, it feels like new technological devices are introduced to us almost every day. New websites, computer and mobile applications and breakthrough devices are developed at an incredible rate. It seems impossible to keep up with the details of all this progress, but the general trend, at least, is undeniable. Technology is going mobile. Already our lives are surrounded and influenced by mobile device such as MP3, MP4 players, portable computers and smarter phones, and with each passing day, the devices are getting thinner, faster, cheaper, and their interfaces are getting simpler and more intuitive (Gorichanaz, 2011; Goodwin, 2012). These newer technologies are getting embraced into the
educational arena now more than any other times and the resultant effect is the birth of mobile learning an off-shoot of e-learning (Ali, 2013).

Mobile learning is a dynamic concept; it is a kind of learning in which learners use mobile devices with digital content inside, to learn anytime, anywhere and in any situation (Ali, 2013). Mobile learning in this context means that the learners carries with him/herself the learning content in digital form everywhere he/ she goes. He has the liberty to stay in any place, anywhere and anytime and in any comfortable conditions to access the learning content when he/ she so desire. This freedom is also important to the learners and teachers alike as learning can be said to no longer restricted to the four-wall of the classroom. The mobile learning also comes with it, constructivist learning philosophy characteristics. The learners can learn on their own without waiting for a particular interaction period with a physical teacher.

According to Wikipedia, an online Encyclopedia (2013), mobile learning is 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. M-learning technologies include handheld computers, MP3 players, netbooks, mobile phones and tablets. M-learning focuses on the mobility of the learners, interacting with mobile technologies, and learning that reflects a focus on how society and its institutions can accommodate and support increasingly mobile population. Another direction in m-learning that give instructors more mobility includes creation of on the spot and in the field learning
materials that predominantly uses smartphones with special software such as AHG Cloud note (Wikipedia).

Describing M-learning, UNESCO (2013) sees it as a modern way to support learning process through mobile learning devices such as handheld and tablets computers, MP3 players, smart phones and mobile phones. It represents a unique attribute compared to conventional e-learning: personal, portable, collaborative, interactive, contextual and situated, according to UNESCO (2013) M-learning emphasizes “just-in-time” learning instruction and can be delivered anywhere and at any time through it. Moreover, it is an aid to formal and informal learning and thus holds enormous potentials to transform the delivery of education and training.

As a dynamic concepts, the debates about how to define mobile learning will rages on (M-learning.org, 2013) and the difficulty in reaching a consensus among experts has been largely due to the rapid evolution of this as a field, and partially because mobile learning work best when it is a part of something else. Nevertheless, M-learning.org (2013) defined m-learning as any activity that allows individual to more productive when consuming, interacting with, or creating information, mediated through a compact digital portable device that the individual carries on a regular basis, has reliable connectivity, and fits in the pockets or purse.

Putting above definitions together, Mobile learning can be seen to be any "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" (Ali, 2013). Mobile learning, through the use of wireless mobile technologies, allows anyone to obtain learning content from anywhere and at any time. There is no time or location restriction anymore; learners have the ability to learn whenever and wherever they want (Ozdamli & Cavus, 2011).

Maria and Daniela (2010) while commenting on the use of mobile technology in education submitted that, the advent of wireless technological tools such as mobile phones, Bluetooth, smartphones brought about its application for educational purposes. Mobile technology such as mobile and smartphones are used to access data from the Global Positioning System (GPS), short messages are sent through mobile phones, Bluetooth are used to transfer learning materials from one object to the other. Students are free to move and learn at the same time.

Learners who embrace m-learning do not have to learn what is initially introduced to them only, they have the ability to use wireless mobile technologies for formal and informal learning where they can access additional and personalized learning content from the Internet and choose whatever they want to learn about. On the other hand, workers on the job can use mobile technology to access training materials and information when they need it for just-in-time training, which encourages high level of learning since they access the learning content right away. In fact, educators and trainers are further empowered since they can use the mobile technology to communicate with people from anywhere and at any time. Meanwhile,
educators and trainers can also access learning resources from anytime and anywhere to plan and deliver their lessons (Ali, 2013).

With all the advantages mobile technologies have brought to education, Maria & Daniela (2010) however cautioned that, they cannot be used for teaching and learning of all courses in the mobile learning environment. They argued that they are most suitable for short courses where communications takes place through Short Messages Services (SMS), Multimedia Messaging Services (MMS)

Mobile learning has certain elements that must be properly arranged and interact in an efficient way so that successful outcome can be achieved. According to Ozdamlia and Cavus (2011) these elements include; Learners, teacher, environment, content and assessment. These elements must be well arranged and interact to form a whole for the purpose of achieving the m-learning goals, absence of anyone of them may jeopardize the learning objectives.

Learner: Learners are at the centre in all teaching and learning activities according to new educational approaches. All the other elements serve the learner. Mobile learning builds on the learner’s interest, experiences and needs. As claimed by Ozdamlia and Cavus (2011) that, as mobile learning concept implies the pedagogical approach places the learner at the centre of the learning process. The learner plays an active role from the conception of the teaching –learning goals to the point of evaluation. He further listed the learner’s roles to include:

- Access information when he needs
• Responsible for own learning

• Learning with his learning speed

• Discover and use his learning styles

• Create and share new information or product

• Study with peers collaboratively

• Evaluate himself and other group members

Teacher: not long ago, books and other media elements are used to store information and convey same to students in traditional learning environments. But today with emergence of new technologies, information, supports are more accessible to students through mobile devices. This situation created a new dimension opposed to traditional teacher’s role about information search and use. The role of the teacher as variously changed from being the expert in pre-technology era through to a presenter of facts then to a moderator of opposing views with the advent of web 2.0 and now to a consultant in the mobile technology era. The teacher has to identify the learner’s interest, relate the student’s interest to the learning goals and offer opportunities to reach these goals that are related to the specific conditions a learner is in (Ozdamlia & Cavus, 2011). The teacher’s role in mobile technology era includes:

• Qualified to use required mobile tools and technologies
• Determine the strength and weaknesses of used methods and study to resolve the weaknesses with different methods

• Facilitator

• Advisory increase motivation of learners

• Arrange activities to support interactive interactions between collaborative groups

• Arrange activities for evaluation of process

Content: These are materials expected to be learnt by students. What to be learnt should be determined by the stakeholders; the learners, teachers, parents etc otherwise the learning goals might be unachievable. The contents must be that which will enable user to zone into the needed information whenever he desires. It must be engaging and allows greater students interactivity.

Environment: This is where students come in contact with the learning materials; it must be properly designed for positive learning experiences to be achieved. It is important for students who mainly access their learning materials to have all the needed materials including the learning outcomes, assignment requirements and relevant resources. Also, students attending the face to face class may source for learning contents online with mobile technologies in addition to the once received from the classroom.
Assessment: This element is equally important in mobile learning, in that it can access and report performances of learners to the instructor as at when due. This can be done through database log, software packages, online exams, chat room, discussion board, online quizzes, or project evaluation. Students can also do a self-evaluation (Ozdamlia & Cavus, 2011).

In this same vein Ali (2013), asserted that there are three important pillars which need to be put into consideration when dealing with m-learning systems. According to Ali (2013) these pillars are: The learner’s style, the mobile applications and the learning content. Each pillars of the m-learning system environment depends on, or is influences by the other pillars.

**Learning Style**

Ali (2013) described learning style as "a term that refers to an individual's characteristics and consistent approach to perceiving, organizing and processing information." Every individual has his or her own learning style, and in order to understand these styles the learning process itself must be understood. Learning in its natural, structured manner involves a two-step process: reception and processing of information. In the first step, external information, which is observable through the senses, and internal information will become available to the learners. The second step, processing of information, is based on the availability of learning material. Learners will choose and utilize learning material that they are able to process and skip the rest of it.
Learning Content

Learning content is the type of information that has to be delivered to the learners for them to obtain knowledge. This knowledge could be gained by reading or surveying the content. In order for the learners to obtain knowledge the learning content should be new, and not to have been introduced before. Typically, there is a strong relationship between learning style, learning content, and mobile applications any mismatch between these three important factors will lead to lack of motivation to utilize m-learning which will, in turn, cause some usability issues.; for instance, lack of learnability or understandability. As a result, learning content in itself should be prepared in different versions or formats; that way the learner is free to choose which version of the learning content he/she prefers.

Mobile Applications

As explained by Ali (2013), Mobile devices have more varied capabilities than desktop machines. This therefore forces software developers to structure learning content in a way that will be compatible and work in different kinds of devices. As explained, not all the learners prefer to use the same types of devices. In fact, some learners prefer to use laptops or smartphones, and others prefer PDA. Software developers can use the Extensible Markup Language (XML) to provide learners with the same content that will work across a range of platforms. The learning content, in this case, can be dynamically transferred to different mobile devices.
Characteristics of Mobile Learning

There are many characteristics of mobile leaning and they include ubiquitous, portability and mobility, blended, privacy, and interactive, collaborative and instant information, wireless networking, ability to have access to variety of materials from anywhere at any time, spontaneity and flexibility (Al-Ahmadi, 2013; Goodwin, 2012; Ozdamlia & Cavus, 2011).

Collaborative: mobile learning enhances learner-learner, learners-teacher and teacher-teacher collaborations for effective teaching and learning scenarios.

**Portability and mobility:** mobile learning tools are small and portable and they can be used to access learning resources anytime and anywhere.

**Privacy:** when students learn on mobile learning platform, they do that independent of their peers. They can access, download, upload and write or participate in an exam independently.

