INFLUENCE OF MOBILE PHONE TECHNOLOGIES ON SCIENCE STUDENTS’ ACADEMIC PERFORMANCE IN SELECTED GHANAIAN PUBLIC UNIVERSITIES

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MAY 2014
DECLARATION

Student: Declaration

I confirm that this research thesis is my original work and has not been presented in any other university. The thesis has been complemented by referenced sources duly acknowledged. Where text, data (including spoken words), graphics, pictures or tables have been borrowed from other sources, including the internet, these are specifically accredited and references cited in accordance in line with anti-plagiarism regulations.

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DEDICATION

This thesis is dedicated to my mother, Mavis, for her untiring parental love, inspiration and tremendous support throughout this course of study and to my special daughter, Kabuki, for her unwavering faith in me.
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ABBREVIATIONS AND ACRONYMS

3G     Third Generation
GPA    Grade Point Average
HOD    Head of Department
HTML   Hypertext Markup Language
ICT    Information and Communication Technology
IT     Information Technology
ITU    International Telecommunication Union
KNUST  Kwame Nkrumah University of Science and Technology
MMS    Multimedia Messaging Service
MPEG-3 Moving Pictures Expert Group Layer III (MP3)
PC     Personal Computer
PDAs   Personal Digital Assistants
PISA   Programme for International Student Assessment
QR     Quick Response
SMS    Short Message Service
SRMIS  Student Records Management and Information System
UCC    University of Cape Coast
UEW    University of Education, Winneba
UG     University of Ghana
Wi-Fi  Wireless Fidelity
ABSTRACT

Many university students struggle a great deal in the Sciences because of complex concepts, laws, theories and models. In Ghana, the situation is not any much different. This study was designed to examine the use of mobile phones which is a widespread technology and determine how this technology influences science students’ academic performance. This study sought to find out the extent to which the use of mobile phones influences science university students’ academic performance in public universities of Ghana. The study involved examining the type of mobile phone technologies available for university students pursing programs in science, assessing students’ level of academic satisfaction with the use of mobile phone in learning science, establishing the role the various types of learning styles play in influencing the use of mobile phone technology for learning, investigating the influence of utilization of mobile phone technology on academic performance in science by university students and determine the factors that influence mobile phone usage by university students in science learning. The study proposes a model that would support the use of mobile phone technologies to support learning science and examines the type of mobile phone technologies available for lecturers to support teaching of science in their universities. Papert’s (1980) ICT theory supported by Ally’s (2004) mobile learning model formed the theoretical framework of this study. The research design employed was a descriptive survey, which used both quantitative and qualitative data. The target population included students, lecturers and ICT coordinators in three public universities in Ghana. Three universities out of 6 major universities were purposively selected because they are the largest public universities in Ghana which have exceptional wireless network infrastructure as compared to other universities. Six hundred forty-three students, lecturers and ICT coordinators formed the sample. Purposive and convenience sampling techniques were used in selecting the sample size. The data was collected using questionnaires from both students and lecturers, while interview schedule was used for ICT coordinators. Both descriptive and inferential statistics were used to analyze data. Further analysis was done using the t-test, Pearson Product Moment correlation coefficient and one way ANOVA. These were used to determine the relationship between the independent variables and the demographics of both lecturers and students. Four hypotheses were tested at 0.05 level of significance. Qualitative analysis from open ended items from the questionnaires and interviews were considered and inferences drawn from the opinions of the respondents. Validity and reliability were ensured through piloting. The findings revealed that the mobile phone had great potential as a learning tool and it could positively influence learning science in universities. After analyses the results were presented in the form of tables and bar charts. Discussion and conclusions were drawn. The study came up with recommendations for students, lecturers, curriculum planners, content developers for policy and further research.
CHAPTER ONE

INTRODUCTION AND BACKGROUND OF THE STUDY

1.1 Introduction

The study focused on how mobile phones have contributed and enhanced educational experiences for science students at the university level. This chapter has been organized under the following headings: background to the study, statement of the problem, research questions, objectives of the study, significance of the study, assumptions of the study as well as limitations and delimitations of the study. Theoretical and conceptual frameworks as well as operational definitions of key terms are also considered.

1.2 Background to the study

Science is a dynamic discipline that deals with investigation geared toward the understanding of the real or natural world. McComas (2006) posits that science consists of the discovery and exploration into the world, which determines the questions that lead to compelling and consistent generalizations and explanations, using the process of investigating and producing evidence that can be reviewed by others. Science provides us with an important means for understanding how the world operates and how we exist and interact with our physical surroundings. Science can thus be observed as both a body of knowledge as well as a process (http://undsci.berkeley.edu).

Science is derived from the Latin word scientia which means knowledge. The process of science is a scientific method. This is the process of developing a precise, consistent,
duplication of a real world model, in which scientists work together towards a particular goal over time (http://en.wikipedia.org). In other words, science can be explained as a system that constructs and puts in order knowledge that can be explained and predicted about the world (Heilbron, 2003). Scientific knowledge generally takes the form of facts, concepts, principles, models, theories and laws (National Research Council, 1996).

Vavolua (2005) explains “science as involving experimentation and understanding advanced methods as well as techniques for gathering data, determining facts, formulating and testing hypothesis.” Consequently, science is considered to be a ‘difficult’ discipline as compared to others, especially since it is mainly about complex concepts, theories, laws and models which generally not only involve instruction of a body of knowledge but also includes the procedures and practices of scientific work (Flick & Bell, 2000). Similarly, science learning entails creating knowledge about complex concepts, which can be made more understandable if students are able to develop a relationship concerning their formal knowledge and their personal experiences (Vavoula et al, 2007). It is true that science learning as well as teaching can be quite difficult and demanding.

In one of the universities in Ghana, in a graduating class of 2012, only 38% of students obtained a First Class or Second Class Upper Honours in the Sciences as compared to 65% of them obtaining a First Class or Second Class Upper Honours in Humanities. And also, 27% of students acquired a Third Class or Pass Honours in the Sciences while 21% of them acquired a Third Class or Pass Honours in Humanities (SRMIS, 2012).
Therefore, it is accurate to state that learning science can be quite difficult and demanding.

Consequently, there is a need to involve collaboration and co-construction of knowledge and ideas, which demands change in educational practices to allow students to learn how to utilize mobile phone technologies in learning. It can be argued that these technologies can support learning by increasing the possibilities for student participation and collaboration in the learning process (Khoo et al., 2012). Additionally, science educationists are becoming more aware of the vast possibilities of mobile phone technologies in science teaching and learning. Therefore, these technologies could as well supplement a new dimension to science education which includes content and scientific processes that are presently considered as difficult (Taber, 2005).

1.2.1 Rationale for Use of Mobile Phone Technologies in Teaching and Learning Science

During the 21st century there have been exceptional developments in the advancement of mobile phone technology that have reorganized and redefined the means in which students produce, retrieve, and share information (Avraamidou, 2008). As a result, mobile phone technologies with internet connectivity are being more recognized and used in science teaching and learning. According to Downes (2005), the internet was altered from a medium that conveys and utilizes information, to a platform that constructs, exchanges, remixes, repurposes and then passes along content.
Technology is changing science teaching and learning and therefore lecturers and students need to change with it. According to Shuler (2009), lecturers must change their perception about these modern devices and try to understand how mobile phones in particular would best help their students in learning. The potential of mobile technology in enhancing teaching and learning is so immense that it is presently at the front of technological development in education in North America. Students are now more aware of the potential of technology than ever before (www.brighthubeducation.com). Mobile learning especially with mobile phones can therefore impact how students learn and how educators teach.

Research shows that mobile phones can bring a number of possibilities to learning experiences. For example, Swett (2002) points out that about 90% of public universities in America have some level of services in mobile learning. Mobile phone technologies can enhance science learning experiences that involve collaboration, accessibility, and integration with the world beyond the classroom (Prensky, 2005). Besides, mobile phone technologies can present science students with vast opportunities for interacting with their lecturers, course mates and science content (Vavolua. 2005). Attewell and Savil-Smith (2003) add that mobile phone technologies facilitates student motivation, develops their organizational skills, encourages both independent study and collaborative learning, acts as a tool for referencing, tracks the progress of students and also delivers assessment.

There are various educational benefits of mobile phone technologies that are most often cited as; easily accessing content, integrating a broad range of educational activities, supporting independent study and student organization, encouraging student enthusiasm,
supporting classroom-based collaboration and interaction as well as supporting inquiry-based instruction and learning (Roschelle, 2003). More sophisticated mobile phones, also known as smartphones, can be used to assist students in accessing information from the web, transforming it, transferring it, collaborating among students and also creating a more media-rich approach to instruction (Ferry, 2009). Recent advances in ICT have significantly increased the possibilities of mobile phones being used as instructional tools, because of their increasing processing power, memory and connectivity which have made these technologies drastically more interactive (Pea & Maldonado, 2006). Additionally, Vavolua (2005) suggests that these technologies can be used in science during field trips, where students gather scientific data for future analysis in the laboratory.

It is known that in this generation, students own very powerful multimedia technologies which make it easier for file sharing and messaging to take place, these activities do not normally fit into the conventional classroom setting (Open Universiteit Nederland, 2009). Today’s young adults are more at ease with the use of collaborative technologies and they have fully grown in an era of mobile phone technologies. There was a time in previous generations where a notebook and pen were the basic learning tools, but nowadays students attend their classes equipped with mobile phones (Economist Intelligence Unit, 2008).

Students are more likely to engage in rich technology interactions when they are outside the classroom (Haythornthwaite & Andrews, 2007) in order to supplement what has already been taught in class. According to Prensky (2005), mobile phone technologies are
not only used in communicating with others, but are actually computers that are small as well as portable and students carry this technology wherever they go, therefore these technologies can be used for learning purposes. Science educators need to realize that today’s students have these mobile phone technologies and it has become central to their lives, so the best thing is to integrate these devices into teaching and learning.

Mobile phone technology is a necessity in a student's life and also an important technological device to them. They are basically used for making and receiving calls, text and picture messaging and accessing the internet. Today’s students are extremely competent in the use of mobile phones (Haythornthwaite & Andrews, 2007). Students consider these devices as a pleasant, individual possession in which no other device is observed.

Mobile phones are also seen as a trendy accessory that suits students’ individual needs often expressed choice of mobile wallpaper, ringtones, phone covers and other fashion accessories (Attewell, 2005; Srivastava, 2005). University students use mobile phones far more often than desktop computers and even laptops. This implies that mobile phones can be an even more significant learning tool and a typical raised area in the near future (Kimura, 2011). Therefore, mobile phone technologies can support students in their learning by exploring their world through these technologies.

Some scholars believe that students must take a more active role in their own learning by being their own private, personal reference librarians (Brown & Bransford, 1999). Additionally, Brown (2005) believes that lecturers need to encourage learners to discover
knowledge on their own and also guide them to solve questions and to convey this knowledge to others. Therefore, Brown and Bransford (1999) as well as Brown (2005) seemed to insist on some key points to ensure this. Firstly, being that ICT tools are a growing and a beneficial force in young people lives and should therefore be embraced as well as used to their full advantage. Secondly, is that this capacity to use ICT tools can be developed better, if students are guided by lecturers. Ferry (2009) also affirms the fact that students should use their mobile phone to check emails, use the dictionary, read materials, listen to audios or watch lectures from anyplace and at any time. Since, these devices also have downloading features students and lecturers can download several types of materials through their mobile phones easily to aid in effective learning.

According to Cuing and Wang (2008), universities in United Kingdom use mobile phones in order to save and retrieve information by means of electronic books and other educational materials, therefore, making access to information for teaching and learning more readily available. But this is not the case in most African countries, such as Ghana. Science lecturers and students in the universities of Ghana should also consider the vast benefits of using mobile phone technologies in teaching and learning.

Therefore, in order to understand the advantages associated with using mobile phone technologies, it is essential to understand the definition. According to Ally (2009), m-learning is when students and lecturers communicate by accessing and studying learning materials through the use of mobile technologies, which can take the form of tablets, e-reader, PDAs and mobile phones. However, Traxler (2005) defined it as using handheld
devices for educational purposes. Mobile learning stresses learning on the go (Kukulska-Hulme & Traxler, 2005).

JISC (2005) describes mobile learning as that where students are able to learn at any place, with any person, and at any given time. According to the Wikipedia (2012), M-learning is the delivery of education by means of mobile technologies, such as mobile phones and PDAs. M-learning can also be defined as the use of mobile technologies in instruction in order to increase student interaction, motivation and learning (Zurita & Nussbaum, 2007). Sharples (2004) also defines it as a type of learning different from the conventional way of learning using mobile technologies. E-learning Guild (2009) describes m-learning as a process by which students interact or produce information through a convenient digital device that a student carries on them most of the time. This technology also has reliable connectivity and can easily fit in a student pocket or purse.

Among the mobile technologies personally owned and used among young people is the mobile phone which presents an appropriate learning environment as there are a variety of mobile applications that both lecturers and students can use to enhance their educational experiences. Obuobi et al (2006) remarked that the most relevant learning technology in Africa should be one that can be sustained and would allow students to learn every time and everywhere exclusive of internet reliability. Meaning once the student is able to download and gather information, he or she will then be able to save and therefore retrieve it at anytime without necessarily having access to the internet at that moment, and is therefore able to download and read the learning materials offline.
Additionally, Brown (2005) emphasizes that the mobile phone is the most suitable mobile device for learners in Africa. Therefore, Ghana must make the effort to utilize this potential to its fullest. Researching into the use of mobile phone technologies in South Africa, Brown (2003) reports that mobile learning has already started playing a very essential role in African education. For that reason, this research will be limited specifically to mobile phones.

1.2.2 Description of mobile phones and its access worldwide

In order, to appreciate the role of m-learning, it is vital to understand the purpose and description of a mobile phone. Mobile phones range from simple to complex. A basic mobile phone is regarded as a pocket-sized device which has telecommunication capabilities that stores contact information, possesses text messaging features and keeps track of appointments as well as setting reminders. Mobile phones vary in design with basic models allowing students to have access to others simply by phone or text on the go (Wood, 2006). More complicated mobile phones present a better variety of abilities such as video, camera, audio recording, multimedia messaging and internet access (Livingston, 2004).

Additionally, these sophisticated mobile phones, also known as a smartphone, offer a greater range of capabilities, such as integrated PDA device that combines Bluetooth, built-in calculator for simple mathematics, mass storage, gaming features, text messaging, MP3 player and networking features into one compacted system (Corbeil & Valdes-Corbeil, 2007; Wood, 2006; Wikispaces, 2013). Mobile phones organize the purposes of phone, camera, video, media player and wireless computers into a single
gadget. These functions could supplement science teaching and learning which contains complicated content and scientific processes that are otherwise difficult to teach (Taber, 2005). Mobile phones can be used in making calls, texting, taking pictures, recording audio and video, storing information, providing music and movies as well as interacting with the internet. All of these capabilities enable us to become so connected into our daily lives that it seems almost impossible to hear that somebody does not have a mobile phone (Horizon Report, 2009).

It is necessary, therefore, to describe how mobile phone technologies can be used in learning. In some cases applications come pre-installed on smartphones, while others are freely or cheaply available. Mobile phone technologies are used in presenting the course syllabus, lecture notes, assignments, schedules, quizzes or other educational materials as well as retrieving course materials online (Yuen, 2008). These technologies are also used in playing pre-recorded lectures, recording lectures, accessing class news bulletins, listening to podcasts and digital audio books as well as watching educational videos. Both audio and video recordings would be sited online for distribution, downloaded to the mobile phone, and then played on the phone in which the student can listen or view at anytime and anywhere.

If used, these technologies enable lecturers to provide the educational materials (in text, audio, and video formats) to their students on a mobile phone (Yuen, 2008). Additionally, latest types of phones are no longer used for just talking and sorting out contacts, but also functions as computers that can fit in the palm of our hands and are even able to deliver learning experiences.
From a global perspective, mobile technology has not only grown but spread very rapidly both in developed and developing countries. Out of all the technologies accessible at the present time, mobile phones indeed have been the most acknowledged and recognized personally-owned technology worldwide. The United Nation’s ITU (2013) estimated that there were 6.8 billion mobile phone subscriptions worldwide and that a full 96% of the world population now has access to a mobile network. In contrast, only approximately 2.7 billion people worldwide use the Web on their phones, which is 40% of the world’s population (http://mobithinking.com). In Africa, however, only 16% of the people are using the internet (ITU, 2013).

In Ghana, internet usage has increased and the people over 15 years of age that had access to a phone were observed to be 59.5%. Only 28.5% of those phones were capable of accessing the internet while those who actually browsed on the internet were found to be 13.4% and 9.5% were using mobile phones in reading and writing emails (Calandro, 2012). By 2014, mobile internet is expected to exceed desktop internet usage. It was approximated that 73.4% of internet users in 2013 accessed the internet from a mobile device (eMarketer, 2014). As a result, mobile web penetration (as a proportion of total internet usage) is at a maximum in Middle East and Africa at a massive 92.7% in 2013. For the purpose of this study, it is important to look at the availability of mobile phones and internet use in Ghana.

The number of mobile phone subscribers in Ghana has astoundingly increased since 2005 (Sutherland, 2009). By January 2013, the number of people using mobile phones in Ghana grew to 26.09 million (www.modernghana.com). Current statistics from the
analytics website and Internet World Statistics show that the number of Ghanaians accessing the internet has grown by 4,223% over the past 10 years. This increase is steady and shows no signs of slowing down in the near future. In this respect, more Ghanaians are using their phones to browse the internet (Dogbevi, 2009). It was also noted that those who used these types of phones were usually young adults. Yet, while the rapid growth of internet adoption in Ghana has been a welcome trend, in absolute terms the country still has a long way to go. As a percentage of the country's population, internet users only represent 5.3% of citizens (www.modernghana.com). Therefore, the potential of mobile phone use in learning should be looked at critically.

Web-enabled phones have great potential to make a considerable contribution to education, especially in the area of science. It has been observed that students who use the internet fall short in recognizing that such resources are supposed to offer a meaningful knowledge to whatever information wanted and are a broadening of lecture rooms (Afari-Kumah & Tanye, 2009). Digital cameras on mobile phones have immense potential as they can be used for recording visual materials and also gathering scientific information (Commonwealth of learning, 2008).

The National ICT in Education Policy (2004) identifies two key objectives, which are; “enabling graduates from educational institutions in Ghana to confidently and creatively use ICT tools and resources in order to develop essential skills and knowledge required to be active take part in the global knowledge economy by 2015” and “transforming Ghana into an information rich, knowledge based, technology driven, high income economy and society”. In the same vein, according to Mangesi (2007), major Ghanaian universities
have their own separate ICT policies, which allow students to have access to computer laboratories with broadband connection. However, these universities have switched over to wireless connection. Telecommunication companies in Ghana are now playing a vital role in accessing internet on university campuses. In line with this, wide access to internet requires services from mobile phone companies. For that reason, even when the student is not in a lecture room, he or she should still be able to have access to internet networks anywhere on campus, where students are able to get information rapidly at a relatively reduced cost.

Ghana currently has six mobile telecommunication companies licensed to execute business. These are MTN, Tigo, Vodafone, Airtel, Expresso and Globacom. Kulski et al (2002:6) notes that “There is increasing evidence that mobile phone technologies are having an immense effect on academic practices and expectations of students about the place, time and nature of their learning.” As a result, since globally the mobile phone revolution has become crucial in education and Africa, Ghana also needs to make the effort to embrace this technology in order to reap benefits of these services for their students in higher education.

How students view mobile phones in the education context is crucial. Students need to examine the benefits mobile phones offer learning, so that they will gain a better perspective on the use of these technologies in their learning. There is growing evidence that the effect of the mobile phone as a tool for learning is multiplying fast and is expected to gain greater influence in many areas, especially in the world of academics. That is why this study found it necessary to find out how science students at the
university level appreciate and engage mobile phones for academic purposes. The researcher basically looked at three aspects of academic performance; mainly learner satisfaction, learning style as well as learner performance.

1.2.3 Mobile phones influence on academic performance in science

The use of mobile phone technologies seems to positively influence students’ academic performance in science by impacting on students’ academic satisfaction and learning style. Academic satisfaction involves two aspects, which include academic and facilities dimensions. The academic aspect deals with teaching styles (how lecturers use technologies to support their teaching), constructivist environment, group work and discussions and collaboration among students. The other dimension deals with the facilities available on campus. The more satisfied the students are with their universities’ academics and facilities, the more likely they are to perform better.

Learning styles are one of the most important factors in facilitating students learning and in improving their academic performance (Liu et al., 2007). Since each student has different learning preferences; technology being integrated into a students’ learning style can potentially have a positive influence on their learning. In addition, lecturers are more effective when they understand the variation in learning styles and actively use teaching strategies that include many learning styles (Felder & Spurlin, 2005). Ally (2005) defines learning style as a means by which an individual learns, processes information, interacts with others, and completes practical tasks. This study involved Felder-Silverman’s model of learning styles.
According to the Felder-Silverman model (1988), there are four dimensions of how students learn: visual/verbal, sensing/intuitive, active/reflective, and sequential/global. The ‘Input’ dimension (visual/verbal style) is one in which visual students learn best through pictures, diagrams, flow charts, tables, while verbal students learn best through written explanations and spoken words. The ‘Perception’ dimension (sensing/intuitive) involves sensitive learners preferring facts and rote learning while intuitive learners would rather learn with theories and mathematical models. The ‘Processing’ dimension (active/reflective) includes active learners who often process information through physical activity or discussion. Reflective learners, however, prefer introspection and like to think things through first before acting.

At the ‘Understanding’ dimension (sequential/global), sequential students solve problems and gain understanding about situations through a linear, step-wise fashion which is logical and systematic. Global learners have to see the ‘big picture’ before tackling the details of the problem. Digital natives are also said to be able to process information rapidly as well as multitask, meaning that they could be listening to music, talking on the mobile phone and also playing computer games simultaneously (Brown, 2003). Learning style greatly influences the learning process, and hence the outcome (Vincent and Ross, 2001). Figure 1.2 illustrates the various types of learning styles according to Felder and Silverman (1988).
In Figure 1.1, there are four dimensions, namely; input, processing, perception and understanding, which were diagrammatically presented. Under each dimension, there are two categories. The student belongs to one of these categories, depending on their learning style.

Academic performance basically involves the cumulative grade point average (GPA) at the time this study took place. The GPA was measured on a 4-point scale. The cumulative overall GPA for three years (6 semesters), from Level 100 to Level 300, was used in this study. This cumulative GPA provides the average grades, which combines continuous assessment (assignments, projects and quizzes) with their examination marks. This is awarded in all courses taken by the given student during his or her three academic years.
This study looked at science students who were in Level 400, in their first semester. In spite of many studies, ICT usage on students’ academic performance remains indeed a bit complicated to measure and much open to rational discussions. But, not withstanding, there are many benefits in using ICT tools, especially mobile technologies to support and influence students’ learning.

Not much research has been done in regard to the influence of mobile phone technologies on students’ academic performance. There is, however, much research on the influence of ICT on student’s learning. For example, the findings conducted by Kulik and Kulik (1991) reported that students in the computer-based instruction (CBI) classes had higher exam scores than students who were taught traditionally without computer technology. As a result, it was observed that the use of computer technology in education had a significant positive effect on students’ academic performance.

Livingston (2009) advised lecturers that instead of being annoyed with the mobile phone revolution, they should put effort towards seeing how best these devices can be used to support educational experiences and services. Amenya (2009) observes that the profuse use of mobile phones, wireless internet connectivity and video conferencing technologies should make it achievable for lecturers to implement these mobile technologies as a support to their teaching. Similarly, Prensky (2004:4) in support of using mobile phone technologies in learning has emphasized that:

Mobile phones are not just communication devices sparking new modalities of interacting between people, but they are also particularly useful computers that fit in your pocket, are always with you, and are always on. Like all communication and computing devices, cell phones, can be used to learn. So rather than fight the
trend for kids to come to school carrying their own powerful learning devices – which they have already, paid for! – why not use the opportunity to our advantage?

In their study, Gulek and Demirtas (2005) observed that students who used mobile technologies had increased collaboration, participation, access to information, time spent on assignments as well as improvement in research. Students also showed independent study, a more active learning approach, problem solving skills, critical thinking and showed greater enthusiasm in using mobile phone technologies. Gulek and Demirtas (2005) further explains that mobile phone, just like any other instructional technology, are not supposed to substitute personal interactions between lecturers and their students, but rather should be used as an additional means to supporting and enhancing students’ learning experiences. Although, there are benefits that come along with the use of mobile phone technologies, it certainly does not come without challenges.

It was found in the study conducted by Joan Ganz Cooney Center that most of the teachers perceive mobile phones to be distractions and are of the view that these devices should not be used in school (Shuler, 2009). According to Shuler (2009), presently there is no widely accepted learning theory for the use of mobile technologies, hence, hindering the effective evaluation, pedagogy, and development of new applications for learning. Physical features of mobile phone technologies that may inhibit a most advantageous learning experience consists of limited text entry, undersized screen size, and reduced battery life (Shuler, 2009). It is against this background that the study examined the influence of the mobile phone on science students’ academic performance in Ghanaian public universities.
1.3 Statement of the problem

In Ghana, the mobile phone currently is the most accessible mobile technology that most students possess. The mobile phone is an effective technology that Ghanaian students already own, and their potential is continuously growing. When this tool is exploited, it can even be used even during lectures (Bright Hub Education, 2012). Mobile learning, therefore needs to become a significant part of science education.

The study of Science and Mathematics is a major problem for many students globally and is not an exception for students in universities in Ghana (Brew, 2011). As a result, a good number of students in the Sciences do not perform as well as students in Humanities (SRMIS, 2012). Many of these students find science to be a difficult and demanding discipline as compared to other areas. This is especially because it deals mainly with complex concepts, theories, complicated laws and models. Studies that have been conducted have focused on the inability or the weakness of the student to understand the concepts. Indeed the assertion that students do not perform well in Science and Mathematics may be linked to the fact that students are not engaging in the frequent use of mobile phone technologies to support and supplement their learning experiences, as these technologies assist in simplifying concepts and could lead to improved academic performance. It is, therefore, necessary to look at this technology, with a view to understanding how beneficial it would be in learning of science.

Not much empirical study has been conducted in Sub-Saharan Africa, particularly Ghana to identify the current status of the usage of mobile phones for learning purposes. Research has been done in North America, Europe, Asia, South Africa and East Africa on
mobile learning (Ally, 2009; Brown, 2003; Bustos & Nussbaum, 2007; Sharples, 2000) but researchers concentrated on other mobile devices such as iPODs (Perlman, 2005), iPADs (Warschauer, 2011; Corlett & Sharples, 2004; Goodwin, 2012; Brand et al., 2011), laptops (Gulek & Demirtas, 2005; Weaver & Nilson, 2005; Warschauer, 2006; Wurst et al., 2008) and PDAs (Cochrane, 2005; Maag, 2006; Corlett et al., 2005; Akkerman & Filius, 2011). The essence of this research was therefore to answer key questions relating to the support of mobile phone technologies on students’ academic performance in Ghanaian public universities.

1.4 Purpose of the study

The main purpose of this study was to find out the extent to which the use of mobile phones improves university students’ academic performance in science in public universities of Ghana.

1.5 Objectives of the study

This study set to address the following objectives:

a. To examine the type of mobile phone technologies available for students taking science in the university

b. To assess the students’ level of academic satisfaction with the use of mobile phone in learning science

c. To establish the role the various types of learning styles play in influencing the use of mobile phone technology for learning among students in science faculty

d. To investigate the influence of utilization of mobile phone technology on academic performance in science by university students
e. To determine the factors that influence mobile phone usage by university students in science learning

f. To examine the type of mobile phone technologies available for lecturers to support teaching of science in their universities

g. To propose a model that would support the use of mobile phone technologies to support learning science

1.6 Research Questions

This study has the following research questions:

a. Which types of mobile phone technologies are available for students taking science in the university and how frequently are they using these technologies?

b. To what extent are students academically satisfied with the use of mobile phone in learning science?

c. What is the role the various types of learning styles in influencing the use of mobile phone technology for learning among science university students?

d. What influence does the utilization of mobile phone technology have on academic performance of science university students?

e. What are the benefits and challenges influencing mobile phone usage by university students in science learning?

f. Which types of mobile phone technologies are available for lecturers to support teaching of science and how often are they using these technologies?

g. What kind of model would assist students and lecturers in using mobile phone technologies to support teaching and learning of science?
1.7 Research Hypotheses

The following null hypotheses were tested for the study at a level of significance of 0.05. Inferential statistics will be used to accept or reject the hypotheses.

$\textbf{Ho}_1$ There is no significant difference in the usage of mobile phone technologies in science and students’ demographic characteristics.

$\textbf{Ho}_{1a}$ There is no significant difference in the usage of mobile phone technologies in science and students’ gender.

$\textbf{Ho}_{1b}$ There is no significant difference in the usage of mobile phone technologies in science and students’ universities.

$\textbf{Ho}_{1c}$ There is no significant difference in the usage of mobile phone technologies in science and students’ age.

$\textbf{Ho}_2$ There is no significant relationship between students’ academic satisfaction and the usage of mobile phone technologies in science by university students.

$\textbf{Ho}_3$ There is no significant relationship between academic performance and utilization of mobile phone technology in science by university students.

$\textbf{Ho}_4$ There is no significant difference in the usage of mobile phone technologies in science and lecturers’ demographic characteristics.

$\textbf{Ho}_{4a}$ There is no significant difference in the usage of mobile phone technologies in science and lecturers’ gender.

$\textbf{Ho}_{4b}$ There is no significant difference in the usage of mobile phone technologies in science and lecturers’ universities.
**Ho₄c** There is no significant difference in the usage of mobile phone technologies in science and lecturers’ number of years spent lecturing.

**Ho₄d** There is no significant difference in the usage of mobile phone technologies in science and lecturers’ qualification.

### 1.8 Significance of the study

It is hoped that the findings of this study will benefit various educational stakeholders. It would be useful to science students in determining the many opportunities the mobile phone technology provides in their academic lives. Science lecturers would be guided on how integrating mobile phone technology will create a richer environment for teaching and learning. The mobile phone companies would be more informed and therefore invest in providing mobile phone technologies to universities with internet connectivity and smartphones at a reduced price.

Curriculum planners and policy makers would be aware of the numerous possibilities of using mobile phone technologies in learning, so as to assist in implementing and designing activities to support the various learning styles. The findings of this study would also complement other studies and provide appropriate information for content developers and mobile learning developers in designing mobile phone applications for science learning at the university level. This research would contribute to the body of educational research in that it explores students’ academic performance with multiple indicators of learning, which is satisfaction, learning style and performance. The research may provide literature so as to add more information on innovative uses of mobile phone technologies to enhance educational experiences of science university students.
1.9 Limitations of the study

This study involved the following limitations. First, even though, there are other mobile devices that can be used to support learning, this research was only limited to the mobile phone. Second, the use of mobile phone technologies would be limited to out of the classroom (not during lectures). This would prepare the student before lectures as well as supplement what has been taught after lectures.

1.10 Delimitations of the study

This study included the following delimitations. First, this study involved only undergraduate science students who were enrolled with the universities at the time of sampling and agreed to participate voluntarily. Second, students pursing degrees in Botany or Environmental Science, Biochemistry, Chemistry, Mathematics and Physics participated in the study. Third, other indicators affect academic performance, but for the sake of this study only academic satisfaction and learning style with the utilization of mobile phones was observed.

1.11 Assumptions of the study

The study is based on the assumptions that:

a. Most students and lecturers in Ghanaian universities have mobile phones.

b. Students’ demographic characteristics will directly or indirectly influence how the mobile phone technology is used to support learning experiences.
1.12 The Theoretical Framework

This study was guided by the constructivist theory of learning. More, specifically, the study was based on ICT constructivist learning environment theory (Papert, 1980). The theory was applied because, it was closely related to the use of technologies not only within the classroom environment but also beyond the classroom. A constructivist approach in the m-learning was relevant because this type of learning involved the active construction of knowledge. The theory is discussed in the proceeding section.

The constructivist approach to learning is pioneered by Piaget (1954) who believed that students construct their own knowledge based on their own experience. Additionally, Papert (1980) applied Piaget’s theories to students learning with computers. Thanasoulas (2002) notes that students construct their own knowledge through investigation and methods based on their prior understanding and experience, application of these to new situations and integration of the new understanding achieved by an active process of construction. Moreover, students construct new ideas or concepts based on what they currently know (Bruner, 1996).

Within a constructivist learning environment, lecturers are supposed to encourage students to initiate new ideas and find out principles on their own. Students need to make the transformation from a passive role to an active one in constructing knowledge and this is only possible when lecturers provide students with an environment which allows them to make their contributions to the learning process, and by giving them suitable tools to work with that knowledge (Thanasoulas, 2002). Chesterman (n.d.) emphasized that constructivist theory involves students actively constructing concepts based on
previous and recent knowledge that can be discovered through text, videos, animations and news bulletins with mobile phones.

The ICT constructivist theory is supported by Ally’s mobile learning model proposed in 2004. This model is vital in this study, since mobile devices present an exceptional chance for students to be surrounded by a practical perspective while at the same time having access to supporting tools. When students hold a web-enabled mobile phone, it allows them to take an active participation in what they are learning about (Naismith et al., 2004). When students use mobile phone technologies, a connection between the student and the device should be established in order for the device to assist the student learning. As a result students think critically about science while creating thoughts that otherwise would have been unattainable without the device (Naismith et al., 2004).

Figure 1.2 respresents a diagrammatical representation of the theoretical framework on the m-learning constructivist environment. In a constructivist environment, unlike the traditional way where the lecturer does all the talking and students only listen, students actually get the opportunity to take an active part in the learning process. The lecturer’s role is to facilitate students’ learning. Therefore, lecturers guide the learner in order to discover things on their own. In this way, students discuss with lecturers and recieve feedback instantenously.
Figure 1.2: A diagramatic representation of m-learning

Source: Adapted from Ally (2004)

From Figure 1.2, lecturers. This occurs in a constructivist m-learning environment. In a constructivist environment, the student receives the content and understands information according to their personal experiences and collaboration with other students. The lecturer then guides and reshapes the students’ experiences to meet the expected standard. The technology used in this study was the mobile phone. In a constructivist environment, teaching and learning does not end in the classroom, but goes beyond the classroom. For the sake of this study, mobile phone technologies were used either before or after lectures.
1.13 The Conceptual Framework

In developing the conceptual framework of this study, an attempt was made to investigate the possible nature of relationship between mobile phone technologies and educational experiences. Fig 1.3 exhibits the conceptual framework, which encompasses mobile phones technologies and the possible pattern of influence on students’ educational experiences.

Independent Variables

<table>
<thead>
<tr>
<th>Mobile Phone Technologies</th>
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<tbody>
<tr>
<td>- Group Conferencing</td>
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<tr>
<td>- Real chat</td>
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<td>- Email</td>
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<tr>
<td>- Audio/Video</td>
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<td>- Calculator</td>
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<td>- Dictionary</td>
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Intervening Variables

- Hardware
- Software (Mobile Apps)
- Connectivity
- Peer influence
- Competency of lecturer
- Competency of student

Dependent Variable

- Satisfaction

Academic Performance

Learning Style

Figure 1.3: Mobile phone technologies and educational experiences

Source: Author, 2012

Figure 1.3 presents a schematic plan, which involves students using mobile phones for conferencing calling, sending emails, reading digital materials and so on. These
technologies being used can be affected by hardware, software, lecturer competency, peers and also student competency. These technologies have influence on academic performance, which involves the academic satisfaction and learning style of the student.

Intervening variables have high possibilities of altering the trend positively. In this study, intervening variables include hardware, software, peer influence, connectivity, lecturer, peer influence and self. Hardware included the mobile phone and wireless campus network. Software included operating system used and educational mobile applications. In this study, dependent variable is academic performance involving academic satisfaction and learning style.
1.14 Operational Definition of key Terms

The following are the operational definitions of key terms used in this study:

**Academic Performance:** The GPA of the university student.

**Academic Satisfaction:** A measurement of the degree of approval by which mobile phone technologies and academic services offered by the university either fails to meet, meets or goes beyond a student’s expectation.

**Blog:** A website that allows students to reflect, share opinions and discuss various topics in science in the form of an online journal, where they can comment on posts and entries.

**Bluetooth:** A short-range wireless technology that lets students connect mobile phones to each other and to the Internet.

**Chat:** Text-based, real-time communications between or among two or more students.

**Collaborative learning:** A type of learning which involves a relatively small number of students form a group through which tasks are shared in an effort to achieve a common academic goal through mobile phone technology.

**Constructivist environment:** They are technology-based environments in which students are engaged in meaningful interactions, where emphasis is on students who interpret and construct meaning based on their own experiences and interactions.

**Conventional classroom:** An environment in which lecturers and students share the same physical locality and are involved in face-to-face teaching and learning.

**Digital immigrants:** A group of people who were not born into the digital era, speak an outdated language (pre-digital age) and are struggling to speak the new (digital) language.
**Digital natives:** A group of people who were born into the digital world and therefore understand the digital language of computers, video games and the Internet.

**Educational experience:** This involves the hands-on and interactive learning of a student, which includes satisfaction, learning style and performance.

**E-mail:** Text-based, delayed communications which are exchanged between and among students.

**Learning style:** The way a student consistently responds to and uses stimuli in the context of learning with the support of technology.

**Mobile application:** It is a piece of software that runs on the Internet on a smartphone, which can be downloaded from websites.

**Mobile phone:** The usage of wireless Internet to exchange voice messages, email, and small web pages, anywhere and anytime.

**Mobile phone technologies:** Those technologies (hardware/software) that deliver instructional content and learning materials in way that fits into students’ mobile phones for their digital lives.

**MP3:** It is a digital music format for creating high-quality sound files in which students use to download audio files so that they can listen to audio lectures at any time or place.

**Multimedia Messaging Service (MMS):** It is a technical standard to provide lecturers and students messages with the addition of rich media (audio, video, etc.).

**Personal Digital Assistant (PDA):** A palmtop computer used by students for simple word processing and spread sheeting.

**Podcasts:** A digital audio or video file published and available for download through syndication on the World Wide Web.
**QR (Quick Response) code:** A two-dimensional barcode which a camera phone equipped with the correct reader software can scan to provide information for the student.

**Science students:** Those students who are pursuing programs in the area of science.

**Short Message Service (SMS):** It is a convenient and cost effective way of text messaging important information to students through their mobile phones.