**Interactive:** In mobile learning, students are not passive; they are involved in the learning process at various levels. According to Al-Ahmadi (2013), interactivity of mobile learning can be in three aspects:

**The educational cognitive environment:** Here mobile learning provides an enhanced educational environment in which distant learners can interact with themselves, their instructors, learning materials, physical and virtual environments.
Learners: Mobile learning allows learners to direct the process of learning; they are actively engage in the learning processes by creating and sourcing for learning materials themselves.

Skillful aspect: The use of latest applications such as voice and video communication, text messaging promotes interactivity and students’ technological skills.

Instant information: mobile learning must imply instant information; it is a platform for instant response. When learner seeks immediate information, he/she gets it.

Blended: the teacher can combine this approach with blended learning model thereby affording the learners more opportunity for interactions. The combination of m-learning with other approaches is something that has been agreed to be commendable (m-learning.org, 2013).

Advantages of Mobile Devices in Education

A mobile device is a small, handheld computing device, typically having screen with touch input and /or a miniature keyboard and weighting than 2 pounds (Wikipedia, 2013). Mobile device is any type of computer device that has the capability to connect to the Internet without a permanent cable connection. There are many types of mobile devices e.g, Cell phones, Smartphones, Laptops, PDAs, notebooks and net-books, Tablets MP3 player etc.
The impact of these devices is becoming increasingly distinguished in our daily lives. Many researchers are experimenting with the use of these devices for different learning and teaching purposes (Ali, 2013). The use of mobile technologies offers more opportunities for new types of learning, because they change the nature of the physical relations between instructors, students, and the objects of learning. They are a great way to ensure mobility and ubiquity in learning without technical limitations, time, and place restrictions.

Goodwin (2012) identified Mobile devices as an emerging technology likely to have a large impact on teaching and learning. Mobile devices, especially smartphones and tablets, they argued enable ubiquitous access to information, social networks, tools for learning and productivity. It has been proposed that mobile devices offer an affordable and advanced solution to foster collaboration, engagement and personalization of the learning environment (Goodwin, 2012).

One of the chief affordances of mobile learning device is that it enables learning anywhere, anytime, allowing learning to be shifted away from the industrial era model where the classroom is the central place of learning, driven by the teacher and limited to instruction within the school day. With mobile devices, the teacher is no longer at the centre of the learning process and the instructional time transcends the school day. Today, children are conditioned to expect that their technological experiences; accessing online communities, collaborating, creating content, sharing ideas and learning new things are available 24 hours per day (Goodwin, 2012).
With devices such as Mobile phones, tablets and other mobile devices learners now have greater access to a much more broad and flexible learning materials than they would otherwise have in the traditional classroom settings. The amount of contents available and accessible to learners, the immediacy and latest are part of the advantages mobile learning offered in education (Fetaji, Ebibi & Fetaji, 2011).

According to Falloon (2010), unlike more traditional desktop technologies, mobile technologies is “woven into all times and places of students’ lives”. In many ways mobile technologies have the capacity to stimulate a redefinition of what constitutes a learning ‘space’, away from the constraints of fixed place and time, towards a conceptualization based on connecting people with each other and information, through virtual collaborative spaces and communities which are highly fluid, and not bounded by time or location.

The ability to learn within one’s own context when on the move in time and space is arguably the central learning affordance of mobile technologies.

Mobile devices allow teachers to customise and personalise student learning experiences with appropriate content and resources that are congruent with their preferred learning styles. Goodwin (2012) reported that today’s students revealed common characteristics in their use of technology in out-of-school contexts. These he said include self-motivation, student ownership, purposeful learning and peer-to-peer learning.
Gorichanan (2011) while commenting on the advantages of mobile learning in education submitted that mobile devices offer five distinct affordances for education:

1. **Portability:** Mobile devices offer portability in such a way as to change the pattern of learning or work activity.

2. **Affordable and ubiquitous access:** Mobile devices (e.g. the 4.5 billion cellphones worldwide) put web access and ‘high-spec’ functionality in the hands of more users than any other digital technology.

3. **Situated, ‘just-in-time’ learning opportunities:** There is a social expectation that we can engage and process information whenever and wherever we want, and the development of cloud-based computing supports the way in which mobile devices can decentralise our learning experiences (Fetaji et al. 2011).

4. **Connection and convergence:** M-learning is often concerned with enabling social interactivity and connectivity. Mobile devices connect us to other people, other devices, other networks, and other technologies.

5. **Individualised and personalised experiences:** Mobile devices offer individuality, unique scaffolding that can be customised to the individual’s path of investigation. iPhones, iPads and iTouchs offer an array of applications (‘apps’) that can be easily commissioned for local use and can be selected to meet the learning topics and themes that an individual requires.
Fetaji et al. (2011) explained that using mobile devices offers individual user, private and learning at own pace and learning within specific contexts which provides reliable, cultural and environmental indications for understanding the uses of information which may enhance encoding and recall. Accordingly, they highlighted that mobile learning as valued by students’ employment of the devices include that it:

- facilitates individual, co-operative and interactive work in class
- enables the sharing of ideas and responses and the building of knowledge
- increases participation in whole-class settings
- enables learners to revisit areas for consolidation and reflection out of the classroom – this helps to increase understanding
- provides opportunities for autonomy and independence
- provides work and resources in one place, and to hand
- gives the ability to transfer work between digital devices and to and from other areas such as shared drives and learning platforms,
- Alleviates pressure on the computer rooms and makes learning more flexible.

**Drawbacks for Mobile Devices in Education**

The potential application of mobile devices as learning devices is tremendous. It affords the students to learn on these devices whenever and wherever they want.
Affordable applications are being developed on a daily basis and are available at a low cost. Students learn how to use them at a very young age and they understand how it can help them collaborate, take notes, read electronic books, search the WEB, play games and numerous other activities. New cellular networks have become faster and faster; thus allowing the mobile device designers and developers to use embedded sensors, cameras, and GPS to bring new educational apps to life: faster videos, improved animations, interactive and collaborate games, adaptive and augmented learning capabilities (Moore, Utschig, Haas, Klein, Yoder, Zhang & Hayes (2008).

However, there are some challenges that must be addressed before mobile devices will be fully accepted by all as the primary learning tool for students.

Size is definitely a consideration: because the mobile devices come with smaller screens, the fear is students will be hunched over the small screens to make maximum use of them, this may pose a great challenge to a prolong usage.

Data storage can become a limiting factor: most of these devices come with limited internal storage facilities; however, with the advent of the cloud computing, this problem may go away. One other drawback is the rate at which cell smart phones become quickly outdated as soon as they are released and students are forced to keep up with the constant changes. Existing applications may not perform well or work at all if not upgraded.
Another drawback is the amount of time spent by students in texting, chatting, socializing through Facebook or other social sites, game playing, and tweeting, rather than focusing on using the devices for learning purposes (Moore, et al. 2008; Gorichanaz, 2011).

To effectively use these mobile devices in education, teachers and students must possess the necessary skills, without the user being proficient; the expected objectives will be elusive (Nsofor, Ala & Gambaki, 2012).

The Evolution and Impact of Tablets in Education

Since the iPad was released in April 2010, many other slender touch-friendly tablets have increasingly become part of our daily activities (Riyaz, 2011). It was reported that as at 2012, Twenty-two percent of all U.S. adults are owners’ of tablets. The tablets as we now have it today has been an evolving idea since the 1960 and it was not released for public use until the ‘80s (O’neill, 2012).

The tablets as described by Henrik and Martin (2012) are a portable version of a personal computer and a companion to the smartphone in the sense that at most times they share operating system and input method. There is also a consensus amongst many that a tablets is a synergy of the latter and the former (Hursh, n.d.), mostly because of how it is identified as a device that does same tasks as their personal computers and mobile phones. The tablet’s primary input method is the touchscreen which made the user’s fingers to function as mouse cursors; this
removed the need for physical accessories like the keyboard or the mouse. The tablets come in various sizes larger than the smart phone but smaller than the laptop computer. It runs on various operating systems and can connect to the internet wirelessly.

While tracing the evolution of the tablet, Holleran (2013) noted that the device has been around for decades, stating that the first patent attributed to the development of the tablets computing was issued in 1888 to Elisha Gray, who developed an electrical stylus device that would capture handwriting. In 1915 and 1942, other inventions that recognized handwritten characters based on handwriting motion were patented in the US. These three inventions are considered the basic technologies that planted the seeds of what would become a full-fledged industry more than a century later (eCycleBest, 2013).

However, the first demonstration of tablets using a handwriting text recognition device to input data rather than a keyboard didn’t occur until 1956. By 1980s and 1990s, the tablets computers emerged as a viable platform, although it was the personal computer that dominated the consumer and business market, tablets computers were still available, but they were only used in a small niche of the enterprise market (Riyaz, 2011; Holleran, 2013).

In the early ’90s, few companies started building tablets that would allow for pen-based or finger-based input for data entry. Because these early tablets did not require keyboards, they were perfect for mobile workers who were also technology
novices. These early users as noted by Holleran (2013), were mainly utility workers, first responders (e.g. policemen and firemen), workers in warehouses (where tablets could be mounted onto forklifts) and other workers who were in situations where a standard personal computer simply could not stand up to tough environmental conditions.

The built tablets needed to withstand all sorts of tough environmental conditions such as extreme temperatures, drops and a variety of issues that were not normal conditions for a standard PC or notebook computer. These users’ characteristics resulted in the development of the rugged tablets PCs of that time and as the industry continues to grow and today's workforce becomes more mobile, the need for a product that will withstand real world conditions becomes more necessary. Software developers only are beginning to react to the tablets' popularity with increased development of programs that can run industry-critical and well-defined applications.