**Smartphone:** It is an electronic device that combines mobile phones with a PDA, camera, video, mass storage, MP3 player, Internet access, and networking features in one compact system.

**Wi-Fi (Wireless Fidelity):** A wireless networking technology that allows mobile phones and other devices to exchange data or connect to the internet over a wireless signal.

**Wireless networking:** The ability of devices to connect to the Internet or send signals to other devices without being connected by physical wires.

### 1.15 Chapter Summary

This chapter of the study addresses the influence of mobile phone technology on science students’ academic performance in Ghanaian public universities. This study recognizes the use of the mobile phone to support teaching and learning. In the study, statement of the problem was identified, objectives and research questions were stated, theoretical and conceptual framework were diagrammatically presented. Assumptions were made, limitations and delimitations were specified and operational definitions of key terms were stated.

The next chapter is a review of recent literature and includes results of researches and projects related to learning with mobile phones.
CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.1 Introduction

This chapter reviews the literature on what others have done globally, in African countries and in Ghana. This chapter is divided into two sections, namely; literature related to main concepts and literature related to study objectives.

This section reviews the literature related to main concepts under the following subheadings: conventional ways of science teaching and learning, constructivism and ICT in a science environment, the changing technological science classroom environment and the adoption of m-learning in developing countries.

2.2 Conventional ways of Science Teaching and Learning

Traditionally, the major concentration in education was on how the student was able to master specific content. Lecturers were perceived to be the most important sources of knowledge and therefore had the task of transferring their knowledge to the students (Brown, 2005). Consequently, in the traditional classroom setting, lecturers usually did all the talking while students only listened (Flanders, 1973; Devinder & Zaitun, 2006). As a result, students were only supposed to ‘chew and pour’ the content the lecturer had passed on previously.

Conventional methods of education in the lecture rooms generally involve the transfer of knowledge on complex concepts. The conventional approach to science teaching includes lecture and discussion sections. Science lecturers present students with only text for
substantial supplementation and reinforcement of course topics in which they are supposed to rely (Pursell, 2009). Given this gap, it is only appropriate that students obtain academic information such as essays, articles, eBooks and diagrams which can support their learning experiences, hence improving their academic performance.

Motiwalla (2007) emphasizes that learning on mobile phones can never replace the conventional classroom, but rather could be used as a complementary learning tool. In a survey of 90 engineering university students on M-learning, Wendeson and colleagues (2011) found that most of the respondents were willing to use this technology as a complement of conventional learning. They believed that M-learning was the best approach to complement the current conventional learning. Whereas in conventional classrooms the main aim is to transfer knowledge from lecturer to student, m-learning rather allows students to take an active role in the learning process (Dela Pena-Bandalaria, 2007). Therefore, it is recommended that students use mobile technologies in higher institutions to support their learning.

In most conventional science environments, students are not given the opportunity to ask questions, interact socially with other students, discover and solve issues on their own. Instead, students are presented with only a predetermined view of versatile issues and a set of facts, which means that there is no collaboration between students and so they are forced to learn on their own (Devinder & Zaitun, 2006). This creates great difficulty in understanding and application of concepts since conventional classroom environments often do not allow discussion with peer classmates.
Construction of new knowledge needs to be emphasized rather than the student demonstrating knowledge of what the lecturer told them. The constructivism approach to learning is important in science education and lecturers need to accept it and be more understanding and approving of how students construct their knowledge. It may be vital for students to be given the opportunity to construct their knowledge from their experiences and collaborate with their course mates in order to share ideas. Students should be able to take the extra mile and research topics that would be treated in class, so that there will be discussion and interaction between the lecturers and the students in order to get a better understanding of the content. Such learners are likely to be self-reliant and critical in analyzing information (Devinder & Zaitun, 2006).

Universities merge instruction, learning, research as well as professional development (Cheese, 2003). In this technological era, lecturers must capture the chance to use mobile phone technologies in their teaching in addition to encouraging students to use these mobile phones in learning. As a result, the adoption of using mobile phone technologies in education will assist in supporting teaching and learning.

2.3 Constructivism and ICT in a Science Environment

In the last three decades, constructivism has played a crucial role in science education. It is basically a means that involve thinking about knowledge and then coming to know, which includes both difficult concepts and the processes of science (Vavolua, 2005).

Constructivism has its pioneers as Piaget (1954), Vygotsky (1978) and Papert (1980). This philosophy of education moves emphasis from a teacher-centered to a learner-
centered approach (O’Malley et al, 2005). Constructivism is when students take an active role in their own learning and develop new and existing knowledge from their prior experiences through collaboration, conversation and interaction with others as well as contextualizing and reflecting what they are learning (Fisher & Baird, 2007). Ally (2004:4) in further explaining constructivism has stated that:

Constructivism is a theory of learning that postulates that learners are active during the learning process and that they use their existing knowledge to process and personalize the incoming information.

The constructivist learner basically interacts with the environment and therefore achieves an enhanced understanding of the world. Learners develop their own ideas and discover solutions to their own problems. The theory states that the learner actively constructs new ideas build on their current knowledge (Vygotsky, 1978). Just as Piaget’s (1954) describes how a child forms their own understanding that was build on prior understanding. Papert (1980) further developed the Piaget’s theory to older children’s learning with computers. Papert saw an era of the PC that presented text, graphics, sound and video through input devices such as mice and joysticks, which offered numerous potential for interactive learning activities.

Constructivists assert that students understand knowledge and the world according to their personal experiences. Students also learn by observing, processing, interpreting and then personalizing knowledge as well as contextualizing what they learn. For instance, this may involve application and acquiring of personal meaning that allows students to develop problem-solving skills through learning by doing (Ally, 2004). Zurita and Nussbaum (2004) suggested that mobile phones could be utilized to encourage
constructivist educational activities through group collaboration, motivation improvement, interactive learning promotion, cognitive skills development and its association with real world experiences. Mobile learning, therefore, enlightens existing ways of learning from a different angle in which learning can be dealt with across life transitions (Haythornthwaite & Andrews, 2007). Within the constructivist learning paradigm, mobile phone technologies are able to engage students in learning activities that allow them to think and understand a particular learning scenario (Fisher & Baird, 2007).

Fisher and Baird (2007) asserts that m-learning supported by the constructivist theory points out the growth of a software that has numerous advantages which includes the application of collaborative and communicative tools as well as accessing information in order to permit students to learn from different perspectives. In line with this, mobile phone technologies can be supported to provide concise course notes, summaries, assignments and tutorials directly to students after each class or topic is covered. An example of constructivist approach is a system where the student is involved in a realistic situation and utilizes support tools from previous experiences and prior knowledge in order to deal with the situation at hand and transmits, interacts and conveys their knowledge with other students (Averianova, 2012). With mobile phones students can construct their own knowledge and share it freely with their course mates at anytime in any place (Naismith et al, 2004).
2.4 The Changing Technological Science Classroom Environment

Education is a kind of communication where the lecturer is supposed to assist the student in applying knowledge to problems and technology allows this communication to take place and hence changing the way we teach and learn (Rajasingham, 2011). ICT supports diverse learning needs and styles of students so that they are able to deeply process and understand information (McCombs, 2000). Current research recommends that undergraduate students utilize technologies in supporting their learning and great diversity exists in how frequently the technology is used, the types of technologies adopted and their willingness to incorporate technology into learning (Kennedy et al., 2008).

Honey et al (2005) found strong evidence that modern technology supplements good teaching through extending their reach and expanding their students’ learning experiences beyond the classroom. Specifically, these modern technologies can assist students to deeply explore and integrate information, have a higher level of thinking skills and increase engagement by encouraging them to create, discover, experiment, access information and model complex phenomenon. Tileston (2000:235) in supporting technology has noted that:

Technology is a tool that can help teachers embody best practices to create an enriched and collaborative learning environment, meet a variety of learning style needs, support learning transfer, and assist with the attainment of long term memory and deep understanding . . . Technology possesses unique capabilities for delivering instruction and designing intellectually stimulating real-world assessments.
Prensky (2001) claimed that teaching must transform in order to meet the needs of present digital learners. Technology savvy students are emphasizing on the use of portable devices such as mobile phones in accessing information and immediate communication (Pollara & Broussard, 2011). Technological advancements like computers, projectors, PowerPoint presentations, digital cameras, mind training software and other technologies have enormous potential for lecturers to help science students understand science concepts without difficulty. As a result, visual explanation of difficult to grasp concepts, make learning more interactive and interesting (Pandey, 2011).

Technologies have restructured the way education is perceived during the past few years as they offer a chance in accessing information, engaging and manipulating resources as well as opportunities for communication of ideas and collaboration. In fact, these applications have been considerably used in numerous ways with students of different ages because of the benefits to support learning (Avraamidou, 2008). That technology is influencing almost every area of our life and especially in academics, is an undisputable fact.

Technology presents a tremendous platform where students are able to gather information in multiple formats and then arrange, connect, and find out relationships among facts and events. In essence, the tremendous development in the potential of mobile phone technologies and the current rapid increase in accessibility of mobile phones in combination with their apparent affordability have led to the recognition of an ubiquitous learning tool by several researchers and educators in higher education (Pollara &
Broussard, 2011). Even though this technology is available, lecturers still adhere to traditional instructional methods (Rajasingham, 2011).

For successful implementation in use of mobile phone technologies to support learning, the UNESCO Workshop Report (2005) suggests; giving students the opportunity to contribute to the curriculum, concentrating on education and not just the technology, thinking about learner styles and needs, developing an inclusive student and teacher training process and then testing the learning activity before implementation. Consequently, efforts must be made in encouraging the use of mobile phone technologies as support for what has already been taught in the class. To derive optimum benefits, students must take the step forward to actively find more information on the topics discussed in class.

2.5 Adoption of m-learning in developing countries

Most countries in Africa, such as Ghana and Kenya are increasing the adoption and utilization of the internet, which can create immense possibilities (Leary & Berge, 2006). Between 2002 and 2006 several research studies reported findings indicating that the use of m-learning was growing and was becoming more common place in the learning environment (McConatha et al, 2008). As a result, students are finding out ways to use mobile phones to support their learning experience, implying that lecturers need to be committed in exploring different ways in which they can deliver educational products and align them to fit into students' digital lives as well as their mobile phones (Prensky, 2004). Young people in Ghana were extremely interested in the ability to learn at a time of their choosing and while “on the go” (GSMA mLearning, 2012). Many studies
(Attewell, 2005; Commonwealth of learning, 2008; Sharples, 2004; Brown 2003; Duncan-Howell & Lee, 2007; Haung et al., 2010) have shown the significant possibilities of mobile technologies when being utilized to enhance teaching and learning.

Mellow (2005:470) captures the importance of mobile phones in learning and he remarks that:

"Phones are no longer toys; they are powerful communication tools, if we choose to use them. Whether we like it or not, whether we are ready for it or not, mobile learning represents the next step in a long tradition of technology-mediated learning."

Clark (2007) stressed that a few researchers dated the foundation of mobile learning to the innovation of the PDA, approximately thirty years ago. A good number of PDAs nowadays have numerous functions as well as the software of a laptop. Most PDAs can be used as mobile phones with extra functions and capabilities, such as internet connectivity, watching videos, listening to audios and playing games (Ismail et al, 2010).

Handheld computers are currently at the forefront in the development of technology. This involves pocket-sized computers and wireless connectivity presenting ‘anyone, anytime and anywhere learning’ (Pownell & Bailey, 2001). The key reasons why students should use mobile phone technologies to support their learning are that they aid in motivation, assist in organizational skills, promote a sense of responsibility, encourage both independent study and collaborative learning, work as reference tools and can be utilized to assist track their progress and for assessment (Pownell & Bailey, 2001). Mobile phones enhance the effectiveness of learning material since in addition to text media-rich elements such as graphics, audio and video are incorporated (Chalk media, 2009).
Mobile phone technologies present another vision of utilizing handheld devices in wireless classrooms for computer supported cooperative learning (Farooq et al, 2002). Students in m-learning environments have the opportunity to choose when they are accessing resources for learning purposes, where they are learning and how they are using the learning materials (Solvberg et al, 2007). Mobile phone technologies encourage micro-learning as a new and efficient way of learning where students are presented with information that is broken down into smaller units that is much easier to comprehend (Habitzel et al, 2006) and students digest these small bits of information while on the move (Chalk Media, 2009).

M-learning is progressively being integrated into education in Ghana. Recently, in a 2011 workshop in Ghana with the theme: Harnessing mobile technology for tertiary education: Using m-learning Platform to provide ubiquitous teaching and learning, the stress was on how m-learning could be facilitated in institutions of higher education. The importance of the workshop was basically to add to the national debate on the utilization and demonstration of m-learning in Ghana.

The workshop in Ghana was largely motivated by the reality that mobile devices were becoming smaller, had more powerful functionalities and were becoming more widespread among young people, especially for learning purposes. The workshop incorporated awareness on the potential of employing mobile education in Ghana as well as producing a broader foresight in the role of m-learning (Stakeholders’ Workshop, 2011). M-learning signifies learning that is “not just for the sake of producing a storage
of knowledge, but rather correspond to learning that is ‘just-in-time,’ ‘just enough,’ or ‘just-for-me’ (Traxler, 2007, p. 5).

In public universities, the nature of m-learning should be that students can get access to the internet on their mobile phones anytime but also anywhere they spend their time on campus (de Heer-Menlah, 2008). M-learning can encourage individualized learning, support collaboration with other students, enhance student engagement, improve attendance and participation as well as encourage easier access to information (Friend, 2011). As the increase in use of mobile phones in education increases in Africa, Ghana has taken the bold step of harnessing the rich opportunities that mobile phones can add to learning. Prensky (2004) concludes that mobile phones should be used to our advantage, since they are powerful computers that fit in our pockets or purses and are with us all the time.

Brown (2005) investigation attested that m-learning had numerous benefits for students in Africa. He believed that the most suitable mobile technology for African students was the mobile phone because of practicality, usability, and cost-effectiveness. According to Trifonova, approximately 600 Italian and 200 Bulgarian students participated in a study from the University of Trento, mainly from the Science and Engineering disciplines. The results revealed that students used mobile learning services in order to access supporting educational information online or off-line, communicate with their lecturers and other students, collaborate with their peers and receive supporting educational information through SMS/MMS on demand or request.
Additionally, the main services which m-learning can offer are supporting rich and actual educational information, ensuring fast and convenient access to learning materials, sending information on a regular basis through SMS/MMS about academic news or changes, downloading and reading offline files, presenting brief and clear information on topics and enhancing interaction between students and lecturers via mobile phones (Trifonova, 2006).

This section reviews the literature related to the study objectives under the following subheadings: mobile phone technologies available for science students in supporting learning, students’ satisfaction on the use of mobile phone technologies in learning science, learning styles and mobile phone use in learning science, the use of mobile phone technologies on academic performance, factors that influence mobile phone usage in science learning and mobile phone technologies available for science lecturers in supporting teaching.

The use of mobile phone technologies on academic performance is becoming an area of interest in teaching and learning. Currently, there are more opportunities for learning by linking to mobile phone technology than for other existing or thriving implementations. Educationists are beginning to see that mobile phone technologies have the potential of being used in learning; especially since the bandwidth of mobile phones has increased considerably, therefore these technologies will certainly become a significant part of education in Africa, especially Ghana in the near future.

The direct relationship between using mobile technologies and students’ performance has been the focal point of extensive literature throughout the past twenty years (Youssef &
Dahmani, 2008). Several recent studies have tried to establish the significance of mobile technologies in and out of the classroom and their impact on student’s performances. Studies show that university students’ awareness and utilization of technology continues to steadily increase. As a result, students who use technology in learning attain academic success (Chase & Herrod, 2005).

2.6 Mobile Phone Technologies Available for Science Students in Supporting Learning

Mobile phone technologies promote learning that is anywhere and at anytime, improve 21st century interactions, easily fit with learning environments and encourage a more personalized learning experience (Shuler, 2009). As a result, approximately eight percent of Apple's applications are specially designed for educational purposes (Chen, 2011) and Android has over 50,000 mobile phone applications (Dawson, 2010). Sharples (2005:1) explains the different eras of technology by noting that:

Every era of technology has, to some extent, formed education in its own image . . . In the era of mass print literacy, the textbook was the medium of instruction, and a prime goal of the education system was effective transmission of the canons of scholarship. During the computer era of the past fifty years, education has been reconceptualized around the construction of knowledge through information processing, modeling and interaction. For the era of mobile technology, we may come to conceive of education as conversation in context, enabled by continual interaction through and with personal and mobile technology.

Electronic books (e-books) are digitized forms of books that can be read on mobile phones. They have been fundamentally suggested as educational tools since they present a less expensive access to textual materials, avail more updated information and provide a more interactive experience with content (Savill-Smith & Kent, 2003). In a biology
course, 10 pocket e-books were used to substitute textbooks. As a result students were able to read their e-books in many places because of its size, weight and portability compared to a course that needs a variety of different science textbooks (Simon, 2002). In a study by McConatha and colleagues (2008), 112 university students found out that reading on mobile phones was more productive than reading on paper when preparing for examinations. Public Universities in Ghana have integrated ICT tools in teaching and learning and are steadily shifting from lecture notes and textbooks only, to electronic resources (Afari-Kumah & Tanye, 2009).

In addition, Cuing and Wang (2008) noted that universities in United Kingdom are utilizing mobile phone technologies in order to store and retrieve information such as e-books and educational materials hence making learning practices more successful. In another study, teachers were offered strategies on how they could simply convert educational materials into e-books, multimedia resources or interactive exercises with the aim of being utilized on a variety of mobile phones (Lam et al, 2011). This study found that teachers were eager to find new methods in presenting information to their students and therefore found the mobile phone as a relevant teaching tool. Furthermore, some universities have recently started utilizing PDAs or mobile phones for storing and retrieving information such as e-books, educational materials and timetables (Kim, Mims, and Holmes, 2006; Ferry, 2009). As a result, students found this technology useful in storage and retrieval of information and believed that this learning tool provided greater accessibility and convenience. This technology enhanced the means for learning and
collecting information which was used to support learning beyond the classroom environment (Goundar, 2011).

One of the most prevalent features of the mobile phone is SMS. Although SMS has been around since 1992, its use for educational purposes has been limited. Most students own mobile phones and are communicatively competent with SMS in higher education institutions in Ghana. SMS is also an application available on mobile phones that can be intentionally used for science learning. Brown (2005) observed that SMS offered information that was “in mass and almost immediate.” He went further to explain that there was a decrease in cost of distributing relevant important information and provided just-in-time information by using messaging services. However, observations have shown that this is not the case in many developing countries, including Ghana.

In South Africa, text messaging is being extensively used in education. SMS is technologically and functionally straightforward and ranks favorably in terms of user convenience (Brown, 2005). Text messaging provides feedback on lectures, ideas or projects as well as alerting students of important dates, deadlines and cancelled/rescheduled classes, homework, quizzes, exams or updates on marking or on assignments available for collection. Lecturers can ask their students questions or share views or information with their students. Science students can also participate in peer-tutoring so that those who understand the topics taught in class could aid those who were not able to grasp the concepts presented in class. Finally, it can be used for consolidation of tasks and suggestions for revision (Lomine, 2009).
The concept of receiving daily SMS to remind students of course material in a research was revealed to be effective and well received, where 84% of students found it relevant and 83% took pleasure in it. Students found these text messages positive as well as useful and perceived it as the best medium for receiving important information which was received conveniently and automatically (Clarke et al., 2008).

MMS is the latest means of mobile messaging application. Consequently, fewer institutions in higher education have begun to experiment MMS as a prospective means of teaching and learning. MMS basically provides automatic and instant delivery of personal messages in the form of text, sound, images and video messages, which has the potential to improve teaching and learning in the near future (Trifonova, 2006). Both SMS and MMS are inexpensive means of getting essential information immediately and efficiently.

Another mobile phone technology that can be used in science learning is QR codes. This type of technology is a two-dimensional bar code that can be read on any mobile phone that has a built-in camera. Many mobile phones have the ability to download free QR code readers. Once the code is accessed, it allows users to receive immediate information, such as text, video, an image or link to a web page and so on. QR codes can be utilized in learning in order to display printed materials such as lecture notes, links to reading materials or labels of equipment in a science laboratory. In a chemistry classroom, one practical example of QR codes would be instruments with those barcodes on, which connect students to their correct operating instructions (Williams & Pence, 2011).
In a study in Japan, 333 university students were surveyed regarding their use of mobile phones. All students reported owning a mobile phone, out of which 99% send e-mail on their mobile phones. Students use mobile phone technologies to support educational experiences, in that 66% of them e-mail their peers about classes and 44% e-mail for studying (Thornton & Houser, 2005). Chen and Chung (2008) considered the effectiveness of mobile devices in improving English learning of Taiwanese students and assessed the attitudes of students towards using mobile devices for English learning. An experimental design was employed in which the results revealed that m-learning can promote students’ English learning and interest. Most students rated the mobile device as being positive. Mobile devices allow learning to take place in a more flexible way.

English vocabulary lessons were emailed to 44 Japanese university students on their mobile phones. The results revealed that students preferred receiving vocabulary lessons on mobile phones rather than PCs and 99% of them considered this to be a valuable teaching method. Also a Web site explaining English idioms was created where students created animation shows, in which each idiom’s literal meaning would show a video of the idiomatic meaning. Materials in text form included explanations, scripts and quizzes. Seventy percent of the students rated these videos as being highly effective (Thornton & Houser, 2005).

Therefore, through mLearning, students are given the flexibility of submitting assignments, downloading notes, discussing and performing activities according to their needs and time requirements. Students were also willing and interested in using SMS and
MMS, voice calling, video conferencing, Bluetooth and Wi-Fi as mediums for learning as well as the internet, organizer and calculator (Marwan et al, 2013).

2.7 Students’ Satisfaction with the Use of Mobile Phone Technologies in Learning Science

Satisfaction is the feeling of pleasure or disappointment achieved from evaluating a perceived performance (outcome) in relation to a learner’s expectations. If the performance falls short of expectations, matches the expectations or exceeds expectations then the student is either dissatisfied, satisfied or highly satisfied (www.wikipedia.com).

According to Muhammad et al (2011), the results of a study revealed that students can use mobile phone technologies for exchanging relevant information with their peers. This technology assisted in improving students’ academic performance. The level of the quality of education increased, since crucial and helpful information was conveyed to their peers. Students were observed to be using the dictionary, thesaurus and calculator that were also available on their mobile phones. Students therefore felt highly satisfied with the mobile phone facilities accessibility, instructional methods and collaborative teamwork with their peers (Muhammad et al, 2011).

Through mobile phones students and their peers are able to disseminate, combine, and share information easily and conveniently. As a result there is more encouragement and collaboration among students. Collaborative learning activities encourage teamwork. These activities involve students coming together to work on a particular theme, where they brainstorm, question and contribute to a compilation of materials on a topic. This may include newsgroups, email, web pages and video-conferencing (iEARN Australia
Collaborative Projects, 2002). Additionally, Stead (2004) states that in m-learning projects, students that engage most in collaborative activities gain more learning experiences either by sharing technologies or by transferring data between mobile phones.

Business college students in a large urban university were surveyed to determine whether the introduction of laptops contributed to student academic performance, student academic satisfaction and constructivist teaching activities (Wurst et al, 2008). The first year group of students did not have laptops while the second and third year group of students were given laptops by the university. The results showed that students observed their learning environment to be more constructivist than their traditional classrooms. Students with laptops reported no statistical improvement in student achievement as measured by GPA and statistically less satisfaction with their education as compared to students with no laptops (Wurst et al, 2008).

Two classes (120) of nursing students had their exam scores compared, where the 2007 class had content presented in the traditional lecture format whereas the 2008 class had the same content presented through podcasting (Vogt et al, 2009). Both techniques used the same lecturers and examination questions. The results showed that there was no significant difference in correct responses on examination questions between the traditional lecture technique and podcasting. Examination scores were improved with the first podcast, same for the second, but got worse with the third podcast. Students were generally satisfied with the experience of using podcasts and remarked positively on its
convenience. Therefore podcasting can have a positive impact on student’s satisfaction (Vogt et al, 2009).

Wu and Lai (2009) observed that PDAs were used in a clinical nursing course where students recorded information, organized ideas, assessed patients and interacted as well as collaborated with their classmates during clinical practicum. This mobile technology provided students with the opportunity to enhance their learning and also facilitate peer cooperation and interaction with their instructor (Wu & Lai, 2009). In another study conducted by Alzaidiyeen et al (2011), 250 students participated. The results of this study showed that attitudes were significantly different according to students’ gender. Males’ attitudes in the use of PDA’s were significantly higher than females. But, in terms of age, there was no significant differences found in students’ attitudes towards the use of PDA. Hence, PDAs can have a positive influence on students’ learning.

2.8 Learning Styles and Mobile Phone use in Learning Science

Learning style is how an individual prefers to learn. Learning styles vary and these differences become very crucial when it comes to academia. Hence, lecturers need to be more informed on the different types of learning styles in order to enhance learning. Felder & Silverman (1988) model was used in this research to define learning style as well as matching mobile phone applications with combinations of different learning styles (Franzoni & Assar, 2009). More recently, the Felder learning model concentrates on aspects of learning styles that are considerably important in IT education. This model assists students to learn at their own pace while individually providing their requirements in a personalized way using ICT tools (Zywno & Waalen, 2002). Students assimilate
information at their own pace through various means. Mobile phone technologies can be used to suit different learning styles.

Felder (1996) implies that students learn in different ways. Some concentrate on facts and data while others prefer theories and mathematical models. Some favor visual information like pictures and diagrams while others have a preference of spoken and written words. Oblinger (2004) has pointed out that the learning styles of the millennial student focus more on group work, experiential activities and the use of technology, which include strengths such as multitasking, positive attitude, goal orientation and a collaborative style. Some students prefer interactive learning whereas others learn better individually. In this respect, learning styles play a major part in how mobile phone technologies can be used in learning.

In one study, a questionnaire was administered in lectures and tutorials for nine subjects across seven faculties of the university. Most students classified their ability with technology as 67.0% intermediate, 23.2% advanced users and 8.5% as beginners. Therefore, it is not all young people that may have a high level of digital literacy due to their exposure of technology (Oblinger & Oblinger, 2005). This study concentrates on learning styles from Felder and Solomon (2009) research, which has four dimensions, in which each student is characterized for each of these dimensions.

2.9 The Use of Mobile Phone Technologies on Academic Performance

Kulik (1994) study showed that, on average students who used ICT-based instruction were likely to score higher than students without computers. In a study conducted by Project K-Nect (2010), it was found that students that used mobile devices achieved
higher mathematics test scores and interestingly enough students were observed to utilize social networking facilities to help one another. Additionally, when undergraduate students are engaged in real-world activities that can actually represent the concepts they are learning about it can actually present a means of modifying and simplifying learning.

In Canada, a study explored the utilization of iPhones in accessing web-based grammar and vocabulary lessons for primary level French. Twenty-two university students were trialed in which the content consisted of five lessons. Respondents took a pre and post, multiple-choice test to evaluate learning gains. As a result, students who were involved in this study found these lessons relevant and were interested in taking more lessons using this technology (Ally et al, 2011). Another study described a Saudi Arabian project that examined the possibility of social networking through mobile phones in an English learning environment. The study revealed that social networking via mobile phones played a vital change in language learning fostering the shift from a teacher–directed instruction to a more collaborative and student–centered learning environment (Al-Shehri, 2011).

Technology can make students hopeful in reflecting their learning and considering its relation to the world around them (Waycott & Kennedy, 2009). This is especially crucial for science learning, in the sense that it involves increasing knowledge about complicated concepts, which in turn can be more significant if students are able to construct a relationship between their formal knowledge and their personal experiences (Vavoula et al, 2007).
Mobile phone technologies can also assist science students to construct a connection between learning science in the classroom and their personal experiences in the outside world (Waycott & Kennedy, 2009). Fozdar and Kumar (2007) conducted a research to better appreciate students’ attitudes and perceptions towards the effectiveness of mobile learning. Results of this research showed that adopting mobile phone into the learning environment can improve retention of science students. This could be done by supplementing and supporting teaching and enhancing students’ learning experiences. In South Africa, Motiwilla (2007) found mobile phone technologies effective and a useful supplementary tool for learning. This tool provided interaction, flexible access, convenient use and efficiency in delivering personalized content. Students found the interaction tools simple to use for discussing educational materials with other students and lecturers.

Vihavainen et al (2010) conducted a study involving the use of smartphones for the teaching of English and supporting of reading English by primary school students. Twenty-five students used smartphones to take pictures of one of the pages from the book they were reading. Later, this picture was sent to a web server in which the text was identified and returned to the students in any of the three types of tutorial exercises, which were: missing words, crossword puzzles, and text listening. The use of smartphones for this purpose was highly rated by the students.

Zurita and Nussbaum (2004) conducted a classroom experiment that compared the ability of two groups. Each group consisted of 12 Spanish primary school children. These students’ constructed Spanish words presented to them through either PDAs or printed
cards. The results revealed that those students from the PDA group had significantly higher test scores on constructing words than those from the printed card group. It was also found that PDAs took less time on the task and used less teacher support (Zurita & Nussbaum, 2004).

According to (Cavus & Huseyin, 2009), there were many different studies on whether sending educational text messages through mobile phones in education had positive effects and these included: improving learning and increasing understanding of difficult concepts; satisfying students’ needs, abilities and interests of learners; improving critical thinking skills; and using time productively. In another study, according to Evans (2008), he asserted that students were more interested in learning materials that were in the form of podcasts than those in traditional lecture notes or textbooks. Students observed podcasting to be helpful especially as a revision tool that was used to review content material on their own time after a lecture was conducted.

In another research, Zurita and Nussbaum (2007) researched on the support of computer technologies in teaching mathematics and the results revealed that students realized cooperation and collaboration was essential in achieving their goal and hence showed positive influence on students’ social interaction, motivation and learning. Also, Sivin-Kachala and Bialo (1998) reviewed 219 studies from 1990 to 1997 on the effect of technology on performance across all learning domains and different ages of learners. It was found that students in a technology rich environment experienced positive effects on their academic performance. Therefore, the usage of mobile phone technologies in
tertiary education can have a significant positive impact on students’ academic performance.

2.10 Factors that Influence Mobile Phone Usage in Science Learning

When discussing the factors that influence mobile phone usage in learning science, this includes the benefits as well as the challenges in the use of mobile phones in learning. This is discussed in the following sub-sections.

2.10.1 Benefits of Using Mobile Phone Technologies in Science and How Mobile Phones can enhance the Quality of Education

The booming of mobile phone technologies currently gives numerous opportunities for students to utilize mobile applications in supporting learning activities (Wendeson et al., 2010). Brown (2005) emphasizes that mobile phone technologies such as mobile teleconferencing and SMS can support interaction and collaboration. In addition, these technologies play an important part in education.

Many researchers (Robson, 2004) believe that mobile phone technologies can supplement the conventional learning in the classroom as well as create an environment beyond the classroom. In a research conducted by Gaskell & Mills (2010) it was proven that mobile phone technologies played an important role in education. Mobile phone technologies offered a major chance in enhancing access to learning and enabling many institutions, especially in higher education to develop learner support as well as learning opportunities in ways which would build on modern techniques.
Mobile learning is certainly capturing the attention of the student to a greater degree than passive learning and has immense possibilities. For example, students gain positive performance and confidence, while learning at their own pace, interacting with lecturers and communicating their ideas to a greater extent (Project K-Nect, 2010). A study by Shuler (2009) points out possibilities in which mobile phones can encourage educational experiences. Firstly, mobile phones offer opportunities for students to gather, access, and process information beyond the classroom and support learning in a real-world context. Secondly, mobile phone technologies encourage and promote collaboration as well as communication, which are considered vital for 21st-century academic success. Thirdly, mobile phones can help encourage instruction that is adaptable to individual and diverse learners.

Trinder (2005) stresses that mobile phones can be used in presenting documents, writing notes, playing educational games, listening to audio recordings and other sound files, viewing pictures and watching video clips plus taking photographs. Mobile phones offer numerous potential for teaching and learning, since they are light and flexible making them appropriate for digital reading or accessing content, mobile data collection or note taking in addition to access to free or low-cost educational mobile applications that are used in enhancing learning experiences (Warschauer, 2011).

In Japan, ninety-six English university students used iPads for creating PowerPoint type presentations, retrieving web-based multimedia resources, making voice recordings and accessing digital class handouts (Brown et al, 2012). The results showed that the iPad presented many benefits especially in speed, video viewing, and versatility. This
technology also brought to light its usefulness on task, familiarity and capability in application software. In an Iranian study, 30 high school students from the experimental group participated by writing sentences of between five and six words. These sentences were sent through SMS to the instructor and their peers. The control group also consisted of 30 students and did likewise by exchanging written papers. The purpose of the study was to investigate the effectiveness of SMS for English vocabulary acquisition. The results indicated that the SMS group significantly performed better than the control group on the post-test in vocabulary acquisition. Therefore, both teachers and students were of the view that the use of SMS had a positive influence on vocabulary learning (Tabatabaei & Goojani, 2012).

In the United Kingdom, Corlett et al (2005) conducted a study in which they reported that a small number of students who were given PDAs for one semester took part in an experiment on the potential and limitations of M-Learning in a college environment. These college students encountered some problems when using the PDA, which were limited memory and short battery life. In spite of this, the students believed that the PDA had a positive and promising impact on their learning.

Another research in the United Kingdom revealed that mobile phones had numerous benefits to support learning in and out of class (Hartnell-Young & Heym, 2008). Students in high schools used the stopwatch available on the mobile phone to time experiments, take photographs of the apparatus and results of experiments for reporting. Students took photographs of text and whiteboards for future reference and review. Lessons of teachers were recorded for revision. Students were observed using Bluetooth to transfer material
among classmates. Calendars or timetables were synchronized in setting reminders. Teachers sent text messages and email reminders to their students. Students also accessed and downloaded information from the internet and also transferred files between school and home (Hartnell-Young & Heym, 2008).

Huang et al (2010) also established that in a secondary school, mobile phone technologies can enhance students learning content conveniently and provide them with the opportunity to interact with others collaboratively anytime and anywhere. Averianova (2012) asserts that connectivity is an important feature on the mobile phone as it is the one needed to send and retrieve information via Bluetooth connectivity (transfers data within short distances) and Wi-Fi networks (transfers long distance data). Williams and Pence’s study (2011) indicates that the smartphone is an influential tool that is being used in the chemistry classroom. In chemistry, reference applications assist students learning chemical formulae, present detailed information on the elements, standard amino acids, and nucleobases permitting them to review and take notes on what they learn, visualize 3D structures, observe chemical reactions taking place and then test their understanding (Williams & Pence, 2011).

Other benefits identified were getting access to content at anytime and anywhere, promoting interaction as well as communication between students and lecturers, fostering student-centered learning, encouraging a media-rich environment, supporting various student learning needs and styles, facilitating peer collaboration and also improving the academic performance of students (Corbeil & Valdes-Corbeil, 2007). In addition, Attewell (2005) emphasizes that m-learning aids students in improving their literacy and
numeracy skills, supporting both individualized and collaborative learning experiences, assisting students in identifying areas where they need support, combating resistance in using ICT, removing some formalities from the learning experience which engages unwilling learners as well as increasing students attention and concentration spans for longer periods.

Prensky (2001) additionally points out that digital natives use their mobile phones in socializing in chat rooms through instant messaging, sharing information through blogs, collecting through downloading, coordinating and collaborating through wikis, exchanging information through peer-to-peer technology, reporting through their cameras and surfing the Web. Hence, mobile phones can improve students’ understanding of complicated concepts especially in science, facilitate appropriate and relevant social relationships with learners through collaboration, exchange and share information at any time and in any place, meet the needs and interests of learners as well as increase their abilities and critical thinking skills (Karim, 2012).

In United States, mobile technologies have numerous advantages. These technologies can be used in having current information about changes made in course scheduling, deadlines and upcoming events. Students can also access course materials so that they can learn at a convenient time and place (Bruce, 2010). They also can access links to relevant websites, videos, further reading and online tutorials (supplementary activities) that extend or support learning.

Mobile phone technologies also increase interactivity and collaboration through the use of discussion forums and chat rooms. Emails or text messages can also be used to give
instantaneous feedback of students’ assessment (Bruce, 2010). According to Schofield et al (2011), there are numerous possibilities in using mobile devices in supporting learning. Mobile phones provide different ways of inputting information via touch, stylus and voice; therefore allowing students to key in personal notes, observations and other relevant information needed for academic progress.

In the United Kingdom, mobile phones have been used to listen to audio clips, such as podcasts of lectures and interviews, which can be downloaded and accessed at any time or place. Majority of the students agreed that mobile learning utilization gave them more independence in their learning activities, provided more efficient ways of learning, trimmed down the time in getting learning materials, assisted in revision and promoted study group practices (Wendeson et al, 2010).

Mobile phones can make use of photos or videos through viewing as well as recording, sharing and transferring ideas or information with others, supporting evidence for assignments, allowing visual representations and mind mapping in organizing thoughts and ideas (Pilter et al., 2007). These technologies encourage communication between students and lecturers through normal calls, texting or emailing messages and using forums to create and discuss issues concerning their course subjects. Information gathering and research through search engines are encouraged as well as accessing websites to search for instantaneous information, accessing and downloading study materials or content for revision or practice, organizing personal learning schedules in order to monitor deadlines and set reminders, reviewing and managing daily learning activities and also staying informed about course context (Pilter et al., 2007).
Another simple tool that can be used to ask students to respond to objective questions about topics and content pertaining to their subjects is polling. This can take place in or out of the classroom and it allows lecturers to quiz students as well as assess their understanding before, during, and after a lesson. Additionally, Poll everywhere becomes a tool for providing instant feedback, a use of mobile phone technologies purposely designed at improving core instructional strategies (Pilter et al., 2007).

Mobile phone applications provide access to information for utilization which is available and include scientific calculators, periodic tables and dictionaries (Schofield et al., 2011). Berger (2001) adds the possibilities that mobile phone technologies can offer education, which include: having the freedom of organization both in and out of the classroom, collaboration among students living in different parts of the country, integration of information and the change from “anywhere, anytime” to “everywhere, every time.”