While rugged tablets started to make inroads into a variety of industries, and the companies behind these tablets continued to make them more and more rugged, the advent of consumer tablets began with Bill Gates and his introduction of the Microsoft Tablets PC in 2000. Gates, with much fanfare, introduced his Microsoft Tablets PC running a specifically tablets-enhanced version of Microsoft Windows operating system. At the time, Gates believed the tablets computer would revolutionize computing. These tablets were developed to address business needs, and in working with companies like Xplore Technologies, they also began to build
more rugged tablets for field work. Unfortunately, the initial units simply were not consumer-friendly; they were heavy, cumbersome and the software was inadequate to make them viable alternatives to traditional PCs or notebook computers (Holleran, 2013).

While the rugged tablets market remained stable with relatively flat growth, the consumer tablets market was pretty much dead until the launch of the iPad in 2010. The iPad's sleek design, coupled with the thousands of applications that could be run on it, made tablets the hot phenomenon they are today.

Corroborating the above account on the sleekness of the tablets design, eCycleBest (2013) commented that typing words on current tablets models can be done with the use of a virtual keyboard. The tablets PC market it explained began to experience full development with the device’s mass production in 2010, and the industry has largely been dominated by Apple’s iPad which runs on the iOS operating system. Other major players in the industry include Samsung, Amazon, Microsoft, Google, HTC, RIM, Motorola, Sony, HP, Toshiba, and Asus. These tablets use Google’s Android, Microsoft’s Windows, or RIM’s QNX as their operating systems. The tablets platform’s inherent portability, doubled with increased computing power and battery life, gives it a huge potential to replace desktop PCs and laptop computers for both personal and business use.

The evolution of tablets PCs has become dependent on a number of factors, particularly consumer preferences. For example, a certain segment of the market
wanted a tablets and smartphone in one device. In answer to this, manufacturers came up with the hybrid called the phablet of which Samsung’s Galaxy Note is an example. On the other hand, there are also tablets hybrids that can be used as tablets or converted to a laptop when docked on a base like the Asus Transformer. Changes in other tablets’ design involve the conversion of the tablets protective cover into a laptop when opened. The percentage of Internet users worldwide that use tablets for mobile consumption of online content such as videos, news, blogs, and even online games continues to increase, which means the demand for tablets PCs will continue to be on the rise. Thus, aside from market trends, the resulting future evolution of the tablets PC will likely be a result of emerging technologies and design innovations from tablets manufacturers (eCycleBest, 2013).

Presenting a brief history of the tablets computer, eCycleBest (2013) explained that the evolution period can be divided into five periods namely; Pre-1950 tagged as the Root which saw Elisha Gray developing an electrical stylus device that would capture handwriting. This period also saw two other patents granted in US in year 1915 and 1953 respectively.

**1950s to 1980s:** In this period, it was reported that the Dynabook which was developed by Alan Kay was envisioned as an educational device for children. Today, this Dynabook is believed to be the blueprint for many mobile computing devices such as the tablets and laptop. The Dynabook prototype weighs approximately two pounds and had an integrated touchscreen keyboard with virtually unlimited power supply. Other devices developed during this period as presented by eCycleBest(
2013) include the Penpad by the Pencept Inc, the GRiDPaD of the 1989 which was described as the “first commercially available portable tablets PC”. The GRiDPaD had a backlit 10-inch grayscale screen that accepted stylus input, a fax/modem card, an internal floppy drive, a three-hour battery life and it ran on MS-DOS.

In the 1990s tagged as the Rise of the PDAs, this decade did not directly influence the development of tablets PCs, but instead saw the growth of its smaller cousin, the PDA. Some of the PDAs developed during this period include: AT&T’s PDA device launched 1993; it was capable of sending fax and email and was marketed to business executives with a free AT&T subscription. Also Apple with her Newton MessagePad (referred to as PDA) in 1993 which was originally designed to be as large as the GRiDPad but when it was launched, it featured a 336 x 240 display, 640K of RAM, an ARM 610 processor, and handwriting recognition software. During this period, Microsoft also came up with its own OS for PDAs, the Pen Extensions for Windows 3.1 and launched it as Windows for Pen Computing with features such as on-screen keyboard and a programme compatible with stylus input.

This era also witnessed the deployment of the Palm Pilot line of PDAs which boasted of many features such as a glass touch screen, expandable memory, enough space for hundreds of names and addresses, calendar scheduling, longer battery life, and the ability to sync with a desktop. The success of this device was however cut short by the advent of the smartphones such as the blackberry which offered both functions of a PDA and a phone.
2000s – Birth of the modern tablets: In 2001, Bill Gates announced the launch of the Windows XP Tablets Edition, this promised all the features and functions found in Windows to be available on a touchscreen interface compared to the OS used by PDAs. Hardware manufacturers such as Acer, Toshiba, and Hewlett-Packard collaborated with Microsoft and produced tablets PCs that ran with these tablets OS. However, these tablets did not get the consumer response that Microsoft anticipated. Despite looking like modern tablets, these devices were too heavy and too difficult to use, making them far from strong alternatives to PCs or laptops. In 2003, despite Apple’s involvement in the development of multi-touch technology, it did not immediately make its way into the tablets market. Instead, the company used the technology it developed for its smartphone, the iPhone and eventually its enhanced music player, the iPod Touch. Apple fans who wished to have an “Apple tablets” had to have their MacBook undergo conversion with the converted device called the “Modbook.”

2010 – The Tablets PC as We Know It: In 2010 Apple launched the iPad which ran on iOS and had a 9.7-inch screen. It was equipped with a 1GHz A4 processor, and had a battery life of 10 hours with the users given the choice among 16, 32, and 64 GB models for storage capacity and Wi-Fi or 3G for connectivity. iPad users also had access to an application library/store with thousands of apps to choose from. Also launched in 2010 were the Slate 500 from HP, the QuadPad 3G Plus from Quaduro Systems, and the Galaxy Tab from Samsung. The succeeding years saw more devices such Motorola’s Xoom, HP’s TouchPad, RIM’s BlackBerry
Playbook, Amazon’s Kindle Fire, and Barnes & Noble’s Nook Tablets, Google’s Nexus and Microsoft’s Surface tablets developed.

In the same vein, Evans (2011) traced the 10 most memorable milestones in tablet history from 1968 to 2011:

1. **The Dynabook (1968):** which was envisaged a portable device that would give children easy access to digital media. It was a name perfect for a new and dynamic device that would act as a paper and pencil, artist’s easel, typewriter and musical instrument.

2. **GRiDPad (1989):** This was a hefty-looking pad built by the GRiD Systems Corporation, the tablet PC ran MS-DOS, supported stylus input on a 10-inch monochrome screen and had about 3 hours of battery life. This tablet in particular was tagged as a creative breakthrough in laptop computer design. It was followed by series of other tablets such as Momenta Pentop (1991), the Compaq Concerto (1992) and the AT&T EO PC (1993).

3. **Tandy Zoomer (1992):** The failure of the GRiDPad spurred Jeff Hawkins, a GRiDPad engineer, to consider taking the tablet and shrinking it down to a more portable size. Together with Tandy and Casio, Hawkins produced the Zooner, a touchscreen device through Palm computing which he earlier founded.

4. **Apple Newton MessagePad (1993):** This device was referred to as phrase Personal Digital Assistant (PDA) by John Sculley, the CEO of Apple in the early
nineties. It features an ARM 610 processor ambling along at 20MHz, 640K of RAM and a 336 x 240 display

5. **Microsoft Tablet PC (2000):** The tablet announced by Bill Gates and the prototype released was not much of a success. It was described as being weighty (Holleran, 2013) and running on windows XP likened it to a full Windows computer.

6. **Compaq TC1000 (2003):** This was a silver tablet/notebook with a detachable 10.4-inch touchscreen. It matched Windows XP with a Transmeta Crusoe processor which wasn't the wisest of choices and it also makes it performance lousy.

7. **Amazon Kindle (2007):** This device was made primarily with consumers who love their books on mobile devices in mind. For Amazon, the Kindle was the perfect way to nudge customers beyond ordering physical books. By making the Kindle software available on the iPhone, Android, Blackberry, Windows Phone 7, Mac and PC, customers could buy an ebook once and read it on any device they wanted to.

8. **Apple iPad (2010):** Launched in April 2010 with a 9.7-inch display, 10-hour battery life, powerful 1GHz A4 processor and access to the biggest app library on the planet. Although the device allows pinch/zoom capabilities, it however does not have Flash support and camera capabilities. The iPad was followed by Android-powered Dell Streak, Archos tablets and a Samsung Galaxy Tab, a, Android-powered tablet with a 7-inch screen.
9. **Motorola Xoom (2011):** A 10-inch (1280 x 800 pixel) display with 1GHz dual-core and front and rear-facing cameras with additional SD card storage. It also runs Android 3.0, which is designed specifically for tablets.

10. **Hybrids and iPad 2 (2011):** In this era, we are likely to see faster, thinner, smaller and higher resolution tablets. It’s an era when manufacturers will try everything possible to stand out from the crowd. We may likely see hybrid devices like the Lenovo LePad, a standalone Android tablet or or perhaps a return to the idea of a dual displays devices to take advantage of multi-tasking.

**Tablet and Education**

The use of various technologies within schools is not a new occurrence; many schools globally are currently using laptops and netbooks in the school systems. However, this is gradually changing with the advent of tablets. Many of the concerns regarding the use of laptops and netbooks in education, such as their weight, battery life and time taken to load, have being eradicated with the use of Tablets technology. Tablets also comes with additional features which makes it a superior educational tool with wide spread adoption. Features such as a touch screen, built in easy to use camera, and voice recognition are some of the things that set it apart from the laptop and netbooks (Clarke & Svanaes, 2012).

These tablets technologies have introduced a new generation of educational tools that afford creative use and instant access to a wealth of online resources. They have been touted as ‘revolutionary’ devices that hold great potential for
transforming learning. The most important benefit of mobile devices including tablets in education is its ability to enable learning anywhere and anytime which clearly is a deviation from the industrial era where traditional model of learning where classroom is the central place of learning driven by the teacher and limited to instruction within the school day (Goodwin, 2012).

Although tablets introduction into the teaching and learning situations is still at the infancy, many countries are already trying out its full implementation. As reported by Clarke and Svanaes (2012) the implementation of Tablets in schools appears to have been led by the US where the use of the iPad is prevalent. As at October 2011, Apple noted that nearly 1,000 K-12 schools had an iPad one-to-one programme and that more than 2,300 K-12 school districts in the United States were running iPad programmes for students or faculty. Jaffray (2011) in Clarke and Svanaes (2012) confirmed that all US districts are in the process of testing or using iPads, and most districts indicated that they expect Tablets could outnumber computers in education within five years.

In Europe, trials of tablets in classroom situation is also been carried out, countries such as Estonia, France, Germany, Italy, Portugal, Spain, Turkey, and the United Kingdom were reported to be participating in the Acer Tablets pilot trial with schools. Other countries such as Turkey which began her tablets trial in February 2012 across 52 schools is expected to run the programme over a period of four years.
Scandinavian countries such as Sweden which had commenced Tablets trial in primary schools across the country and Norway with her intervention to have tablets in both secondary and Primary schools. Among the Scandinavians, Denmark had gone a step further with a national policy for mobile learning with emphasis on smartphones and Tablets (Clarke & Svanaes, 2012).

Also in Australia as stated by Clarke & Svanaes (2012), (the states of Queensland, Victoria and New South Wales are each looking into the use of Tablets in their education system. As part of the ‘Smart Classrooms Strategy 2011-2014’, the Queensland Department of Education and Training undertook an iPad trial in the 2010-2011 academic years at Doomadgee State School and Kedron State High School.

In Asia, South Korea schools have been testing the use of Tablets with Wi-fi zones and ‘digital textbooks’ in schools for the last 5 years. The South Korean Ministry of Education announced in June 2012 that it will replace textbooks and all paper in its schools with Tablets by 2015. Japan’s ‘The Future School’ scheme, which started in October 2010, has seen its Ministry of Internal Affairs and Communications give Tablets to more than 3,000 pupils under the age of 12 at ten elementary schools. In the same vein, Singapore carried out a trial at Nanyang Girls’ High School where 120 pupils and 16 teachers were given iPads. The Education Ministry proposes to give every child in the school an iPad by 2013 and is providing schools with grants to purchase Tablets, software and services. Thailand initiated “One Tablets per Child” campaign pledge and in May 2012, she signed a contract with Shenzhen Scope
Scientific Development, a Chinese firm, for the provision of 400,000 Tablets and in June of same year, the first batch was delivered to pupils. In India, a trial has been carried out with the iSlate device (developed in Singapore) that uses solar power. In March 2012 it was announced that some 50,000 of these devices, each costing about US$ 45, will be used by 10- to 13-year-old pupils over the next three years in Mahabubnagar District in Andhra Pradesh (Clarke & Svanaes, 2012).

Another country Russia is planning to implement bespoke Tablets. In addition to this, during the 2010-2011 academic year another Russian entrepreneur, Alexander Evgenievich Shustorovich, ran a trial where approximately 300 year-six pupils from 11 schools in cities across Russia were loaned a portable hybrid e-book and Tablets computer with which to learn, do their homework, revise for exams and order lunch from the school cafeteria.

Africa is not left out of the embrace of tablets in education; Zimbabwe is implementing a scheme with a focus on solar powered Tablets (Clarke, 2012), while in Nigeria, Osun state has commenced the distribution of Tablets to Senior secondary school students across the state (Tijani, 2013).

**Advantages of Tablets in Education**

As explained by Goodwin (2012), some of the advantages of the tablets in education include:

**Redefinition of teachers’ role:** With the deployment of the tablets, the teachers are no longer the chief repertoire of knowledge; rather they have become
the chief guide towards the learning discovery. On the other hand, students’ now have opportunity to access learning contents from anywhere and at any time

**Unrestricted access to learning contents:** The portability of tablets provides users with access to a broader and more flexible source of learning materials than what is offered in current classroom settings. With over 500,000 apps (mobile applications) available to download from the App Store teachers have access to an abundance of learning materials for use on mobile devices.

Contributing to the advantages tablets would bring to education, Hursh (n.d.) submitted that: Tablets PCs offer some unique abilities for instructional use. The portability, pen-based input, low power consumption, and optional portrait screen format may make it possible to present material in new ways. The Tablets PC could also be used for remote data collection for later classroom presentation. This he submitted might be especially valuable for courses that are based on data from fieldwork.

Also, with the tablets, Hursh argued that an instructor can "draw" directly on the presentation using the stylus. He stressed that while it is possible to draw with a mouse; drawing with a pen-like artifact is easier for most people. The Tablets he argued can also be used in either horizontal ("landscape") or vertical ("portrait") modes which makes it convenient for displaying material that may have originally been in portrait format (e.g., most books are in portrait format).
Tablets PCs tend to be ultra-light and have long battery life. This is important if an instructor may be carrying the computer long distances or may be away from electrical outlets for long periods of time. Classes which use field work may especially benefit from this. Making the transition to the Tablets PC is reasonably easy. "Ink" versions of popular applications (such as the Microsoft Office suite) are available, making it possible to gain the benefits of the Tablets PC without lengthy training or adaptation (Hursh, n.d.).

**Drawbacks of Tablet in Education**

Even with the advantages of tablets in education, it has its own drawbacks. According to Hursh (n.d.) some of the drawbacks include; high cost of purchase over notebooks of the same processing power, not all software is tablets-aware, it can be difficult to read from tablets under fluorescent lights or bright sunlight. Again, unlike a mouse, the Tablets PC stylus doesn't leave an arrow on the screen when you're not holding it. This makes it difficult to point at specific material without actually drawing something. This can be done with a pen or finger on a traditional overhead, of course.

In a recent review presented by ProCon.org titled Tablets vs Textbooks, it presented the various advantages of tablets over the textbooks in education to include that:

- Tablets help students learn more learning materials faster.
• Tablets can hold hundreds of textbooks on one device, plus homework, quizzes, and other files, eliminating the need for physical storage of books and classroom materials.

• E-textbooks on tablets cost on average 50-60% less than print textbooks.

• Tablets help to improve student achievement on standardized tests.

• Tablets contain many technological features that cannot be found in print textbooks.

• Print textbooks are heavy and cause injuries, while a tablets only weighs 1-2 pounds

• Tablets help students better prepare for a world immersed in technology.

• On tablets, e-textbooks can be updated instantly to get new editions or information.

• Tablets lower the amount of paper teachers have to print for handouts and assignments, helping to save the environment and money

• Tablets allow teachers to better customize student learning.

• Files on one tablets can be downloaded onto any other tablets, increasing flexibility and convenience for teachers and students

• High-level education officials support tablets over textbooks.
- Students who own tablets purchase and read more books than those who read print books alone.

- Using tablets is so intuitive that it makes learning fun and easy.

On the other hand it presented the drawbacks of the device in education to include that:

- Handheld technological devices including tablets are associated with a range of health problems.

- Using tablets is more expensive than using print textbooks

- Tablets have too many distractions for classroom use.

- People who read print text comprehend more, remember more, and learn more than those who read digital text.

- Many students do not have sufficient home internet bandwidth to use tablets.

- Manufacturing tablets is environmentally destructive and dangerous to human health.

- A broken tablet requires an experienced technician to fix, which can be costly and time-consuming.

- Print textbooks cannot crash, freeze, or get hacked.

- The average battery life of tablets is 7.26 hours, shorter than the length of a school day.
• Tablets are more susceptible to theft than print textbooks.

• Tablets enable students to cut corners or cheat on schoolwork.

• The higher cost of tablets marginalizes poorer school districts and increases the "digital divide.

• Tablets increase the number of excuses available for students not doing their schoolwork.

• Tablets shift the focus of learning from the teacher to the technology.

• Many textbooks are not available in digital format or on the specific tablets used by a school.

• Tablets may be too difficult for less-technologically-savvy students to operate.

In a recent evaluation study, Clarke and Svanaes (2012), highlighted why the tablets computers are becoming more popular now than before, they however listed the following reasons as being responsible.

**Cost:** Tablets are significantly cheaper than laptops and desktop computers, and being personal and portable can potentially reduce the cost of resources in terms of school space significantly. Also, the schools appeared to have fewer problems with Tablets in terms of software and crashes compared to PCs and laptops, saving them not only cost but also productive time.
**Tablets portability:** Tablets are more portable than laptops which mean pupils can easily take the device with them, allowing them to share and collaborate with each other.

**Tablets intuitiveness:** Touch screen devices appear to have a more intuitive interface compared to PCs and laptops. This makes it easier for both pupils and teachers to learn how to use the device quickly. Pupils who had previously not been engaged by technology were finding the Tablets much easier to use and were happy to use them for their schoolwork.

**Empirical Studies on Impact of Tablets in Education**

Since the Tablets PCs entered education, they are being evaluated in many colleges and universities for their effectiveness in improving student learning, promoting student engagement, enhancing the delivery of electronic course materials, and providing an effective way to connect the instructor and student together in an integrated learning environment (IEEE, 2008).