There are significant opportunities for supporting independent and individualized learning along with cooperative and collaborative learning through mobile phone technologies (Berger, 2001). Students need to discover the numerous possibilities of using this technology within and out of the lecture room. Lecturers must also support students using this technology during lectures. But, in Ghana, that is not the case, since students are not allowed to use their mobile phones during lectures. Lecturers and students, therefore, need to realize the potential of mobile phones and use this technology for both teaching and learning purposes.
2.10.2 Possible Challenges in the Use of Mobile Phones in Science Learning

Even though mobile phones are powerful with amazing speed, their screens remain comparatively small (Trifonova, 2006). As a result, mobile phone technologies can be a great hindrance triggering uneasiness because of the size of keypad and screen (Wang, 2007). Navigation is also difficult thus, making users lose more time in searching for information than actually reading it (Trifonova, 2006).

It was investigated that students in Massachusetts Lowell College of Management found that mobile phone keypads and screens were very difficult to use, especially when navigating, reading and typing messages. On the other hand, the m-learning applications used for interaction was straightforward, once students overcame the problem of user-interface (Motiwalla, 2007). Reviewed literature affirmed steadily that smaller screens were relatively complicated to use and slowed down browsing of pages on the Internet (Stockwell, 2008). Additionally, a major reason why some students are reluctant to use the mobile phone technologies for learning is that the Internet fees can be relatively high (Stockwell, 2008). Inappropriate use of mobile phones by students can be very problematic and distracting in class when students are found beeping their friends, sending inappropriate text messages, cheating and taking pictures during class hours (Kissko, 2010).

Brown (2005) explained that there was a great challenge in designing and developing appropriate learning environments that would be based on appropriate educational philosophies in order to ensure optimization of knowledge in the m-learning environment. The major obstacle for most educators and technology developers of the
future was discovering a means to ensure learning that is greatly personal and collaborative, one that is actually student-centered (Naismith et al., 2004). Learning is not supposed to come to an end once the lecturer has left the classroom, but rather there should be a transition from one learning mode to another. Hence, higher education institutions are required to concentrate on real and virtual spaces beyond the classroom with the purpose of encouraging learning (Oblinger & Oblinger, 2005).

One major challenge for teaching in tertiary institutions is to ensure that the learning environment encourages students to learn. Developments in recent technology have produced a new generation of computer-based learning environments that can support learning experiences (Solvberg & Rismark, 2012). In respect to that, lecturers need to exploit the pervasive use of mobile phones by students for learning purposes (Pursell, 2009).

Mobile phones can be disruptive and distracting when used in class, but these technologies can also be used as a learning tool, if used properly (Docksai, 2009). As a result, Burns and Lohenry (2010) recommended ways to overcome distractions caused by students who use their mobile phones during class hours. These include having a mobile phone policy, orientation on this policy, communication of mobile phone etiquette during class time, demonstration of mobile phone etiquette and reinforcement of mobile phone etiquette in the course syllabus.

Most lecturers see the mobile phone as a disruptive device instead of a learning tool. They believe most students lose their concentration or perform badly because they text or go online while taking down notes or the lecturer is talking. This challenge may be solved
by lecturers making their notes available to their students, before class, so that they have access to them anytime, anywhere. Lecturers can even add quizzes and educational games in order to enhance and support learning experiences. While possibilities are available to provide for new forms of learner needs, there is the major challenge for lecturers in redesigning instructional activities in order to maintain intellectual depth in a modern, hi-tech, mobile setting (Rajasingham, 2011).

2.11 Mobile Phone Technologies Available for Science Lecturers in Supporting Teaching

Lecturers indeed play an important role in the learning process. Prensky (2001) argued that the major issue facing today’s education was the lecturer and not the student. Students were technology savvy, but a good number of lecturers resist use of mobile phones. Duncan & Howell (2007:224) in support of teachers using new technology goes on to explain that:

As teaching professionals we need to consider the experiences and capabilities of our students and incorporate new technologies in a meaningful way within the tertiary context. This consideration is not only designed to motivate and engage the learners, but will also help prepare our students to be significant members of society. New technologies will continue to improve and have an impact on our teaching and learning.

Additionally, Sharples (2003) suggests that instead of perceiving mobile phones as technologies that disrupt and disturb when used in education, lecturers ought to take the advantage of the potential of these technologies and find different ways in putting them into good use to support teaching and learning, since students bring them to class anyways. Students are already discovering numerous ways in which their mobile phones
can be utilized in learning, hence it is vital for science lecturers to also determine how to deliver educational activities in a way that easily fits into their students’ mobile phones and also enhance students’ digital lives (Sharples, 2003).

Even though mobile phone technologies have vast potential in education, unless lecturers upgrade their teaching by learning how to utilize these technologies, there will be no transformation in the present generation of lecturers and students (Groundar, 2011). It was observed that lecturers still had a negative attitude towards the use of mobile phone technologies during class. But, in the more developed countries, the role of the lecturer is always changing (Sanjakdar, 2009).

Developing countries and Ghana especially endeavor to make more effort to enter and play a part in the fourth wave that involves using mobile communication technologies in education (Pownell & Bailey, 2001). Since, lecturers play a very important role in the learning process; it necessary for them to discover how learning will be able to positively transform the use of mobile phones in teaching and learning so as to encourage students to use them to enhance their educational experiences. Today’s generation of students are digital natives who insist on a media-rich environment in order to support their learning and lecturers need to provide this or they will be at a disadvantage (Maag, 2006). In spite of the increasing demand from students, mobile phone use in education worldwide is still fairly low, especially in Africa.

Increased technology places greater demand on lecturers who are challenged to take a clearer look at their instructional methods and think about supplementing it with mobile
phone technologies in order to support students’ learning experiences. A mobile learning environment should have collaboration between lecturers and students as well as between other students, so as to process information to create new knowledge that pertains to real-life situations (Rajasingham, 2011). The major problem for lecturers in higher education is to design instruction and develop an approach that involves bits of information in the form of text, audio or video clips that can fit and will be available on the mobile phone (Starr, 2003).

2.12 Summary and Gap Identification

Studies reviewed in this chapter showed several gaps that existed in relation to the current study. For instance, not much has been done with using mobile phone technology in science learning, although there is much recognition of the use of other ICT tools in learning. In previous studies, other mobile devices were utilized; especially PDAs, podcasts, laptops and iPads for learning. This study, therefore, investigated how the mobile phone can be utilized to increase students’ academic performance in learning science in universities.

Most studies have been conducted in Health Education (Vogt et al, 2010; Bloom & Hough, 2003; Robinson et al, 2013), Mathematics (Vanska & Roberts, 2011) and English (Thornton & Houser, 2005). Therefore, this study looked into the area of teaching and learning in Science and Mathematics. A few studies concentrated on secondary (Hartnell-Young & Heym, 2008) and primary school students (Zurita & Nussbaum, 2004). The interest of the study was university students. Despite, these expectations in ICT use, not much research has been done in developing countries to understand its full potential.
Research has been conducted in North America, Europe, Asia and South Africa. As far as this study is concerned there has not yet been any empirical study done in Ghana to address the concerns related to use of mobile phones in learning science.

For the learning styles, Felder & Silverman (1988) model was used because it was most appropriate for the area in Sciences. Previous studies involved the use of mobile phone technologies within the classroom. This study examined the use of mobile phones beyond the classroom as supplementary learning tools. This is because there is not yet a policy in Ghanaian public universities that allows the use of mobile phone technology during lectures. A good number of lecturers also see this technology more of a disruptive tool instead of an effective educational tool, therefore they insist and do not allow students to use their mobile phones during lecture hours.

Constructivist environments was also encouraged, since this supports more independent learning on the part of students as well as collaborative activities, so that students are able to adjust and learn from information constructed on their own. Mobile technologies will make the classroom more constructive than conventional, giving students the chance to construct their own knowledge in order to discover things on their own. There is also a gap between students owning a mobile phone and actually using them for academic purposes. Similarly, findings also indicated a gap between lecturers use of mobile phone technologies to support teaching and students insistence on integration of these technologies in education.
2.13 Chapter Summary

This chapter provided a review of previous research studies in the use of mobile phone technologies in learning. Their findings have been cited which provides some insight into the utilization of mobile phones in learning and how it would be beneficial to education in Ghana. In previous studies, other mobile devices were used as ICT tools for learning, but very little research has been done using mobile phone technologies. Therefore, this study investigated how the mobile is used to support learning, since this technology is personally owned by most students.

The studies reviewed mobile phone use in fields of Health and Mathematics, English and other languages while this study focused on the area of Science. Previous studies investigated the use of mobile devices at the secondary or primary level while this study looked at the use of mobile phones at the university level. Research showed that satisfaction plays an important role in the learning process, thus affecting students’ performance positively. This is especially the case when mobile technologies are used to supplement other resources. It is noted that most studies in this area are outside the continent of Africa. This gives one of the main reasons for getting into this study.

The next chapter displays the methodology used in the study, the instruments involved, the data collection procedures and the data analysis methods.
CHAPTER THREE

RESEARCH DESIGN AND METHODOLOGY

3.1 Introduction

This chapter dealt with the research methodology. Methodology involves procedures of data collection, processing and reporting. It outlined the research design and the process of empirical investigation which was guided by the research questions. It also outlined the population of the study, sample size and sampling techniques, research instruments, and how their reliability and validity was ensured, data collection procedure, data analysis as well as logistical and ethical considerations.

3.2 Research Design and Locale

The research design adopted for this study was a descriptive survey. This design was used to seek for information on the influence of mobile phone technologies on science students’ academic performance in public universities of Ghana. This survey provided insight into the research problem that described the variables of interest. The relationships between the independent and dependent variables were defined, estimated, predicted and examined. A descriptive survey was found appropriate because, it provides useful and in-depth information to questions related to whom, what, when, why and how in relation to objectives of the study.

Descriptive survey was used because the mobile phone technology is an innovative learning tool and it was necessary to gather detailed information on how this technology could be used to support science learning. Surveys assisted in gaining a better
understanding of the use of mobile phone for learning purposes and in improving academic performance. This survey also allowed for a larger sample to be gathered. The survey was used to obtain the demographics, types of mobile phone technologies available, opinions of Ghanaian science university students with regard to their use of mobile phones.

The design allows for collection of both qualitative and quantitative data. This enhances analysis and interpretation, before arriving at the study’s main conclusions. A qualitative approach was used when collecting and analyzing data from the ICT coordinators. A quantitative approach was used in data collection and analysis from closed-ended items from both the lecturer and student questionnaire. This was considered appropriate to give wider information and systematic description of the influence of mobile phone technology on the academic performance of university science students in Ghana. This design was important since it led to in-depth information which further assisted in identifying a gap in the utilization of mobile phone technologies for learning and this therefore guided in the designing of an appropriate model for students in Ghanaian universities.

Quantitative approach produces quantities of variables of interest (Leedy & Ormod, 2010). This type of research tries to measure characteristics or behavior using questionnaires, tests or rating scales. This approach was used because it helps provide explanations and predictions about the use of mobile phones to support learning science. Numeric data was collected from a large sample in order to rely on deductive reasoning
to come out with logical conclusions and provide findings in the form of statistics and aggregated data.

Qualitative approach investigates attitudes and behavior through interviews and open-ended items from questionnaires so as to get a more comprehensive view from participants (Dawson, 2002). This approach allowed the researcher to gather views of participants by asking broad and general questions along with collecting the data that consisted largely of words or text from participants. These words were then described, analysed and illustrated for themes (Creswell, 2008). This involved examining information in an efficient and logical approach so as to draw some beneficial conclusions and recommendations.

In the qualitative approach, in-depth information was acquired about the use of mobile phone technologies in science learning and then trends and relationships were observed to see if a model would emerge from the information collected (Mugenda & Mugenda, 2003). The data was in a textual form that was obtained from a small sample through an unstructured interview for ICT coordinators and a questionnaire for students. The data was grouped into themes and categories.
Figure 3.1 presents a schematic plan of the research design and process of this study.

![Research Design and Process Diagram]

**RESEARCH POPULATION**
Fourth year science students, lecturers and ICT coordinators from 3 Public Universities in Ghana

**SAMPLING TECHNIQUES**
- Random Sampling
- Purposive Sampling
- Convenience Sampling

**SAMPLE**
- Departments
- Students
- Lecturers
- ICT coordinators

**DATA COLLECTION**

**DATA ANALYSIS**
- Descriptive Statistics
- Inferential Statistics
- Tables and bar charts

**DISCUSSION, SUMMARY AND CONCLUSION**

**RECOMMENDATIONS**
- Suggestions for policy and further research

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**Figure 3.1:** Research Design and Process of the study

**Source:** Adapted from Creswell, 2008
In this model, the population consists of fourth year science students, lecturers and ICT coordinators from three public universities in Ghana.

### 3.2.1 Variables

According to Fraenkel & Wallen (2002), a variable is a concept that stands for variation with a class or group of objects. This study involved the independent variables which was the utilization of mobile phone technologies and the dependent variable being students’ academic performance in science. The usage of mobile technologies in learning was both observed and recorded. Influence of mobile phone technologies on academic performance was measured using a five point Likert scale. Finally, the relationship between these variables was measured using Pearson’s Product-Moment Correlation. Intervening variables for the study included peer influence, lecturer, hardware, software, connectivity and peer influence as well as lecturer and student competency.

### 3.2.2 Location of the study

The study was conducted in three regions in Ghana, where the three largest public universities are located. The universities possessed an exceptional wireless infrastructure as compared to other public universities. These universities had various programs available in the Sciences. These universities were each located in Accra (Capital city) in the Greater Accra Region, Kumasi in the Ashanti Region and Cape Coast in the Central Region (Appendix F).
3.3 Population

The population involved all fourth year university students pursing programs in science from selected departments in three public universities. A population is a large collection of individuals that develop the key focus of a scientific enquiry (Castillo, 2009). Fourth year students were selected because it was expected that they would have reached some level of proficiency in the use of technologies and also would also have gone through a large volume of work which would necessitate the use of a mobile phone. The population also consisted of lecturers and ICT coordinators in the Sciences. Science was selected for the study because it was an area which was common to all three public universities and whose subject matter demanded in-depth search for the information. The three universities have a target population of 1,490 students, 273 lecturers and three ICT coordinators. Table 3.1 is a representation of the population.

Table 3.1: Population on universities, departments, lecturers, students and ICT

<table>
<thead>
<tr>
<th>Coordinators</th>
<th>Target Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Universities</td>
<td>6</td>
</tr>
<tr>
<td>Departments</td>
<td>35</td>
</tr>
<tr>
<td>Lecturers</td>
<td>273</td>
</tr>
<tr>
<td>Students</td>
<td>1490</td>
</tr>
<tr>
<td>ICT coordinators</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>1766</td>
</tr>
</tbody>
</table>
There are six public universities (APPENDIX E) in which three were chosen as a sample size. The target population for the three universities was 1,490 students, 273 lecturers and three ICT coordinators, which totaled to 1766 individuals.

3.4 Sampling Techniques and Sample Size

3.4.1 Sampling Technique

Purposive sampling was used to select three public universities out of a total of six which is 50% of the target group. The universities were selected from three regions which hosted the largest public universities that offered science based courses. According to Robson (2002), purposive sampling is used to select cases that are expected to give the required data. This technique was employed because the researcher was interested in public universities that had a good wireless network infrastructure, are highly populated and specialized in the area of Science. Three universities were selected so that the researcher would have a more diverse population and a larger population for selecting the samples of key respondents.

In order to arrive at the sample of respondents from the three universities, purposive sampling was first used to select 18 departments that were common to the three selected universities. This was done to ensure that the sample would be selected from common departments. Eighteen departments out of 35 were selected, that is 51% of the target population. The lottery method, a type of random sampling, was deployed when selecting the six departments out of the 18 common departments in the Sciences.

The departments were identified with a tag by writing the names of 18 departments in the Sciences on separate pieces of paper, which were folded, put in a container and shuffled.
well so that the names were not seen. One department was picked at a time without looking at the shuffled papers. Before the next one was picked, the contents were thoroughly shuffled again. This process was observed until the six schools were selected from the population.

Random sampling was used in order to ensure that each department had an equal chance of being selected. Six common departments out of 18 were selected, which is 33% of the target group. Therefore, six departments from each university were selected, making a total of 18 departments. This sample size was chosen so as to get different programs in the Sciences in order to have a variety of information.

Lecturers’ sample was determined using convenience sampling. The sample consisted of 100 out of 273 lecturers, which was 37% of the target population. This technique was chosen since only the lecturers that were available were selected for the study. Convenience sampling was deemed as the most appropriate method as it involved selecting those lecturers who happened to be available at that time and was willing to participate in the study. This assisted the researcher in finding out whether the lecturer uses mobile phone technology, if so, how often was it used and how was it used in supporting teaching science. This type of sampling was found suitable because it is fast, inexpensive and lecturers were readily available. A convenience sample refers to a group of individuals selected on the basis of being accessible hence it is not random, but rather based on the availability of individuals and the added advantage of convenience that it offers (McMillan & Schumacher, 2001).
Convenience sampling was once again used to select science students in the three public universities. Since, a good number of students were needed to participate in the study, it was deemed appropriate to sample at least 35% of the student population. Thus, out of 1490 students 520 were selected to participate. This study involved students who were willing to take part in the study and those who were rich in information that answered the research questions.

Purposive sampling was also used to chose 75 students out of 520 (five students from each department), which is 14% of the target population. This involved student providing information based on their richness of information in relation to the study’s research objectives. Purposive sampling entails a small number of people that would be identified in order to participate in the study. At the end of the survey, the researcher worked and discussed with lecturers who identified students that had the necessary characteristics that were needed for the study. This sampling technique focused on participants that were capable of providing rich and significant information that suited the purpose of the study (Babbie, 2010). This approach was also used because only students who had the mobile phone and were using them for learning purposes were considered.

Purposive sampling was again used in selecting ICT coordinators. Three ICT coordinators from the three universities were selected. This technique was chosen because only persons with expertise on the use of mobile technologies in higher education would be useful for the study. This sample size was arrived at because it was necessary to get the different opinions from the 3 coordinators, so that more rich and varied information would be gathered from them.
3.4.2 Sample Size

Gay and colleagues (2009) points out that for a descriptive study; between 10% - 30% of the available population was sufficient enough to be used as a sample. Hence, this sample was considered representative to characterize the target population. The sample size of 643 respondents was seen as relevant and sufficient for a descriptive research and presented an overview of participant’s opinion at the time of collecting data. Respondents from public universities were used in the study. Table 3.2 provides a tabular representation of the sample size.

Table 3.2: Sample Grid on Universities, departments, students, lecturers and ICT coordinators

<table>
<thead>
<tr>
<th></th>
<th>Sample Size</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Universities</td>
<td>3</td>
<td>50</td>
</tr>
<tr>
<td>Departments</td>
<td>18</td>
<td>51</td>
</tr>
<tr>
<td>Lecturers</td>
<td>120</td>
<td>44</td>
</tr>
<tr>
<td>Students</td>
<td>520</td>
<td>35</td>
</tr>
<tr>
<td>ICT coordinators</td>
<td>3</td>
<td>100</td>
</tr>
</tbody>
</table>

From the table, three public universities have been chosen. Depending on the population in each university, a proportionate student and lecturer sample size was selected. There were 18 departments that were selected as a sample size. The sample for the 18 departments was 520 students, 120 lecturers and 3 ICT coordinators, totaling to 643 expected respondents.
3.5 Research Instruments

Four instruments were used in this study, namely two questionnaires for students and a questionnaire for lecturers as well as an interview schedule for ICT coordinators. The instruments were designed keeping into mind the objectives of the study. The research instruments were administered to respondents and ample time was given to them to respond. The instruments collected both quantitative and qualitative data. The quantitative data was collected by means of close-ended items in the questionnaire for both lecturers and students. Qualitative data was collected through open-ended items in both the questionnaires and interview schedules. These instruments were designed based on information derived from the review of related literature.