Kenar et. al (2013) conducted a study titled, The Effects of Tablets Computer Assisted Instruction on Students’ Attitude toward Science and Technology Course with the purpose of investigating the effects of tablets computer assisted instruction at science and technology course on students’ attitudes toward the use of technology, and using the technology output during the lessons, and students’ attitudes toward science and technology courses at fifth grade.
The study which used three instruments; Attitude toward Technology Scale, Attitude toward the Use of Technology in the Courses Scale, and Attitude toward Science and Technology Course Scale, involved 56 students (27 students in experimental group and 29 students in control group). The experimental group was instructed with tablets computer assisted instruction and the control group was instructed with traditional methods during science and technology courses. The Wilcoxon Signed Rank Test and Mann Whitney U-Test were used as inferential statistics.

The results of the study showed that the tablets computer assisted instruction had positive impacts on students’ attitudes toward technology and technology usage in the courses; however, it had both negative and positive impacts toward science and technology courses in different aspects. Also, gender differences were not seemed significantly important.

Clarke and Svanaes (2012) conducted an evaluation study which looked at the feasibility of giving pupils in secondary schools one-to-one tablets over a period of eleven months. The study involved two secondary schools (one experimental and one control) and tow feeder primary schools. In the study, interview and direct observation of tablets learning in the schools across various subjects were carried out. In addition eighteen focus groups were carried out with pupils, parents and teachers.

Results suggested that Tablets benefits to learning including an increased motivation to learn; increased parental engagement; more efficient monitoring of
progress between pupil and teacher; greater collaboration between teacher and pupil and between pupil and pupil.

The researchers concluded that tablets indeed affect learning positively and that it appears one-to-one tablets offer a sense of inclusion that allow children, irrespective of socio-economic status or level of attainment, an opportunity to thrive through a new pedagogical model of pupil-led learning.

In a study conducted by NSW curriculum and learning innovation Centre and supervised by Goodwin (2012) titled, Use of Tablets Technology (iPads) in the Classroom which covers three primary schools in the Sydney region for approximately eighteen weeks of instructional time with the iPads. The objective of the study was to find out (i) The implications of mobile devices for teaching and learning; and (ii) The technical and logistical procedures for effective deployment and management of the devices in school settings.

The qualitative research involved three schools, five teachers, over 90 students and 75 iPads. A comprehensive data set was provided: lesson observations of the iPads in use, teacher and student online surveys; teacher, student, principal and parent semi-structured interviews; digital work samples; teacher and student blogs; and an ‘app matrix’. After repeated viewings of the multiple data sources, the evaluator identified recurring themes which were recorded in a theme matrix. The Key findings of the study are: (a) Pedagogy- teachers involved in the trial reported that they adopted more student-centered and innovative approaches when using the
iPad. (b) Student Learning- it was found that many of the design features of the iPad offered learning affordances. Findings indicated that both teachers and students believed the iPads supported and enhanced student learning and (c) Learning Content-Scrutiny of the apps utilised in the trial revealed that there was some alignment between the learning content prescribed by NSW syllabus documents and apps available in the iTunes App Store.

**Osun Technology Enhanced Learning System (Opon-imo)**

The Tablets of knowledge also known as Opon-imo is a standalone Educational Tablets for Self-paced learning at the Senior Secondary School levels in Osun State, Nigeria. It is controlled through touch screen interface and runs on android 4.0. Operating system, has 512MB of RAM with a combined memory of about 32GB and a back-up non-detachable battery which can run up to 6 hours. The system contains applications such as camera, games, calculators, calendar, MP3 recorder, English language dictionary etc.

The E-learning software is called OTELS (Osun Technology Enhanced Learning System). This software contains three major content categories namely; the Extra-curricular subjects, the Otels and the Hints and Tips.

The Extra-curricular environment contains subjects such as; Civic Education, Yoruba History, Owe, Ifa, Sexuality Education, Computer Fundamentals and Enterprise Education.
The Hints and Tips environment contains tips on how to read and prepare for examinations on different subjects. It contains 15 sections of subjects such as; Agricultural science, Biology, Chemistry, Christian religious studies, Commerce, Economics, English language, Financial accounting, Further mathematics, Geography, Government, History, Islamic Religious studies, Mathematics and Physics.

The Otels environment has three other sub-environments which are the main trusts of the e-learning device and they are; The E-book library, The Virtual classroom and The Integrated Test Zone.

**The E-book library**


The Science sections of S.S.1, S.S.2 and S.S.3 contain e-books on subjects such as; Agric science, Biology, Chemistry, CRS, Economics, English language, Geography, Further Math, IRK, Mathematics, Physics and Yoruba while the Social science sections of S.S.1, S.S.2 and S.S.3 contain e-books on subjects such as; Accounting, Biology, Commerce, CRS, Economics, English language, Geography, Government, History, IRK, Mathematics, English language and Yoruba.
The Virtual classroom

The virtual classroom environment contains audio voiceovers on 16 subjects for SS1, SS2 and SS3 across Art, Science and Social science classes. Altogether it contains 42 audio materials for all the subjects with 823 chapters culminating in about 15 hours of audio voiceovers with an average of 16 chapters per course.

The Integrated Test Zone

The integrated test zone has two test environments; Practice tests and Mock exam environment. The Practice tests environment contains test items in 42 courses across 1,220 chapters, approximately 29,000 questions referencing approximately 825 images while the Mock exams environment contains over 40,000 past questions from Joint Admission and Matriculation Board (JAMB) and West African Examination Council covering about 20 years altogether.

The state government commenced the distribution of the educational tablets to about 150,000 Senior Secondary students and their teachers across the state-owned schools in September, 2013. This Educational Tablets is assumed to:

- Allow students to learn at their own paces wherever and whenever so wished.
- Provide robust & uniform learning content (Textbooks, Tutorials & Past Question)
- Provides feedback mechanism for monitoring students’ performance
• Promote self-paced learning conducted in an interactive computer-based learning environment and synchronized to a library of relevant e-books and a computer-based testing environment.

• Allow flexible usage i.e in different positions; sitting, lying down, while walking etc.

• Eliminate the burden of heavy back-pack for the learners

Some of the observed educational advantages the device may have over the paper book include:

• Ability to record Audio lessons

• Encourages accidental learning

• Makes the students ICT compliant

• Saves time which hitherto devoted to note-copying

• Serves as mobile library

• Provision of textbooks in digital format

• Source of motivation for teachers and students

Opon Imo recently won an award in World Summit Award World Congress 2013 in Sri Lanka under e-learning and science category. The World Summit Award (WSA) is the global follow-up initiative of the United Nations World Summit on Information
Society (WSIS) organised by the International Center for New Media (ICNM), Salzburg, Austria.

Under e-learning and science category in which Opon Imo competed, to be consider for selection, an application must be seen to be “Serving the needs of learners to acquire knowledge and skills for a complex and globalizing world; transforming schools, universities and other educational institutions through interactive, personalized and distributed learning resources; addressing the learning needs of all and creating active e-learning communities and solutions for corporate training as well as lifelong learning; making science accessible to citizens; presenting results of scientific projects as well as supporting forms of scientific inquiry; fostering global collaboration in science, and providing measures to promote science and demonstrate its results and their value to society and adds substantial value to people’s lives in remote villages and urban megacities”.

The award jury explains further, what makes the project and the availability of tablets attractive is the archival availability of content in terms of questions for the last ten years for the senior secondary students of all 3 levels. Hoping that the students may not be required to look for physical text books, the tablets is enriched with multimedia content including video, images, text and referential material and test questions for practice”(WSA,2013).
Appraisal of Reviewed Literature

This study would carry out the usability evaluation of tablets of knowledge also known as Opon-imo.

Through the literature reviewed on theoretical framework, it was revealed that the theories of learning are in tune with the changing nature of technology and technological changes are gradually being embraced by secondary schools (Koch, 2012; Ebert, 2012). Learning theories were broadly categorized into three namely: Behaviorism, Cognitive and Constructivism (Ford & Lott, 2012). Constructivism, it was ‘discovered emphasizes learners active participation in learning process. Researchers such as Jones and Barder-Araje (2012); Ford and Lott (2012); Glasersfeld (1989); and Kharade and Thakkar (2012) are unanimous in their opinion that learners construct their own knowledge by connecting their past experiences and knowledge with new ideas and concepts.

Historically, Glasersfeld (1989); James and Brader-Ajare (2002) traced the origin of constructivism to Giambattista Vico in 1710 while Ebert (2012); Ford and Lott (2012) were unanimous in their view of origin of constructivism as John Dewey and Jean Piaget. Also, through the review, it was discovered that there are two main forms of constructivism theory of learning namely: Psychological and Social constructivism (Light, 2008). The potential of ICT to support constructivist learning theory was highlighted by Kharade and Thakkar (2012).
From the literature reviewed on the concept of Usability, researchers were unanimous on what the concept signifies; Usabilityfirst (2013); Ali (2013); Nielsen (2012) all sees usability as having to do with the user experiences while interacting with any software, system or devices. These user experiences, they agreed include attractiveness, efficiency and overall satisfaction usability.gov (2013).

According to the literature, there are many International Organization Standards which deals with different issues in Humans Computer Interaction but the appropriate standard according of Brooke (2013) for evaluating software, website and other handheld devices is the ISO 9241-11. This ISO standard covers three separate components of usability which are effectiveness, efficiency and user satisfaction. These components as listed by ISO 9241-11 were however extended to five by usability.gov (2013). On why Usability evaluation is important, researchers such as Zacharias (2004); Brook (2013); Nielsen (2012); Ali (2013) and Federici and Borsc (2010) all agreed that it is only when the user who are the main targets of the development of system, interface or software are able to achieve their goals without much impediments and unnecessary waste of time and are ultimately satisfied with the performance of the system that the system, software or devices can be deemed to be usable. They listed the importance of usability to include; making the different between users completely performing the task or not; whether the user will enjoy the system or not; whether the designer or developer is successful or not, they also believe that usability increase user productivity.
Tracing the history of usability, Federici and Borsci (2010) divided the era into three: 1950 -1963, 1963-1984 and 1984 till now. The era between 1950-1963 was described as the era in which the developers/designer is user, 1963-1984 witnessed a major transition from the designer/user era into majorly users but these users must be skilled in the art of usage and therefore it was not wider usage. This second era the researcher argued gave birth to usability evaluation. The present era 1984 till now witness a situation where the user interaction with the system is on the front burner among developers and designers.


On empirical studies on usability Evaluation, most of the usability evaluation earlier carried out were not in education, the few which were in education were
actually from developed countries. A study conducted by Akinola and Temilola (2012) titled Usability Study of Some Selected Functional Website in Nigeria was reviewed. Also reviewed were studies such as, Suomalainen et al. (2010) titled, A Comparison of the Usability of a Laptop, Communicator and Handheld computer in Finland. Davis, strain-seymour and Gay (2013) with a study titled Testing on tablets: a usability study report on the use of Tablets for k-12 assessment programs. Other studies include Siegenthaler et al.(2010) titled Improving the Usability of E-book Readers. Siegenthaler et al. (2012) researched into The Effect of Torch screen Technology on the Usability of E-reader devices. Bernerus and Zhang (2010) also conducted a study titled A Peek at the Position of Pedagogical Aspects in Usability Evaluation of E-learning system.

On Information and Communication Technology, researchers such as Yusuf (2005); Osakwe (2012); Rodecker & Oyesterm (2013) canvassed for the need to integrate ICT into education. This clamor for ICT in education was traced to the recent improvement in technology such as Tablets by Biagi & Loi (2013). The different views of ICT as a concept to authors were echoed by Obakhume (2011); Womboh (2008); Osakwe (2012); and Elisha (2006). Different authors gave different definitions Bakhshi (2013); Womboh (2008); Oye et al. (2012) but the consensus is that, ICT as a term refers to all technology used to transmit, store, arrange, share, create, exchange information from one person to the other. The review also revealed several benefits of ICT in education, researchers such as Onasanya (2009) in Ayelaagbe (2013); Bakhshi (2013); Osakwe (2012); Olorundare (2011) in
Nwokeocha (2013) all agreed that when used in education, ICT can ensure quality research and bring about improved teaching and learning.

Literature was also reviewed on Barriers to ICT in Education, as explained by Eze and Nwagbo (2013) and Goktas et al. (2009) ICT barrier is a challenges that could affect the use of ICT tools in schools. Researchers such as Eze and Nwangbo (2013); Edith (2013); Ishikaku and Nyenwe (2013); Aduwa – ogiegbaen and lyamu (2005); Nsofor et al. (2012) submitted that inadequate funding, inadequate ICT infrastructure, inadequate electric power supply, negative attitude of Teachers and Students to ICT, lack of human skills, lack of relevant software, lack of government policy, cost of computer hardware and software, limited access to the internet as some of the barriers militating against the effective integration of ICT in education in Nigeria. On a global stage, researchers such as BECTA (2003) in Kipsoi et al.(2012); khan, Hasan and Clement (2012) highlighted barriers to ICT integration in education to include Political factors, Teachers attitude and believe, Lack of knowledge and skill Lack of time, Insufficient fund, Lack of technical and administrative and institutional support.

On concept of mobile learning, it was highlighted that our world is witnessing rapid development in mobile devices (Gori-chanaz 2011; Godwin-Jones (2011) and that these devices are gradually finding their ways into education (Ali, 2013). Authors such as Ju-hing, Chien-wen and Gwo-Jen (2010) in Ali (2013); UNESCO (2013); M-learning.org (2013) and Ozdamli and Cavus (2011) all agreed that mobile learning is learning that happens when learner is not at a fixed location through the use of
mobile technologies at anytime the learner so wished. For this to happen however, certain elements as explained by Ozdamila and Carvus (2011) must be well arranged and interact; learners, teachers, environment and content. Ali (2013) on the other hand mentioned three pillars that holds mobile-learning, he listed learning style, the mobile application and the learning content.

The characteristics of mobile learning as listed by Al-Ahmadi (2013); Godwin-Jones (2011); Ozdamila and Cavus (2013) include ubiquitous, portability and mobility, privacy, collaboration, instant information, wireless networking flexibility, spontaneity etc while its advantages as listed by Fetaji et al.(2011); Traxler (2010) in Falloon (2010); Gorichanaz (2011) include; promotion of individualistic learning, cooperative and interactive work in class, provision of work and resources in one place and to hand. Others include, situated learning, just-in-time learning opportunities, connection and convergence, Affordable and ubiquitous access. Mobile learning allows teachers to customize and personalize students learning experiences. However, drawbacks of mobile devices in education such as device sizes, limited data storage facility, source of distractions to students were highlighted by Moore et. al (2008); Gorichanaz (2011); and Nsofor et al.(2012).

On Evolution and Impact of Tablets in Education, the tablet was described by Henrik and Martin (2012) as a portable device which shares some of the features of laptop ad smartphones. Authors agreed that the Tablets idea was from Elisha Gray in 1888 while other inventions similar to it with the recognition of handwritten
characters based on handwriting motion were patented in the U.S in 1915 and 1942 respectively (Holleran, 2013; eCycleBest, 2013).

While tracing its revolution, eCycleBest (2013) divided the eras into four; Pre-1950 tagged as the Root; the 1950-1980 era; 1990 era tagged as the Rise of the PDAs, 2000 era tagged Birth of the modern Tablets and 2010 era tagged as the Tablets as we know it.

On Tablets and Education, authors in the review explained various places in which Tablets in education is been implemented and they includes: Clarke and Svanaes (2012); Goodwin (2012); Tijani (2013). In explaining its advantages in education, Goodwin (2012); Hursh (n.d); ProCon.org (2013); Clarke and Svanaes (2012) all agreed that Tablets is a veritable tool in education. They listed its advantages such as; Tablets cost is low compare to laptop and desktop, it provides a good source of motivation to students in teaching and learning situations; it allows teachers to customized students’ learning; it helps students to be more prepared for the world immersed in technology; it is light in weight and portable, have long battery life, it has low power consumption, opportunity for learners to learn anytime and anywhere,. On the other hand, Tablets has its drawbacks which includes, health risks, more expensive compare to paper books, internet connectivity is always a challenge, it can freeze or crash, Tablets also shift focus from teachers to technology.
On Empirical studies on Tablets in education, Studies such as Kenar, et. al (2013) titled the effects of Tablets Computer Assisted Instruction on Students’ Attitude toward science and technology. Clarke and Svanaes, (2012) evaluated the Usability of a one-to-one tablets for secondary school students over eleven months were reviewed. Also reviewed were Goodwin, (2012) titled use of Tablets technology (Ipads) in classroom.

On Osun Technology Enhanced Learning system, a description of the e-learning software was given since the software is new and there have not been any empirical study carried out on it. A description of the software having three separate Zones namely; e-book library, Virtual library, and Integrated test zone was presented. Subjects contained were also listed while the virtual and integrated test zones were analysed.
CHAPTER THREE

RESEARCH METHODOLOGY

This chapter deals with the methodology to be employed in carrying out this research. The procedure and technique to be used in gathering the research data are discussed under the following subheadings: research type, sample and sampling techniques, research instruments, validation of research instrument, procedure for data collection and data analysis technique

Research Type

This study is a descriptive survey research. The study would involve the use of Heuristics guidelines by the usability experts to evaluate the e-learning software. A researcher designed questionnaire would also be used to elicit information such as software’s user satisfaction, attractiveness, learnability, ease of use. Also, user acceptance of the tablet as a learning tool would be covered.

Sampling and Sampling Technique

The population for this study consists of all usability evaluation experts and all High School 3 students in Osun state, Nigeria. The target population is all usability evaluation experts across Public Higher Institutions of learning with either Faculty or School of Education and all High school 3 students who had received copies of the Tablet of knowledge across the three Senatorial districts within the state. The state is politically divided into three Senatorial districts namely: Osun East, Osun West and
Osun Central. A simple random sampling would be used to select a Local Government Area from each of the Senatorial district. Purposive sampling would be employed to select two schools from each of the Local government so selected. 600 students (100 per school) who had received the tablets would further be selected on purpose to participate in the study.

To select the usability experts, the four Higher Institutions with a School or Faculty of Education in the State namely: Obafemi Awolowo University; Ile-ife, Osun State University, Osogbo; Osun State College of Education, Ilesa and Osun State College of Education, Ila-orangun would be visited. Two experts from each of the four schools would be persuaded to participate in the evaluation study.

**Research Instrument**

Three research instruments; Tablet of knowledge (Opon-imo), Expert Usability Evaluation Form (EUEF) and Students’ Usability Evaluation Questionnaire (SUEQ) would be used in this study. Two of the instruments (EUEF and SUEQ) would be used to gather information in the study.

The Tablet of knowledge (Opon-imo) is an educational tablet which runs on an e-learning software called Osun Technology Enhanced Learning System (OTELS). The OTELS has three distinctive learning environments namely: (The E-book Library, The Virtual Classroom and The Integrated Test Zones). The E-book Library contains digital textbooks on subjects offered at the senior classes. The Virtual classroom contains lesson presentation in audio format. The Integrated Test Zones is further
subdivided into Practice tests and Mock environments. The test items contained in the Practice test zone are subject- chapter-specific while the Mock exam zone contains two sections; Waec and Jamb sections. From the two sections, students can access past questions conducted by the examination bodies in the last 10 years.