Documentary Analysis was also used in order to gather data about the classes of science students in academic performance for the years 2012 and 2013. The data from documents for the present study were obtained from the Student Records and Management Information Section (SRMIS) of the UCC, which is officially in charge of students’ records. This was to ensure triangulation in support of using various instruments to collect and analyze both quantitative and qualitative data.

3.5.1 Questionnaires for students

Two questionnaires were used for students, namely: Students’ Questionnaire (SQ) and Students’ Questionnaire on Reflection of Mobile Phone Use in Science Learning (SQRMPUSL).
The SQ used closed ended items (Appendix A), which included 100 items. The questionnaire for students was divided into 7 sections. Frequencies for similar responses to each item were tallied and percentages of students’ responses computed. The SQ was used in this study because it is less expensive, produced quick results, offered less opportunity for bias or errors and provided a wider coverage of respondents. It was administered to fourth year science students in each department at various universities. These question items helped to gather information on how students use mobile phones in their learning. The SQ was used in order to collect quantitative data from students.

The SQ measured the reliabilities of types of mobile phone technologies, satisfaction, learning style and performance. The coefficient alpha for the 18 mobile phone technology items was 0.84 and the coefficient alpha for the 13 satisfaction items was 0.75. Also, the coefficient alpha for the 20 learning style items was 0.70 and the coefficient alpha for the 13 performance items was 0.84. Therefore, the coefficient alpha for the entire instrument was 0.78.

The SQRMPUSL was given to 25 students from each university to fill (Appendix C). In total 75 students responded to the instrument. The SQRMPUSL was open-ended and was used in order to offer respondents the opportunity to provide answers in greater detail. An open-ended questionnaire comprising of ten items was distributed to the respondents. This SQRMPUSL was used to gather in-depth information about how mobile phones were being used in student learning. The SQRMPUSL was used to obtain qualitative data from students. Responses to the open-ended items were counted and their frequencies also recorded. The coefficient alpha for the entire instrument was 0.70.
3.5.2 Lecturers’ Questionnaire (LQ)

This instrument was completed by lecturers in the various institutions. This instrument had both closed and open ended items (Appendix B). It was divided into 3 sections. This questionnaire was used to collect data on the role lecturers play in students’ use of their mobile phones to learn, how lecturers help to encourage students to use mobile phone technologies and their views about the future of m-learning. The coefficient alpha for the LQ was 0.78.

3.5.3 ICT Coordinators’ Interview Schedule (ICIS)

Interviews with the ICT coordinator of each university was conducted (Appendix D). The interview involved a face-to-face meeting between the researcher and the informant at a conducive place which lasted approximately an hour. Due to their busy schedules, the researcher met with the ICT coordinators earlier in order to schedule an appropriate time for the interview. Interviews were conducted with three ICT coordinators whereby the researcher used a qualitative approach so as to gain in-depth information based on the opinions and views of respondents about promoting and using m-learning in the future.

3.6 Pilot Study

Piloting the study ensured that complications and difficulties were resolved before the main study was conducted (Robson, 2002). This included the validation of the instruments and in determining their reliability. The split-half method was used in ensuring reliability. Forty students and 10 lecturers from UEW were requested to fill the questionnaires for the pilot study. This university has a Faculty of Science, a relatively large student population and also a good wireless network available on campus.
The pilot study ensured that the items in the questionnaires were comprehensive and that there were no ambiguities so that respondents were able to understand what they were expected to do. The pre-test study proved very useful since it helped modify and reframe the items on the questionnaires. It also helped in enhancing the quality of the questionnaire for the main study. Students and lecturers included in the pilot study were a representative of the population studied and the pre-test was administered in conditions comparable to the final study.

3.6.1 Validity of the instruments

Validity is the exactness and precision of deductions based on the findings from the research (Mugenda & Mugenda, 2003). The validation of the instruments was carried out to check correctness of the data collection instruments during the pilot study. Wiersma (1995) emphasizes that pre-testing of study instruments, before the actual study support criterion and construct validation of the tools. Criterion and construct validation was established through pre-testing the instruments used in the study. This checks the appropriateness of the data collection instruments.

Content validity was ensured by effectively indicating the interests of the study (Fraenkel & Wallen, 2002). Comments were made on the language, clarity, relevance of the items, format, structure and content of the research instruments in order to deem it acceptable. Suggestions were made on rewording questions, adding questions, and deleting some irrelevant questions.
Therefore, amendments were made on the format of the questionnaires and the content in general. Items that were found to be unclear were reframed. This was done in order to make sure that the items in the questionnaire would target the information required by a given objective. The instruments were also examined to ensure that the presentation, structure and form of the items within the instruments were suitable. Therefore, face validity and construct were also ensured.

The interviews were unstructured, therefore consisted of only open ended questions. The questions in the interview guide were re-worded and those with ambiguities were removed. Responses from the pilot helped identify items that were unclear. These were reframed and this also ensured construct validity of the research tools. This was to make sure the instruments addressed the concerns of the study. It was important to place focus on clarity of questions and the ability of the instruments to answer the set objectives. Content validation was carried out to ascertain the comprehensiveness of the items with regard to the study variables (Creswell, 2008).

Triangulation was also used to enhance validity of the research instruments. Triangulation refers to using varied methods and processes in the collection and analysis of data to enhance credibility and rigor of research (Robson, 2003). The study used two aspects of triangulation. One aspect of triangulation was the use of more than one method of data collection which included questionnaires, interviews and documents. The other aspect of triangulation was the combination of quantitative and qualitative approaches known as methodological triangulation. This was used in order to ensure content validity.
of the research instruments. In order to ensure validity numerous sources and modes of evidence were incorporated into the design of this study so as to acquire credible results.

3.6.2 Reliability of the instruments

Reliability reveals that when procedures of the study are repeated, the exact same results are expected (Mugenda & Mugenda, 2003). A Reliability test was carried out with the purpose of testing the consistency of the research instruments. The research instruments were improved by revising or deleting items. For the purpose of this study, reliability of the instrument was established through a pilot study carried out with students and lecturers from UEW. Reliability was established through the piloting. This involved questionnaires from 10 lecturers and 40 students.

To test the reliability of the questionnaire, Cronbach’s alpha formula was used, which measures the internal consistency and dependability of the items (Creswell, 2008). The Cronbach alpha coefficient was valued from 0 to 1. The items from each of the questionnaires for both lecturers and students were split into two, where one side had even-numbered items and the other side had odd-numbered items. Each item was scored from 1 which means “not difficult” to 4, meaning “difficult.” The scores on the items were summed up to give the total score.

Those items that had a high coefficient (0.7 and above) were retained in the SQ, SQRMPUSL and LQ, but the items that had a low coefficient (less than 0.4) were reviewed. This coefficient ensured internal reliability. The split-half method assisted in establishing language, bias in the instrument, methods of data collection, time of collection and level of accuracy.
According to Frankael & Wallen (2002), the coefficient for items is high when its absolute value is greater than or equal 0.7. Therefore, a correlation coefficient of 0.7 should be considered high enough to determine the reliability of the instrument for the study. Transcripts from interviews of ICT coordinators were checked for errors to make sure there was reliability (Creswell, 2009). Maree (2007) supported that the reliability of the research findings can be improved by collecting data from diverse sources as well as through a variety of research instruments.

3.7 Data Collection Procedures

The primary sources of data collection instruments included questionnaires and interviews. The secondary sources of data involved the use of documents and review of related literature. Before administering the questionnaires, an introductory letter from Kenyatta University, Graduate School was obtained, which was given to the Academic Registrars of the study universities of Ghana. The letters (APPENDIX J, APPENDIX K and APPENDIX L) were obtained from Academic Registrars in each of the universities, UCC, KNUST and UG respectively. This allowed the researcher to be introduced to the different Heads of Departments (HODs). After, appointments were made with the HODs, the researcher was introduced to the lecturers and the students from the various departments. This made it possible to gain access to the students and lecturers as respondents needed in the study. The investigation was set out in the first week of September (2012).
With the questionnaires was a cover letter (APPENDIX H and APPENDIX I) to the respondents which detailed the purpose of the study, described its potential benefits, gave assurance of confidentiality and confirmed study was not a risk to participants. It also carried a statement that made it clear to the participants that they could stop participation in the study at any time (Maree, 2007). Therefore, the identity of the participants was not used or disclosed throughout the research study in order to motivate them to give their responses. The questionnaire was administered to the students and lecturers without any undue influence. Students were allowed ample time to complete the questionnaires. The SQ was collected the same day, since this instrument was not time consuming. But, the SQRMPUSL was brought the following day in order to give students sufficient time to give well thought responses. Lecturers were given a week to fill their questionnaires due to their busy schedules.

Prior to each interview session, contact was established with the interviewee in order to: i) explain the purpose of the research, ii) seek for permission to grant an interview, and iii) fix the date and time of interview. Interviewee’s permission was sought to allow the interview to be recorded. The ICT coordinators were interviewed by the researcher herself in their offices. The researcher met with the ICT coordinators and the session was audio recorded, while notes were taken down as the ICT coordinators answered the questions.

3.8 Data Analysis Procedures

The completed questionnaires were serially numbered. The analysis involved coding, organizing, describing, interpreting, cross tabulating and drawing conclusions. The
analysis was done in three stages. The first stage of analysis focused on descriptive statistics that involved computing of frequencies, percentages, cross tabulation, means and standard deviations. The data was synthesized and transformed into tabular form, bar graphs as well as pie charts to illustrate the relative proportions where applicable. The second stage included inferential statistics. Inferential statistics whereby the independent samples t-test, one-way-analysis of variance (ANOVA) and correlation were used. A probability level of 0.05 was used to test the observed differences that were significant. This was adopted for presenting and analysing the data in this thesis.

The last stage of analysis involved content analysis. The interview summaries and open-ended items on the questionnaires constituted the qualitative data that led to comments, interpretations and bar charts. Qualitative analysis was used to deal with text from participants. Creswell (2009) outlines six steps for qualitative data analysis of open-ended question item responses which are as follows: (1) organization and preparation of the data by examining and bringing together the data in a way that the researcher understands, (2) scrutinizing of data critically in order to obtain a better understanding of students’ responses, (3) coding of data through identification and sorting of the categories, (4) categorizing the data into themes (5) representation of the data through tables and figures, and (6) providing a meaningful interpretation of the data. This data was transcribed, put into categories, themes identified, recorded and descriptive analyses run. The data was transformed into the form of bar graphs to illustrate the relative proportions where applicable.
Interviews of ICT coordinators were recorded and transcribed right after the interview. The researcher paid close attention to the audio recordings and listened to them on several occasions and transcripts were double-checked to ensure accuracy (Creswell, 2009). Interviews after transcription were put together and summarized under themes identified. Trends that merged from all the data were highlighted and interpretation as well as discussion of the data was done with reference to the related literature that was reviewed.

Miles and Huberman (1994) identified three major elements of qualitative data analysis, namely; data reduction, data display as well as conclusion drawing and verification. Data reduction involved the process of selecting and simplifying the data that appeared in the interview transcriptions. This ensured that the information was relevant to the issues being addressed. Data display entailed both words (extended piece of text) and diagrammatic form which were used to extrapolate the data in order to determine systematic patterns and interrelationships. Conclusion drawing and verification involved considering what the analyzed data meant and also assessed their implications in relation to the questions of the study. Verification entailed revisiting the data as many times as needed to confirm these emergent conclusions.
Data concerning data analysis is presented in Table 3.3.

**Table 3.3: Data Analysis**

<table>
<thead>
<tr>
<th>No</th>
<th>Objectives</th>
<th>Data Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Examine the type of mobile phone technologies available for science university students and their differences among universities, gender and age groups as well as its influence on academic performance</td>
<td>- Frequencies</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Percentages</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- T-test, ANOVA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Tables, bar graphs</td>
</tr>
<tr>
<td>2</td>
<td>Examine the type of mobile phone technologies available for lecturers to support teaching and their difference among universities, experience and qualification</td>
<td>- Frequencies</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Percentages</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- T-test, ANOVA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Tables, bar graphs</td>
</tr>
<tr>
<td>3</td>
<td>Assess students’ level of academic satisfaction with the use of mobile phone in learning science and its relationship with academic performance</td>
<td>- Frequencies</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Percentages</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Tables</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Correlation</td>
</tr>
<tr>
<td>4</td>
<td>Establish the various types of learning styles and the role it plays in promoting mobile phone technology education among science university students</td>
<td>- Frequencies</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Percentages</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- bar graph</td>
</tr>
<tr>
<td>5</td>
<td>Investigate whether the utilization of mobile phone technology has an influence on academic performance</td>
<td>- Frequency</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Percentages</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Cross Tabulation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Correlation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Tables, bar graphs</td>
</tr>
<tr>
<td>6</td>
<td>Highlight factors that influence mobile phone usage in science learning</td>
<td>- Frequency</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Percentages</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Tables, bar graphs</td>
</tr>
</tbody>
</table>

This Table shows the data analysis tools used for each of the objectives. For each objective, specified statistical tools were used, which involved either descriptive or inferential statistics.
3.9 Logistical and Ethical Considerations

McNabb (2004) points out that there are four stages in research ethics, namely: planning, data gathering, processing and interpretation of data as well as the dissemination of results. Therefore, the researcher obtained a letter of introduction from Graduate School, Kenyatta University. Copies of the letter of introduction were given to the Academic Registrar of each of the public universities. This was done to seek permission to conduct research in the various departments in the universities.

At the data collection stage, in conducting the interview and administering questionnaires, due honesty was exercised. Questions asked were limited to those outlined in the interview schedule, although room was allowed for modifications and probing of the responses. The students and lecturers had the opportunity to fill their questionnaires privately, in order to ensure confidentiality. In dissemination of results, measures were taken to ensure privacy, anonymity and confidentiality of all participants. This means that the names of the participants were not used or revealed throughout the research project (Maree, 2007). The discussion of the findings was based on the trends that emerged from the data and not from any preconceived ideas. A letter of consent to participate in the study was given to lecturers and students. This letter was to show courtesy to them and also a means of ensuring their informed consent to participate in the study.

3.10 Chapter Summary

The research design was a descriptive survey and involved both quantitative and qualitative techniques. The study involved fourth year students, lecturers and ICT
coordinators in three selected public universities in Ghana. The sampling techniques used were convenience and purposive. The research instruments used in the study were mainly questionnaires and interviews. The pilot study was conducted at UEW. Validity and reliability were ensured in the study.

The next chapter shows and discusses the results and statistics about statements in the instrument used in this study.
CHAPTER FOUR

PRESENTATION, INTERPRETATION AND DISCUSSION OF FINDINGS

4.1 Introduction

This chapter focuses on presentation, interpretation and discussion of the findings. It first reports the data on background characteristics of the respondents and then the data in response to the research objectives and the research questions. Descriptive and inferential statistics were used in the analysis. For meaningful interpretation and discussion the data were further illustrated with the presentation of tables, bar graphs and pie charts.

4.2 General and Demographic Information

4.2.1 General information of respondents

A number of respondents were involved in this study and mainly consisted of university students, lecturers and ICT coordinators in three selected public universities in Ghana. The response rate of the number of participants who took part in the study is presented in Table 4.1.
Table 4.1: Response rate of respondents

<table>
<thead>
<tr>
<th>Respondents</th>
<th>Number Expected</th>
<th>Number Responded</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students</td>
<td>520</td>
<td>503</td>
<td>97</td>
</tr>
<tr>
<td>Students (take home questionnaire)</td>
<td>75</td>
<td>75</td>
<td>100</td>
</tr>
<tr>
<td>Lecturers</td>
<td>120</td>
<td>71</td>
<td>59</td>
</tr>
<tr>
<td>ICT coordinators</td>
<td>3</td>
<td>3</td>
<td>100</td>
</tr>
<tr>
<td>Total</td>
<td>643</td>
<td>577</td>
<td>90</td>
</tr>
</tbody>
</table>

Information in Table 4.1 suggests that there was a high response rate from students and at least more than half of the lecturers responded to the questionnaire. All the ICT coordinators were interviewed successfully. A total of 643 questionnaires were administered to both lecturers and students. Mugenda and Mugenda (2003) states that 50% response rate is adequate, 60% good and 70% and above is rated to be very good. Based on this statement the response rate for this study was considered to be a good sample to provide useful data. There was a failure rate of 10% respondents, which could be due to lecturers’ tight and busy schedules that made it difficult for some of them to respond to the questionnaire. Also, some students responded to less than 50% of the items in questionnaires and thus these questionnaires could not be used for the study.

4.2.2 Demographic Data of respondents

a) Students Demographics

The background characteristics of the students were examined in terms of the name of university, gender, age and name of department. The background characteristics of the
lecturers were examined in terms of name of university, gender, departmental affiliation, number of years of lecturing and academic qualifications. In total, three universities provided the study sample. Information concerning the distribution of students in the three public universities is shown in Figure 4.1.

![Figure 4.1: Name of University and their selected population samples](image)

The data in Figure 4.1 indicates that the majority of students, 231 (45.9%) were from KNUST and the least number of students 129 (25.6%) attended UCC. The number of students was sampled in accordance to the populations from the various universities. Information concerning the gender of the students is presented in Figure 4.2.

![Figure 4.2: Gender of students](image)

iHub Research (2012) conducted a study on mobile internet usage in Ghana with 798 respondents who were considered to be receiving a middle class income. Most of the
participants were male. Gender balance can be important in a study. The distribution of males and female respondents shows that males 305 (60.6%) were higher than females 198 (39.4%). This sample was occasioned by the greater ratio of males in the universities. The age distribution of the students was also considered in Figure 4.3.

![Figure 4.3: Age of students in the study](image)

From Figure 4.3 most students, 389 (77.3%) were between the ages of 22-26 years, forming ¾ of the population while only a few students, 7 (1.4%) were 32 years and above. This reflects the common age of entry to university in which case students joined after completing senior high school. Those with good grades are able to enter universities at a young age usually between the ages of 18-20 years old. iHub Research (2012) included participants where the majority were between the ages of 18-29. This is not surprising since Ghana’s population is young with approximately 60% of population under the age of 25.

Further distribution of students based on subject areas or departments is given in Figure 4.4.
The majority of students, 131 (26.0%) and 115 (22.9%) belonged to the Department of Computer Science and Mathematics respectively. Only a few 45 (8.9%) students were from the Botany or Environmental Science Department. The fact that the majority of students came from Mathematics and Computer Science showed the two areas to be popular.

### 4.2.3 Ownership of mobile phone and internet utilization

Students were asked to indicate whether they owned a mobile phone and whether they had internet access on it. The results are indicated in various forms as observed in Table 4.2 and Figures 4.5, 4.6 and 4.7.

**Table 4.2: Ownership of mobile phones**

<table>
<thead>
<tr>
<th>Phone access</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>503</td>
<td>100.0</td>
</tr>
<tr>
<td>No</td>
<td>0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

All students in this study owned a mobile phone. This finding confirmed that the mobile phone is “a do without” tool for young people and especially at higher levels. This is not surprising, since majority of the Ghanaian population has access to mobile phones and
are young people. This agrees with research conducted with 963 students, in which all students reported owning a cell phone (JMU, 2012). Since, virtually all students had mobile phones, the use of this technology as a tool to support their learning is feasible. Whether or not the student had access to internet on their phone was presented in Figure 4.5.