The Heuristics guidelines with items such as: (a) Visibility of system status (b) Match between system and the real world (c) User control and freedom (d) Consistency and standards (e) Error prevention (f) Recognition rather than recall (g) Flexibility and efficiency of use (h) Aesthetic and minimalist design (i) Help users recognize, diagnose, and recover from errors, (j) Help and documentation would be used as a basis of the expert evaluation form to evaluate the e-learning software on the Tablet of knowledge.

A researcher designed questionnaire tagged Students’ Usability Evaluation Questionnaire (SUEQ) which contains questions on: (a) students’ acceptance of the tablet as leaning tool (b) software perceived ease of use (c) perceived attractiveness (d) software learnability (e) software satisfaction would be used to elicit information from the students. The questionnaire is divided into three sections (Sections A,B&C): Section A is designed to collect demographic information of the respondents while section B contains questions bothering on the students acceptance of the Tablet of knowledge as a learning tool and is designed using the 4-point Likert scale namely, Strongly Agree=1, Agree=2, Disagree=3 and Strongly Disagree=4). Section C of the instrument is further subdivided into 4 namely, C1, C2, C3 and C4). C1 contains
questions on students’ perception of the software as easy to use, C2 contains questions on software learnability, C3 asks questions on software attractiveness and C4 contains questions on students’ satisfaction.

Validation of Research Instrument

**Tablet of knowledge:** an e-learning package which has been distributed to students of the Senior Secondary Schools in Osun state. It has been approved for use by the State’s Ministry of Education for use by students and teachers for teaching and learning purposes.

**Students’ Usability Evaluation Questionnaire:** the Students’ Usability Evaluation Questionnaire (SUEQ) would be given to 4 experts including the researcher’s supervisor (2 usability evaluation experts and 2 measurement and evaluation experts) at the University of Ilorin for content and face validity. Their corrections and inputs will be reflected in the final copy of the instrument.

**Expert Usability Evaluation Form:** this would also be given to the researchers’ supervisor and 3 other experts in University of Ilorin for validation.

Reliability of Instrument

The Tablet of knowledge is deemed to be reliable, hence is deployment for use by the State government.

The Heuristics guidelines by Nelsen (1993) had been used by many researchers and found to be reliable.
To test the reliability of the Student’ Usability Evaluation Questionnaire, copies would be administered on 60 High school 3 students of Public schools in Osun. This sample is member of the research population but will not be selected for the actual study. The questionnaire would be administered once on the pilot sample and Kuder-Richardson (KR-21) formula will be used to determine their reliability.

**Procedure for Data Collection**

The researcher will obtain an introduction letter from the Head, Department of Educational Technology, University of Ilorin to the schools concerned. The researcher will personally visit the usability evaluation experts in their respective places of work and their participation in the study will be obtained verbally. Thereafter, the researcher will release to them the e-learning device and the evaluation form which will be returned on an agreed date not earlier than 3 days after the researcher’s visit.

For the users’ participation, the respective school Principals will also be visited by the researcher with the introduction letter from the department. After explaining the purpose of the research to the respective Principals, permission will be sought to from the Principal to administer the questionnaire on the students, once gotten; at least 2 of the teachers will be engaged as research assistants. The assistants will be properly briefed about the purpose and procedure of the exercise, thereafter, the questionnaire will be distributed to the students to gather required information from them.
Data Analysis Technique

Descriptive statistics would be used to analyze the data that would be collected from the study. Research question 1, 2 and 3 would be answered by usability evaluation experts and would be analyzed using frequency counts.

Research questions 4, 5, 6 and 7 would be answered by the users and their responses would be analyzed using simple percentages.
REFERENCES


Kukulska-Hulme, A. (2007). *Mobile Usability in Educational Contexts: What have we learnt?*, International Review of Research in Open and Distance Learning, 8(2),1-17. Downloaded November 11, 2013 from http://oro.open.ac.uk/8134/1/


APPENDIX I

DEPARTMENT OF EDUCATIONAL TECHNOLOGY

FACULTY OF ILORIN

UNIVERSITY OF ILORIN, ILORIN, NIGERIA

STUDENTS’ USABILITY EVALUATION QUESTIONNAIRE FOR SENIOR SECONDARY SCHOOLS IN OSUN STATE, NIGERIA.

Dear Respondent,

This questionnaire is designed to elicit responses, opinion and view on the above subject matter. Any information given will be used for purpose of this research only and will be treated with utmost confidentiality.

Thank you for your anticipated cooperation.

Tijani, O.K
SECTION A

SCHOOL INFORMATION

Name of School: ………………………………………………………………………………………………………………………………

Class: …………………………………………………………………………

Local Government Area: …………………………………………………………………………………………………………………

SECTION B

Please indicate with a tick ( ) the extent to which you agree or disagree with the following statement. The response modes for this section are Strongly Agree, Agree, Disagree and Strongly Disagree.

<table>
<thead>
<tr>
<th>S/N</th>
<th>STATEMENT</th>
<th>STRONGLY DISAGREE</th>
<th>DISAGREE</th>
<th>AGREE</th>
<th>STRONGLY AGREE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>I find the tablet computer cumbersome to use</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>I wish I can take note on my tablet</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Using the tablet of knowledge helps me a lot in learning</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>I am willing to carry out more learning tasks on my tablet of knowledge</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Statement</td>
<td>STRONGLY DISAGREE</td>
<td>DISAGREE</td>
<td>AGREE</td>
<td>STRONGLY AGREE</td>
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<tr>
<td>5</td>
<td>The tablet of knowledge supports critical aspects of my study</td>
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<tr>
<td>6</td>
<td>I can still carry out my learning task without the tablet of knowledge</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>7</td>
<td>I find navigating around the OTELS very easy</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>It is easy to Switch from one zone to the other on the OTELS</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>9</td>
<td>I find it easy to distinguish the icons on the OTELS</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>I find it easy to bookmark, save and retrieve learning contents on the OTELS</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>It is easy for me to read e-book and zoom the fonts in and out</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>To take a test and review it on the OTELS is very easy</td>
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<td>12</td>
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</tbody>
</table>

**SECTION C 2**  
**User satisfaction**

<table>
<thead>
<tr>
<th></th>
<th>STRONGLY DISAGREE</th>
<th>DISAGREE</th>
<th>AGREE</th>
<th>STRONGLY AGREE</th>
</tr>
</thead>
<tbody>
<tr>
<td>13</td>
<td>The OTELS has all the features I need for my learning</td>
<td></td>
<td></td>
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</tr>
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<td></td>
<td></td>
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<tr>
<td>14</td>
<td>the OTELS provides enough suggestions and prompt I need towards the right usage</td>
<td></td>
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<tr>
<td>15</td>
<td>The OTELS is rigid and inflexible to interact with</td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>16</td>
<td>I am satisfied with the functions offered by the OTELS</td>
<td></td>
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<tr>
<td>17</td>
<td>The terminologies that have been used in this OTELS are familiar to me e.g bookmark</td>
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<tr>
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<tr>
<td>18</td>
<td>The arrangement of subjects on the OTELS is perfect</td>
<td></td>
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<td></td>
<td></td>
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</tr>
</tbody>
</table>

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## SECTION C 3
### Attractiveness

<table>
<thead>
<tr>
<th></th>
<th>STRONGLY DISAGREE</th>
<th>DISAGREE</th>
<th>AGREE</th>
<th>STONGLY AGREE</th>
</tr>
</thead>
<tbody>
<tr>
<td>19</td>
<td>I find the OTELS very attractive</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>The OTELS logo is fine and it should not be changed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>The colours and graphics of the icons in the zones are clear and attractive</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>The e-book library, virtual classroom and the test zone logos are not attractive and should be changed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>The colour of the chapter selection screen is unattractive and should be changed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>I find reading on the OTELS more attractive than from the paper books</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## SECTION C 4
### Learnability
<table>
<thead>
<tr>
<th></th>
<th>STRONGLY DISAGREE</th>
<th>DISAGREE</th>
<th>AGREE</th>
<th>STRONGLY AGREE</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>Opening the OTELS is very easy</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>It is easy to locate and listen to contents of the virtual classroom</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>Remembering icons and their functions is very difficult for me</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>Understanding the hierarchical of the program is easy for me</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>29</td>
<td>I can take test while reading my e-books and still return to same chapter</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>While listening to the virtual classroom, I can pause and continue later</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Thank you.
Dear Sir/Ma,

This form is designed to evaluate the usability of the Tablet of knowledge. Your responses will be used solely for the purpose of this research and will be treated with utmost confidentiality.

Thank you.

Tijani, O.K
USERBILITY EXPERTS ONLY

PERSONAL AND INSTITUTIONAL INFORMATION

Name of Institution: ...........................................................................................................

Position: ............................................................................................................................

No. of Years as an Educational Technologist: 1-5 ( ), 5-10 ( ), 10-15 ( ), above 15 ( )

SECTION B

Please use the guidelines below to evaluate the OTELS in the Tablet of knowledge, indicate by ticking ( ) if you find the tablet meeting the guideline or not.

1. Visibility of System Status: (The system should always keep the user informed about what is going on, through appropriate feedback within reasonable time.)

   • Does every display on the OTELS begin with a title or header that describes screen contents?  YES ( ) or NO ( )

   • Is there a consistent icon design scheme and stylistic treatment across the system?  YES ( ) or NO ( )

   • If pop-up windows are used to display error messages, do they allow the user to see the field in error?  YES ( ) or NO ( )

   • Is there some form of system feedback for every user action?  YES ( ) or NO ( )

   • After the user completes an action, does the feedback indicate that the next group of actions can be started?  YES ( ) or NO ( )
• Is there visual feedback in menus or dialog boxes about which choices are selectable?  **YES ( ) or NO ( )**

• Is there visual feedback in menus or dialog boxes about which choice the cursor is on now?  **YES ( ) or NO ( )**

• If multiple options can be selected in a menu or dialog box, is there visual feedback about which options are already selected?  **YES ( ) or NO ( )**

• Is the current status of an icon clearly indicated?  **YES ( ) or NO ( )**

• Do Graphic User Interface (GUI) menus make obvious which item has been selected?  **YES ( ) or NO ( )**

• Do GUI menus make obvious whether deselection is possible?  **YES ( ) or NO ( )**

2. **Match between System and the Real World:** (The OTELS should follow the user’s language, with words, phrases and concepts familiar to the user, rather than system-oriented terms. Are menu choices ordered in the most logical way, given the user, the item names, and the task variables?)

• Do related items appear on the same display?  **YES ( ) or NO ( )**

• When prompts imply a necessary action, are the words in the message consistent with that action?  **YES ( ) or NO ( )**

• Do keystroke references in prompts match actual key names?  **YES ( ) or NO ( )**

• For question and answer interfaces, are questions stated in clear, simple language? (making information appear in a natural and logical order.  **YES ( ) or NO ( )**

• Do GUI menus offer activation: that is, make obvious how to say “now do it”?  **YES ( ) or NO ( )**

3. **User Control and Freedom:** (Users should be free to select and sequence tasks (when appropriate), rather than having the system do this for them. Users often choose system functions by mistake and will need a clearly marked "emergency exit”

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to leave the unwanted state without having to go through an extended dialogue. The system should support undo and redo."

- Are users prompted to confirm commands that have drastic, destructive consequences? **YES ( )** or **NO ( )**

- Is there an "undo" function at the level of a single action and a complete group of actions? **YES ( )** or **NO ( )**

- Can users cancel out of operations in progress? **YES ( )** or **NO ( )**

- If menu lists are long (more than seven items), can users select an item either by moving the cursor or by typing a mnemonic code? **YES ( )** or **NO ( )**

- Are menus broad (many items on a menu) rather than deep (many menu levels)? **YES ( )** or **NO ( )**

- If users can set their own system, file and screen defaults, are there protections against predictable use errors for likely defaults? **YES ( )** or **NO ( )**

4. **Consistency and Standards:** (Users should not have to wonder whether different words, situations or actions mean the same thing. Follow platform conventions.)

- Has a heavy use of all uppercase letters on a screen been avoided? **YES ( )** or **NO ( )**

- Do abbreviations not include punctuation? **YES ( )** or **NO ( )**

- Are icons easy to interpret and is there a redundant way to interpret them (e.g., labels, mouseover labels)? **YES ( )** or **NO ( )**

- Are there no more than twelve to twenty icon types? **YES ( )** or **NO ( )**

- If "exit" (or its equivalent, such as “quit” or “close”) is a menu choice, does it always appear at the bottom of the list? **YES ( )** or **NO ( )**

- Are menu titles either centered or left-justified? **YES ( )** or **NO ( )**
• Are high-value, high-chroma colors used to attract attention? YES ( ) or NO ( )

5a. **Error Prevention:** (Even better than good error messages is a careful design that prevents a problem from occurring in the first place.)

• Is the menu choice name on a higher-level menu used as the menu title of the lower-level menu? YES ( ) or NO ( )

• Does the system prevent users from making errors whenever possible?

  YES ( ) or NO ( )

• Does the system warn users if they are about to make a potentially serious error?

  YES ( ) or NO ( )

5b. **Test interface**

• On the software’s question and answer interface, can users go back to previous questions or skip forward to later questions? YES ( ) or NO ( )

5c. **User identification error**

• Does every display on the OTELS have a title or header?

  If an action will cause any damage to the content of the OTELS, is the user alerted?

  YES ( ) or NO ( )

5d. **Mode error**

• When an unusual mode choice is selected, is the user alerted? YES ( ) or NO ( )

• Is the display designed to reduce the risk of selecting the wrong icon?

  YES ( ) or NO ( )

5e. **Data accuracy error**
• Is information not truncated on the display?  **YES ( )** or **NO ( )**

• Do changes in status (e.g., STAT to NOW) display accurately?  **YES ( )** or **NO ( )**

• Are records of test written properly and accurately stored (date, time and numbers)?  
  **YES ( )** or **NO ( )**

5f. Interpretation error

Are negative structures avoided (e.g., “Do you not want to quit?”)?  **YES ( )** or **NO ( )**

5g. Recall error

Does the OTELS enable recognition of information, rather than requiring users to remember information?  **YES ( )** or **NO ( )**

5h. Feedback error

• Are changes to displays easy to detect and track?  **YES ( )** or **NO ( )**

6. Recognition Rather Than Recall: (Make objects, actions and options visible. The user should not have to remember information from one part of the OTELS to another. Instructions for use of the system should be visible or easily retrievable whenever appropriate.)

• Does the data display start in the upper-left corner of the screen?  **YES ( )** or **NO ( )**

• Have prompts been formatted using white space, justification and visual cues for easy scanning?  **YES ( )** or **NO ( )**

• Have zones been separated by spaces, lines, color, letters, bold titles, rules lines, or shaded areas?  **YES ( )** or **NO ( )**

• Are field labels close to fields, but separated by at least one space?  
  **YES ( )** or **NO ( )**

• Are meaningful groups clearly demarcated (e.g., borders used)?  **YES ( )** or **NO ( )**

• Is color coding consistent throughout the system?  **YES ( )** or **NO ( )**
• Is color used in conjunction with another redundant cue? **YES ( )** or **NO ( )**

• Is the first word of each menu choice the most important? **YES ( )** or **NO ( )**

• Are inactive menu items grayed or omitted? **YES ( )** or **NO ( )**

• Are there menu selection defaults? **YES ( )** or **NO ( )**

7. **Flexibility and efficiency of use** (Accelerators - unseen by the novice user - may often speed up the interaction for the expert user to such an extent that the system can cater to both inexperienced and experienced users. Allow users to tailor frequent actions.

8. **Aesthetic and Minimalist Design:** Dialogues should not contain information that is irrelevant or rarely needed. Every extra unit of information in a dialogue competes with the relevant units of information and diminishes their relative visibility.

• Is only (and all) information essential to decision making displayed on the screen? **YES ( )** or **NO ( )**

• Are all icons in a set visually and conceptually distinct? **YES ( )** or **NO ( )**

• Have large objects, bold lines and simple areas been used to distinguish icons? **YES ( )** or **NO ( )**

• Does each icon stand out from its background? **YES ( )** or **NO ( )**

• If the system uses a standard GUI where menu sequence has already been specified, do menus adhere to the specification whenever possible? **YES ( )** or **NO ( )**

• Are meaningful groups of items separated (e.g., by white space)? **YES ( )** or **NO ( )**

• Is each lower-level menu choice associated with only one higher-level menu? **YES ( )** or **NO ( )**

• Are menu titles brief, yet long enough to communicate? **YES ( )** or **NO ( )**

9. **Help Users Recognize, Diagnose and Recover From Errors** (Error messages should be expressed in plain language (NO CODES).
• Are prompts brief and unambiguous? \text{YES} ( ) or \text{NO} ( )

• Are error messages grammatically correct? \text{YES} ( ) or \text{NO} ( )

• Do error messages avoid the use of exclamation points? \text{YES} ( ) or \text{NO} ( )

• Do error messages avoid the use of violent or hostile words? \text{YES} ( ) or \text{NO} ( )

• Do all error messages in the system use consistent grammatical style, form, terminology and abbreviations? \text{YES} ( ) or \text{NO} ( )

• Do messages place users in control of the system? \text{YES} ( ) or \text{NO} ( )

• Do error messages inform the user of the error's severity? \text{YES} ( ) or \text{NO} ( )

• Do error messages suggest the cause of problem? \text{YES} ( ) or \text{NO} ( )

• Do error messages provide sufficiently detailed information that makes it easy to do the intended behavior? \text{YES} ( ) or \text{NO} ( )

• Do error messages indicate what action the user needs to take to correct the error language? (NO CODES). \text{YES} ( ) or \text{NO} ( )

10. Help and Documentation: (Even though it is better if the system can be used without documentation, it may be necessary to provide help and documentation. Any such information should be easy to search, focused on the user’s task, list concrete steps to be carried out, and not be too large).

• If menu choices are ambiguous, does the system provide additional explanatory information when an item is selected? \text{YES} ( ) or \text{NO} ( )

• Are there memory aids for commands through off-line quick reference or prompting? \text{YES} ( ) or \text{NO} ( )

• Is the help function visible (e.g., by a key labeled HELP or a special menu)? \text{YES} ( ) or \text{NO} ( )
• Is the help system interface (navigation, presentation and conversation) consistent with the navigation, presentation and conversation interfaces of the application it supports? YES ( ) or NO ( )

• Navigation: Is information easy to find? YES ( ) or NO ( )

• Presentation: Is the visual layout well designed? YES ( ) or NO ( )

• Conversation: Is the information accurate, complete and understandable? YES ( ) or NO ( )

• Is there context-sensitive help? YES ( ) or NO ( )

• Is it easy to access and return from the help system? YES ( ) or NO ( )

• Can users resume work where they left off after accessing help? YES ( ) or NO ( )

11. Privacy: The system should help the user to protect personal or private information belonging to him/her.

• Do the OTELS allow user to control access to the software? YES ( ) or NO ( )

• Are protected areas inaccessible under normal circumstances? YES ( ) or NO ( )

• Can protected or confidential areas be accessed when necessary by following relevant security protocols (e.g., password protection)? YES ( ) or NO ( )

Thank you.