![Figure 4.5: Access to Internet by students](image)

The data in Figure 4.5 indicate that an overwhelming majority of students, 458 (91.1%) had internet on their phones. Only 45 (8.9%) of respondents did not have internet access. Hence, virtually all students had internet-compatible phones.

In a study in Nigeria, it was found that majority of undergraduate students had internet service available on their phones (Utulu & Alonge, 2012). According to Kennedy et al (2009), most undergraduate students stated that they had mobile phones that were internet-enabled, which indicates that mobile phones could be used to support learning such as accessing and downloading educational materials as well as capturing and sharing information online. Also, 25% of the students were not having internet available on their mobile phone while 10% of students were not interested and 2% of them were not even aware of the internet feature (Fazenna et al, n.d.). From literature, most modern mobile phones have access to Internet. Therefore, it is appropriate to take advantage of these
internet-compatible phones in order for students to support their learning. The use of internet on students’ mobile phone is shown in Figure 4.6.

![Figure 4.6: The use of Internet on phone](image)

It is seen from Figure 4.6 that 293 (58.2%) of students did not use Internet on their phones. This is surprisingly low considering that most of these students are considered to be ‘digital natives.’ But, on the other hand, this percentage indicates increasing rates of use as compared to earlier research. For example, a study conducted in Ghana, iHub Research (2012) revealed that only 9% use Internet on their mobile phones.

Of the 135 undergraduate students who participated in another research, it was shown that 73% of students used internet-compatible mobile phones, which was either via Wi-Fi or 3G Internet access. Eighty percent of students reported that the internet was primarily using for social networks and 75% of them used it for web browsing. Sixty-eight percent of students used the internet to send or receive emails (Brand et al, 2011). Interestingly, even though most students had internet-compatible phones, a little more than half of the students were not using the internet on their phones. It was observed in a different study with 189 students that only 28% of them were frequently using the internet through their mobile phones, while 35% of students rarely use the internet from their phone. Therefore, students must get on board to realize the potential that these internet-connected mobile
phone technologies can have on their academic performance. Wi-Fi accessibility on students’ mobile phone is presented in Figure 4.7.

![Accessibility of Wi-Fi](image)

**Figure 4.7: Accessibility of Wi-Fi**

About half 242 (48.1%) of students had access to Wi-Fi connection and a few respondents 25 (5.0%) were not aware of Wi-Fi connection on their phones (See Figure 4.7). This meant that if most students were in a ‘hotspot’, they would be able to browse for free granted their Wi-Fi enabled phones. Since, public universities had wireless networks and hotspots available in different areas on campus, students should make it a point to find out the spots and use them to their advantage. Students owned different models of phones, from simple to complex. The range of models is given in Figure 4.8.

### 4.2.4 Models, types of mobile phones and service providers used by students

Students were asked to indicate what model and type of mobile phone they had as well as the service providers they used. The results are indicated in various forms as observed in Figures 4.8, 4.9, 4.10, 4.11 and 4.12.
Figure 4.8: Model of phone student uses

The majority of students, 217 (43.1%) owned a Nokia phone while a small number of students 19 (3.8%) had a Techno phone. This is certainly not a surprise as Nokia is listed as the most popular phone in Ghana, with 46% of Ghanaians using it, followed by Samsung and then Techno (iHub Research, 2012). This finding reveals the superiority and perhaps the popularity of Nokia over other mobile phone brands in the mobile industry. Globally, there was a Nokia branded phone in the pockets of 1 out of every 5 people (http://communities-dominate.blogs.com). Some students 56 (11.1%) had other types of phones such as Sony Ericson, Huawei Ideos, Motorola, HTC and iPhone. Majority of students used an iPhone and the second ranked model was android phone (JMU, 2012). These types of smartphones are quite expensive and may not be affordable to students. The variations could be as a result of the difference in economy and personal appeal. The reasons why students used their specific phone model are presented in Figure 4.9.
Figure 4.9: Reasons students use phone model

The majority of students, 100 (19.9%) used a particular phone model because of the social media platform it allows them. This means that most students were concerned about socializing with their peers. Other students, 99 (19.7%) and 91 (18.1%) used their kind of phone for the reason that mobile applications were available and internet services respectively. The minority of students, 30 (6.0%) and 36 (7.2%) used their model of phone because of its user-friendly and brand image respectively. Fifty-six (11.1%) ticked others which included reasons such as high quality camera, relative buying it for them, easy communication, easy access to information, durability and functionality. The division between simple and complex phones among students is given by Figure 4.10.

Figure 4.10: Type of mobile phone owned by students
It is evident that a good number of students, 242 (48.1%) owned an ordinary phone while the rest of the students 236 (46.9%) had a smartphone. The minority of 25 students (5.0%) did not even know the type of phones they used. This implies that young people are more interested in just owning a mobile phone. A study done in several colleges and universities around the United states found that out of 517 students, 272 (53%) of them owned a smartphone, while 242 (47%) students owned a basic type of mobile phone.

This compares well with the results of this study. However, in another research conducted by Woodcock et al (2012), 69% out of 188 students owned a smartphone. Sixty-three percent of university students owned smartphones (JMU, 2012). Mobile phone users are quickly opting for smartphones as devices become more affordable and 3G network advances (eMarketer, 2014). The service providers for student phones were also identified.

![Figure 4.11: The service provider used by students](image)

The data in Figure 4.11 shows that most students, 220 (43.7%) used MTN as their main service provider and only a few students, 51 (10.1%) used Glo. Most users were using service providers MTN followed by Vodafone (iHub, 2012). This could be because MTN
is the main service provider used by more than 10 million people in Ghana. It was due to its reliability. In the case of Glo, it is a new service provider that has been recently introduced to Ghanaians and could be that it has not been tested. The use of phones was also related to levels of performance of students. Reasons why students used their service provider is shown in Figure 4.12.

**Figure 4.12: Reasons students’ use service provider**

Figure 4.12 demonstrated that most students, 150 (29.8%) and 120 (23.9%) employed their service providers because of excellent coverage and affordable calling services, respectively. A few students, 21 (4.2%) utilized these service providers in order to obtain 3.5 generation on their mobile phones. The students’ level of academic performance was illustrated in Figure 4.13.

**4.2.5 Level of academic performance and the Impact and use of mobile phones in science learning**

Students were asked to indicate the level of academic performance and their perceived impact of mobile phones on their learning of science.
The following results in Figure 4.13 and 4.14 were found.

Figure 4.13: Level of academic performance

The inferences drawn from the data in Figure 4.13 indicated that majority of students, 330 (65.6%) fell into the moderate level and only a few respondents, 30 (6.0%) were in the low level. High level considered students having a grade point average (GPA) between 3.0-4.0 and the moderate level involved students with GPA between 2.5-2.9 points. Students, who fell in the low level, involved those having a GPA between 1.5-2.4 points. How students perceived mobile phones impacted their academic performance is revealed in Figure 4.14.

Figure 4.14: Impact of mobile phones on science learning

The data in Figure 4.14 indicated that most students, 238 (47.3%) believed that mobile phones positively impacted the learning of science, while students 126 (25.0%), that is,
1/4 of them believed that mobile phones had no impact on science learning. Only a few respondents, 29 (5.8%) believed that mobile phones would negatively impact learning in science. This implied that most students were aware of the potential mobile phone technologies had in education, but still a good number of students believed that mobile phone technologies had no impact on their learning, whilst some students had no idea what mobile phones could offer to their learning experiences.

The relationship between students’ perceived impact of mobile phones in learning science and level of academic performance is presented in the Table below.

**Table 4.3: Relationship between students’ perceived impact of mobile phones in learning science and level of academic performance**

<table>
<thead>
<tr>
<th>Perceived impact of mobile phones in learning science</th>
<th>Perceived impact of mobile phones in learning science</th>
<th>Level of academic performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearson Correlation</td>
<td>1</td>
<td>.028</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td></td>
<td>.525</td>
</tr>
<tr>
<td>N</td>
<td>503</td>
<td>503</td>
</tr>
<tr>
<td>Level of academic performance</td>
<td>Pearson Correlation</td>
<td>.028</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.525</td>
<td>1</td>
</tr>
<tr>
<td>N</td>
<td>503</td>
<td>503</td>
</tr>
</tbody>
</table>

Table 4.3 reveals that there is no significance (r = 0.028, p>0.05) between students’ perceived impact of mobile phones in learning science and level of academic performance. With an r value of 0.028, the correlation was seen to be very weak. This
implies that students’ perceived impact of mobile phones in learning science does not influence the level of academic performance, since the correlation was found to be weak.

b) Lecturer’s demographics

A number of lecturers were sampled from three universities in Ghana. The results are shown in Figures 4.15, 4.16, 4.17, 4.18, 4.19 and Table 4.4. The number of lecturers in their various universities is presented in the next Figure.

![Figure 4.15: Lecturers as per universities](image)

The data illustrated in Figure 4.15 highlights that most lecturers, 37 (52.1%) taught at the KNUST, whilst other lecturers 17 (23.9%) taught at either UCC or UG. Data concerning the gender of the lecturers is presented in Figure 4.16.

![Figure 4.16: Gender of lecturer](image)

The analysis of data elaborated in Figure 4.16 revealed that most of the lecturers, 64 (90.1%) that filled the survey were male and only a small number of respondents 7 (9.9%) were females.
With regard to the departments from which lecturers were drawn, Figure 4.17 reflects the staffing in the universities and departments sampled.

![Bar chart showing departments where lecturers belong to.]

**Figure 4.17: Departments where lecturers belong to**

The lecturers were distributed in various departments (Figure 4.17), with the majority coming from Chemistry, while other lecturers belonged to other departments such as Biochemistry, Mathematics, Botany/Environmental Science, Computer Science and Physics. This indicated that there were more lecturers in the Department of Chemistry.

Lecturers were also asked to indicate their experience in years. The responses were as shown in Figure 4.18.

![Bar chart showing number of years in the profession.]

**Figure 4.18: Number of years in the profession**

The results indicate that the majority of respondents, 48 (67.6%) had substantial teaching experience (5 or more years) and respondents 23 (32.4%) had between 1-4 years in
lecturing experience. It can be said, therefore, that the study interacted with largely experienced lecturers.

When asked about their academic levels, the following information in Figure 4.19 was obtained.

![Bar chart showing highest level of qualification of lecturer.](image)

**Figure 4.19: Highest level of qualification of lecturer**

The interpretation of this data (Figure 4.19) is that a sizeable number of lecturers, 35 (49.3%) had a PhD qualification and a small number of lecturers 9 (12.7%) had either a Masters in Science or Engineering. These lecturers were asked to indicate whether or not they owned mobile phones and the results are shown in Table 4.4.

**Table 4.4: Lecturers in possession of a mobile phone**

<table>
<thead>
<tr>
<th>Phone access</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>71</td>
<td>100.0</td>
</tr>
<tr>
<td>No</td>
<td>0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

It was noted that all these lecturers owned a mobile phone. The model the lecturer uses is presented in Figure 4.19.
4.2.6 Models, types of mobile phones and service providers used by lecturers

Lecturers were asked to specify the model and type of mobile phone they had as well as the service providers they used. The results are indicated in various forms as observed in Figures 4.20, 4.21, 4.22, 4.23 and 4.24. The model of the mobile phone the lecturer used is displayed in the next Figure.

![Graph showing model phones for lecturers](image)

**Figure 4.20: Model phones for lecturers**

Figure 4.20 showed that a significant number of respondents, 36 (50.7%) had a Nokia type of phone and only a small number of lecturers, 2 (2.8%) had a Blackberry. Other respondents 8 (11.3%) had an iPhone, HTC and a Sony Ericson. This can be regarded as setting a good example in the ownership and possibly use of mobile phones. Figure 4.21 displays a diagram on reasons why lecturers use their phone models.

![Graph showing reasons lecturers use phone model](image)

**Figure 4.21: Reasons lecturers use phone model**
It was revealed in Figure 4.21 that the majority of lecturers, 28 (39.4%) used a particular mobile phone model because of affordability. This implies that lecturers were only interested in whether the phone was affordable. Other lecturers, 21 (29.6%) and 8 (11.3%) used their kind of mobile phone for the reason of mobile phone being user-friendly and providing internet services respectively. The minority of lecturers, 2 (2.8%) used their model of phone because of its durability. The type of mobile phones lecturers owned is given in Figure 4.22.

![Figure 4.22: Type of phone lecturer uses](image)

The results in Figure 4.22 showed that the majority of respondents, 37 (52.1%) had an ordinary phone and only a small number of lecturers, 6 (8.5%) did not know the type of phone used. Information gathered about the service provider the lecturer used is shown in Figure 4.23.

![Figure 4.23: Service provider lecturer uses most](image)
It is evident from the data illustrated in Figure 4.23 that a significant number of lecturers, 34 (47.9%) are with MTN while only a few lecturers 1 (1.4%) and 4 (5.6%) used Expresso as well as Glo respectively. Reasons why lecturers used their service providers was illustrated in Figure 4.24.

![Bar Chart: Reasons why lecturers’ use their service provider]

**Figure 4.24: Reasons why lecturers’ use their service provider**

The figure demonstrated that most lecturers, 21 (60.0%) employed their service providers because of uninterrupted calling services respectively. When there are not any interruptions in calling services, then this would assist lecturers in communicating with their students more effectively without reception issues.

### 4.3 Types of mobile phone technologies being used by the science university students and how often they utilized these technologies

Objective one was to find out the kind of mobile phone technologies available for science students. A 5-point Likert scale was used which included; very often, often, occasionally, rarely and never. Students were asked to indicate how often they used these mobile phones in learning. The results were as presented in Table 4.5.
Table 4.5: Mobile phone technologies available to students

<table>
<thead>
<tr>
<th>Mobile technologies used to students</th>
<th>Very Often</th>
<th>Often</th>
<th>Occasionally</th>
<th>Rarely</th>
<th>Never</th>
</tr>
</thead>
<tbody>
<tr>
<td>N= 503</td>
<td>Freq</td>
<td>%</td>
<td>Freq</td>
<td>%</td>
<td>Freq</td>
</tr>
<tr>
<td>1 Text Messaging</td>
<td>262</td>
<td>52.1</td>
<td>156</td>
<td>31.0</td>
<td>72</td>
</tr>
<tr>
<td>2 Audio Recordings</td>
<td>175</td>
<td>34.8</td>
<td>150</td>
<td>29.8</td>
<td>102</td>
</tr>
<tr>
<td>3 Research</td>
<td>177</td>
<td>35.2</td>
<td>190</td>
<td>37.8</td>
<td>96</td>
</tr>
<tr>
<td>4 Emails</td>
<td>162</td>
<td>32.2</td>
<td>145</td>
<td>28.8</td>
<td>102</td>
</tr>
<tr>
<td>5 Calls</td>
<td>362</td>
<td>72.0</td>
<td>108</td>
<td>21.5</td>
<td>28</td>
</tr>
<tr>
<td>6 Reading</td>
<td>160</td>
<td>31.8</td>
<td>139</td>
<td>27.6</td>
<td>111</td>
</tr>
<tr>
<td>7 Social Networking</td>
<td>199</td>
<td>39.6</td>
<td>150</td>
<td>29.8</td>
<td>88</td>
</tr>
<tr>
<td>8 Office Application</td>
<td>124</td>
<td>24.7</td>
<td>86</td>
<td>17.1</td>
<td>65</td>
</tr>
<tr>
<td>9 Dictionary/Calculator</td>
<td>184</td>
<td>36.6</td>
<td>151</td>
<td>30.0</td>
<td>101</td>
</tr>
<tr>
<td>10 Alarms</td>
<td>153</td>
<td>30.4</td>
<td>179</td>
<td>35.6</td>
<td>86</td>
</tr>
<tr>
<td>11 Artifacts</td>
<td>106</td>
<td>21.1</td>
<td>137</td>
<td>27.2</td>
<td>118</td>
</tr>
<tr>
<td>12 Learning Materials</td>
<td>148</td>
<td>29.4</td>
<td>152</td>
<td>30.2</td>
<td>105</td>
</tr>
<tr>
<td>13 Notes</td>
<td>109</td>
<td>21.7</td>
<td>152</td>
<td>30.2</td>
<td>95</td>
</tr>
<tr>
<td>14 Bluetooth</td>
<td>174</td>
<td>34.6</td>
<td>164</td>
<td>32.6</td>
<td>81</td>
</tr>
<tr>
<td>15 Discussions</td>
<td>135</td>
<td>26.8</td>
<td>220</td>
<td>43.7</td>
<td>70</td>
</tr>
<tr>
<td>16 Java support</td>
<td>0</td>
<td>0.0</td>
<td>0</td>
<td>0.0</td>
<td>0</td>
</tr>
<tr>
<td>17 Notifications</td>
<td>0</td>
<td>0.0</td>
<td>0</td>
<td>0.0</td>
<td>0</td>
</tr>
<tr>
<td>18 Demonstrations</td>
<td>0</td>
<td>0.0</td>
<td>21</td>
<td>4.2</td>
<td>37</td>
</tr>
</tbody>
</table>

As shown in Table 4.5, majority of students used mobile phones for text messaging (262, 52.1%), audio recordings (175, 34.8%), research (177, 35.2%), normal calls (362, 72.0%) and social networking (199, 39.6%). Not many students were seen to be using YouTube...
videos as a science learning tool. Only 58 (11.6%) of the students were observed to be using YouTube for science demonstrations. The YouTube technology can be used as educational science videos where students can view demonstrations. There are many websites that allow students to download demonstrations of science experiments and science lessons. Some YouTube videos allow students to get involved in “do it yourself” science experiments and how experiments can be recreated, which is a great opportunity for students to use this technology beyond the classroom. Other YouTube videos involve instructors who can be viewed giving short lectures on different topics in the Sciences.

With numerous functionalities added to smartphones these days, voice call, the oldest functionality of mobile phones, is currently less significant and is used less frequently than before (Prensky, 2004). Hence, if m-learning could be achieved through utilizing smartphones on campuses, students would certainly see it as a great advantage. According to a study conducted by JMU (2012) involving 963 students, it was observed that a variety of technologies were frequently used, especially text messaging (90%) and social networking (79%).

In addition, the technologies used on a weekly basis by more than a quarter of the students include downloading music or videos, instant messaging, using the internet from a mobile phone, spreadsheets, presentation software such as PowerPoint and also video chat (JMU, 2012). Some of these technologies could be used in learning science. For example, YouTube videos can be used as demonstrations to explain some complex concepts for easier understanding. These videos can also demonstrate how to perform experiments. Instant messaging can be used by students to discuss assignments and
particular topics in science that were not understood in class. Students can browse the internet to get access to scientific information and materials that can assist in supporting their learning.

Jan Koum, CEO of Whatsapp Messenger, said that he lauded Ghanaian university students for using this application to hold discussions with their lecturers and comparing notes among themselves in a group (Abbey, 2014). A lot of students, 162 (32.2%) also had access to their emails from their phones and 184 (36.6%) of them also used dictionaries or calculators on their phones. Majority of students did not use Java support, receive notifications nor watch demonstrations on their phones. In a study conducted by Fazeena et al (n.d.) it was observed that students mostly used the mobile phones for voice calling and sending SMS. Students used voice calls and SMS equally. MMS was, however, not being used much within the student community.

The top five most visited websites on mobile phone internet was Facebook, Google, Yahoo, Whatsapp and Twitter (iHub, 2012). Mobile phone technologies that were used most often by students were calculator 33(69%), phone camera 20(42%) and video capacity 13(27%) (Woodcock, 2012). A few studies have researched into the use of mobile phones as a learning tool and functions such as the calculator, text messaging and the alarm reminder (Ison et al, 2004).

Table 4.6 shows the mean and standard deviation of mobile phone technologies used by students.
Table 4.6: Mean and standard deviation of mobile phone technologies used by students

<table>
<thead>
<tr>
<th>Technologies</th>
<th>N</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valid N (listwise)</td>
<td>503</td>
<td>2</td>
<td>5</td>
<td>4.29</td>
<td>.675</td>
</tr>
</tbody>
</table>

It was seen from Table 4.6 that the mean and standard deviation of mobile phone technology utilization was 4.29 and 0.675 respectively. This means that most students were using some of the mobile phone technologies to support their learning. Means that were greater than 3.49 indicated high patronage in the use of mobile phone technologies while a mean below 2.49 indicated a low patronage and a mean between 2.5 to 3.49 showed average patronage. The scale for mobile phone usage is as follows:

- Low usage = 1.0 – 2.49,
- Average usage = 2.5 – 3.49,
- High usage = 3.5 – 5.00.

These findings reveal that students were frequently using mobile phone technologies to support their learning, since the mean was found to be 4.29, which falls between 3.5 – 5.0, indicating high usage.

Information concerning the mobile applications that help in science learning in particular is presented in Figure 4.25.
Figure 4.25: Mobile applications that help in science learning

From Figure 4.25, it is clear that most students, 22 (29.3%) felt that browsers helped them in science while 10 (13.3%) viewed office applications and adobe readers as mobile applications useful in Science. Only a small number of students, 2 (2.7%) believed that DropBox benefited them in science learning. A very small group of students, 2 (2.7%) also thought screen munchers as well as language translators helped in learning science.

The mobile phone services used most were observed to be making calls, browsing the internet, text messaging, listening to music and playing games (iHub, 2012).

Table 4.7 presents a cross tabulation of students’ gender with mobile phone technologies.

Table 4.7: A Cross-Tabulation of Gender of student with mobile phone technologies

<table>
<thead>
<tr>
<th>Technologies</th>
<th>Very Often</th>
<th>Often</th>
<th>Occasionally</th>
<th>Rarely</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender Male</td>
<td>126</td>
<td>151</td>
<td>28</td>
<td>0</td>
<td>305</td>
</tr>
<tr>
<td>Gender Female</td>
<td>77</td>
<td>94</td>
<td>23</td>
<td>4</td>
<td>198</td>
</tr>
<tr>
<td>Total</td>
<td>203</td>
<td>245</td>
<td>51</td>
<td>4</td>
<td>503</td>
</tr>
</tbody>
</table>
Table 4.7 showed that males used mobile phone technologies more often than females. A study conducted with Chinese and British students revealed that males in both countries used email, instant messaging, played computer games and were more positive about their skills in using computers as compared to their female counterparts (Li & Kirkup, 2007). Therefore, this could be related to the interest or attitudes of males and females towards technology.

To determine if there is a difference between the male and the female groups of students, a t-test for independent samples was conducted. Table 4.8 shows the results.

**Table 4.8: Independent Samples Test on mobile phone technologies used by students according to gender**

<table>
<thead>
<tr>
<th>Technologies</th>
<th>Levene's Test for Equality of Variances</th>
<th>t-test for Equality of Means</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>F</td>
<td>Sig.</td>
</tr>
<tr>
<td>Equal variances assumed</td>
<td>1.294</td>
<td>0.256</td>
</tr>
<tr>
<td>Equal variances not assumed</td>
<td>1.403</td>
<td>378.289</td>
</tr>
</tbody>
</table>

A t-test was performed to determine differences in gender regarding how university students’ use of mobile phone technologies. Table 4.8 revealed that statistically (p > 0.05,
t = 1.446), there was no significant difference in the use of mobile phone technologies between male and female students. The null hypothesis $H_{0_{1a}}$ was not rejected at 0.05 level of significance since $p = 0.256$. It was revealed that there was no difference between male and female students in their use of mobile phone technologies in learning. This could be due to the fact that more female students are getting more interested and involved in the area of science and technology.

To examine the differences in students’ use of mobile phone technologies in the various universities, the One-Way ANOVA test was conducted. Results are presented in Table 4.9 and 4.10.

**Table 4.9: Descriptives of the use of mobile phone technologies by students amongst the universities**

<table>
<thead>
<tr>
<th>Technologies</th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Std. Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>UG</td>
<td>143</td>
<td>4.21</td>
<td>0.601</td>
<td>0.050</td>
</tr>
<tr>
<td>UCC</td>
<td>129</td>
<td>4.26</td>
<td>0.653</td>
<td>0.057</td>
</tr>
<tr>
<td>KNUST</td>
<td>231</td>
<td>4.44</td>
<td>0.716</td>
<td>0.047</td>
</tr>
<tr>
<td>Total</td>
<td>503</td>
<td>4.29</td>
<td>0.675</td>
<td>0.030</td>
</tr>
</tbody>
</table>

It is clear from Table 4.9 that the means of UG, UCC and KNUST were determined to be 4.21, 4.26 and 4.44 respectively. KNUST is a science and technology biased university and so it is not surprising that students from that university used mobile phone
technologies more than the other two universities. ANOVA of the use of mobile phone technologies amongst the universities is presented in Table 4.10.

Table 4.10: ANOVA of the use of mobile phone technologies by students amongst the universities

<table>
<thead>
<tr>
<th>Technologies</th>
<th>Sum of Squares</th>
<th>Df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>4.946</td>
<td>2</td>
<td>2.473</td>
<td>5.525</td>
<td>0.004</td>
</tr>
<tr>
<td>Within Groups</td>
<td>223.829</td>
<td>500</td>
<td>0.448</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>228.775</td>
<td>502</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

It was revealed in Table 4.10 that statistically (p<0.05, F=5.525), there is a significant difference in use of mobile phone technologies by students amongst the universities. The difference was subjected to further statistical testing. The results are shown in Table 4.10 and 4.11. Therefore, the null hypothesis $H_{01b}$ was rejected at 0.05 level of significance since $p = 0.004$ between the various universities. Further statistical analysis was conducted and the results were confirmed in Figure 4.11 and 4.12.
Table 4.11: Post Hoc: Tukey HSD of mobile phone technologies used by students in the different universities

<table>
<thead>
<tr>
<th>(I) Name of University</th>
<th>(J) Name of University</th>
<th>Mean Difference (I-J)</th>
<th>Std. Error</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>UG</td>
<td>UCC</td>
<td>-.048</td>
<td>0.081</td>
<td>0.060</td>
</tr>
<tr>
<td></td>
<td>KNUST</td>
<td>-0.233*</td>
<td>0.071</td>
<td>0.003</td>
</tr>
<tr>
<td>UCC</td>
<td>UG</td>
<td>0.048</td>
<td>0.081</td>
<td>0.060</td>
</tr>
<tr>
<td></td>
<td>KNUST</td>
<td>-0.185</td>
<td>0.074</td>
<td>0.791</td>
</tr>
<tr>
<td>KNUST</td>
<td>UG</td>
<td>0.233*</td>
<td>0.071</td>
<td>0.003</td>
</tr>
<tr>
<td></td>
<td>UCC</td>
<td>0.185</td>
<td>0.074</td>
<td>0.791</td>
</tr>
</tbody>
</table>

* The mean difference is significant at the 0.05 level.

Post-hoc multiple comparisons using the Tukey HSD tests from Table 4.11 revealed that there is no statistically significant difference in the use of mobile phone technologies between UG and UCC, MD (Mean difference) = 0.048, p>0.05. However, there is a significant difference between UG and KNUST, MD= 0.233, p<0.05 and UCC.
Table 4.12: Homogeneous Subsets of mobile phone technologies used by students in the universities

<table>
<thead>
<tr>
<th>Name of University</th>
<th>N</th>
<th>Subset for alpha = 0.05</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>UG</td>
<td>143</td>
<td>4.21</td>
</tr>
<tr>
<td>UCC</td>
<td>129</td>
<td>4.26</td>
</tr>
<tr>
<td>KNUST</td>
<td>231</td>
<td>4.44</td>
</tr>
<tr>
<td>Sig.</td>
<td></td>
<td>1.000</td>
</tr>
</tbody>
</table>

The results in Table 4.12 indicate that students in KNUST used mobile phone technologies more often than the other two universities. But, the use of mobile phone technologies was the same between students of UG and students of UCC. This again could be related to the courses in Science offered at these universities. According to the findings, the more Science and Technology based the university is, the more the intensity of mobile phone technologies being used in an institution.

The differences in university students’ use of mobile phone technologies according to their ages was examined through the One-Way ANOVA. The results are revealed in Table 4.13 and 4.14.
Table 4.13: Descriptives of the use of mobile phone technologies by students amongst the age groups

<table>
<thead>
<tr>
<th>Technologies</th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Std. Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Below 21</td>
<td>81</td>
<td>4.11</td>
<td>0.791</td>
<td>0.088</td>
</tr>
<tr>
<td>22-26</td>
<td>389</td>
<td>4.33</td>
<td>0.633</td>
<td>0.032</td>
</tr>
<tr>
<td>27-31</td>
<td>26</td>
<td>4.42</td>
<td>0.758</td>
<td>0.149</td>
</tr>
<tr>
<td>32 and above</td>
<td>7</td>
<td>3.57</td>
<td>0.535</td>
<td>0.202</td>
</tr>
<tr>
<td>Total</td>
<td>503</td>
<td>1.71</td>
<td>0.675</td>
<td>0.030</td>
</tr>
</tbody>
</table>

The group of students below 21 years old reported a mean of \( M = 4.11 \) with a standard deviation of \( SD = 0.791 \) while the group of 22-26 years old reported a mean of \( M = 4.33 \) with a standard deviation of \( SD = 0.633 \). The group of 27-31 years old reported a mean of \( M = 4.42 \) with a standard deviation of \( SD = 0.758 \) and the group of 32 and above years old reported a mean of \( M = 3.57 \) with a standard deviation of \( SD = 0.535 \).

It means, therefore, that there is no difference in the use of mobile phone technologies between the age groups below 21, 22-26 and 27-31 years. Students above 32 were seen not to be using mobile phone technologies more frequently. This could be due to the suggested explanation that older students may have more difficulties in coping with the demands of learning as compared to younger undergraduate students. This can be because older students are considered to lack basic skills required for studying effectively.
(Newman-Ford et al, 2009). Therefore, promoting skills in the use of technologies would be important for this age group.

Here, we see some relationship between age and use of mobile phones.

**Table 4.14: ANOVA of the use of mobile phone technologies by students amongst the age groups**

<table>
<thead>
<tr>
<th>Technologies</th>
<th>Sum of Squares</th>
<th>Df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>7.178</td>
<td>3</td>
<td>2.393</td>
<td>5.388</td>
<td>0.001</td>
</tr>
<tr>
<td>Within Groups</td>
<td>221.598</td>
<td>499</td>
<td>0.444</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>228.775</td>
<td>502</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

An ANOVA test between the means revealed in Table 4.14 that F= 5.388 at p = 0.001. As p<0.05, the results indicated that there was a statistically significant difference in the overall mean groups. Therefore, the null hypothesis Ho1c was rejected at 0.05 level of significance since p = 0.001 between the age groups.

The difference was subjected to further statistical testing and the results are shown in Tables 4.15 and 4.16.
### Table 4.15: Post Hoc: Tukey HSD of mobile phone technologies used by students in the different age groups

<table>
<thead>
<tr>
<th>(I) Age of student</th>
<th>(J) Age of student</th>
<th>Mean Difference (I-J)</th>
<th>Std. Error</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Below 21</td>
<td>22-26</td>
<td>-0.215*</td>
<td>0.081</td>
<td>0.042</td>
</tr>
<tr>
<td></td>
<td>27-31</td>
<td>-0.312</td>
<td>0.150</td>
<td>0.162</td>
</tr>
<tr>
<td></td>
<td>32 and above</td>
<td>0.540</td>
<td>0.263</td>
<td>0.169</td>
</tr>
<tr>
<td>22-26</td>
<td>Below 21</td>
<td>0.215*</td>
<td>0.081</td>
<td>0.042</td>
</tr>
<tr>
<td></td>
<td>27-31</td>
<td>-0.097</td>
<td>0.135</td>
<td>0.891</td>
</tr>
<tr>
<td></td>
<td>32 and above</td>
<td>0.755*</td>
<td>0.254</td>
<td>0.016</td>
</tr>
<tr>
<td>27-31</td>
<td>Below 21</td>
<td>0.312</td>
<td>0.150</td>
<td>0.162</td>
</tr>
<tr>
<td></td>
<td>22-26</td>
<td>0.097</td>
<td>0.135</td>
<td>0.891</td>
</tr>
<tr>
<td></td>
<td>32 and above</td>
<td>0.852*</td>
<td>0.284</td>
<td>0.015</td>
</tr>
<tr>
<td>32 and Above</td>
<td>Below 21</td>
<td>-0.540</td>
<td>0.263</td>
<td>0.169</td>
</tr>
<tr>
<td></td>
<td>22-26</td>
<td>-0.755*</td>
<td>0.254</td>
<td>0.016</td>
</tr>
<tr>
<td></td>
<td>27-31</td>
<td>-0.852*</td>
<td>0.284</td>
<td>0.015</td>
</tr>
</tbody>
</table>

* The mean difference is significant at the 0.05 level.

It was observed from Table 4.15 that statistically, there is no difference between the use of mobile phone technologies and the age groups, MD = 0.312, $p>0.05$. There is, however, a significant difference between the age groups below 21 years and 22-26 years, MD= 0.215, $p<0.05$ in addition to the age groups 27-31 years and above 32 years, MD=0.852, $p<0.05$.  


Table 4.16: Homogeneous Subsets of mobile phone technologies by students among different age groups

<table>
<thead>
<tr>
<th>Age of student</th>
<th>N</th>
<th>Subset for alpha = 0.05</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Below 21</td>
<td>26</td>
<td>4.11</td>
</tr>
<tr>
<td>22-26</td>
<td>389</td>
<td>4.33</td>
</tr>
<tr>
<td>27-31</td>
<td>81</td>
<td>4.42</td>
</tr>
<tr>
<td>32 and above</td>
<td>7</td>
<td>3.57</td>
</tr>
<tr>
<td>Sig.</td>
<td></td>
<td>.442 1.000</td>
</tr>
</tbody>
</table>

Results from Table 4.16 indicate that students from the age groups below 21 and between 22 to 31 years old have been using mobile phone technologies to support their learning, but those above the age of 32 were seen not to be using these technologies often. This is not surprising as this age group was considered to be one that is termed as digital immigrants (Prensky, 2005). Prensky (2005) asserted that digital immigrants see mobile phones as being more disruptive than useful.

4.4 Students’ academic satisfaction in the use of mobile phones in learning science

The second objective of this study was to assess the extent to which students are satisfied with the use of mobile phone technologies in learning science. The results were as presented in Table 4.17.
Table 4.17: Students’ Academic Satisfaction in mobile phone use

<table>
<thead>
<tr>
<th>Satisfaction</th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Uncertain</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Freq</td>
<td>%</td>
<td>Freq</td>
<td>%</td>
<td>Freq</td>
</tr>
<tr>
<td>N= 503</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 Science research</td>
<td>18</td>
<td>3.6</td>
<td>23</td>
<td>4.6</td>
<td>52</td>
</tr>
<tr>
<td>2 Mobile Apps</td>
<td>24</td>
<td>4.8</td>
<td>33</td>
<td>6.6</td>
<td>55</td>
</tr>
<tr>
<td>3 Wireless network</td>
<td>173</td>
<td>34.4</td>
<td>258</td>
<td>51.3</td>
<td>13</td>
</tr>
<tr>
<td>4 Info Expansion</td>
<td>104</td>
<td>20.7</td>
<td>142</td>
<td>28.2</td>
<td>47</td>
</tr>
<tr>
<td>5 Interactive learning</td>
<td>18</td>
<td>3.6</td>
<td>35</td>
<td>7.0</td>
<td>16</td>
</tr>
<tr>
<td>6 Obtaining important info</td>
<td>53</td>
<td>10.5</td>
<td>378</td>
<td>75.1</td>
<td>10</td>
</tr>
<tr>
<td>7 Science experiments</td>
<td>25</td>
<td>5.0</td>
<td>32</td>
<td>6.4</td>
<td>36</td>
</tr>
<tr>
<td>8 Group discussion</td>
<td>64</td>
<td>12.7</td>
<td>238</td>
<td>47.3</td>
<td>97</td>
</tr>
<tr>
<td>9 Mixed traditional methods</td>
<td>49</td>
<td>9.7</td>
<td>66</td>
<td>13.1</td>
<td>26</td>
</tr>
<tr>
<td>10 Internet Band-width</td>
<td>76</td>
<td>15.1</td>
<td>184</td>
<td>36.6</td>
<td>66</td>
</tr>
<tr>
<td>11 Instructor sending Info</td>
<td>0</td>
<td>0.0</td>
<td>66</td>
<td>13.1</td>
<td>0</td>
</tr>
<tr>
<td>12 Video podcasts</td>
<td>0</td>
<td>0.0</td>
<td>0</td>
<td>0.0</td>
<td>0</td>
</tr>
<tr>
<td>13 Audio Recording</td>
<td>64</td>
<td>12.7</td>
<td>181</td>
<td>36.0</td>
<td>142</td>
</tr>
</tbody>
</table>

The results show that most students are not satisfied with the use of mobile phone technologies at their universities. Although, the majority 431 (85.7%) of students are satisfied with the wireless networks available on campus. This compares well with some
studies, for example, JMU (2012) which found that 64% of students were satisfied with the wireless infrastructure accessible on university campus. From the point of view of most students, students did not receive information from their lecturers through their mobile phones. It was confirmed that, majority of students 302 (60.0%) used mobile phones to communicate with their course mates and other students 245 (48.7%) used the technology to audio record their lecturers’ lessons (podcasts).

Audio podcasting summaries of lectures assists students in revising notes, catching up on missed classes and improving grasping of difficult concepts. Podcasts are convenient since educational information can even be accessed when the student is away from the university. As a result, students found these podcasts extremely helpful and encouraging (Litchfield et al, 2007). Podcasts also enhance group discussions with peers using mobile phones. Data concerning the mean and standard deviation is shown in Table 4.18.

Table 4.18: Mean and Standard Deviation of Academic satisfaction

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Satisfaction</td>
<td>503</td>
<td>1</td>
<td>5</td>
<td>2.28</td>
<td>.610</td>
</tr>
<tr>
<td>Valid N (listwise)</td>
<td>503</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The Table shows that the mean and standard deviation of academic satisfaction is observed to be 2.28 and 0.610 respectively. This implies that most students were generally not satisfied with the use of mobile phones to support their learning. Means that were greater than 3.49 indicated high satisfaction in the use of mobile phone technologies while a mean below 2.49 indicated a low satisfaction and a mean between 2.5 to 3.49 showed average satisfaction. The scale for mobile phone usage is as follows;
Low satisfaction = 1.0 – 2.49, Average satisfaction = 2.5 – 3.49, High satisfaction = 3.5 – 5.00. The mean was determined to be 2.28, which fell between 1.0-2.49, meaning that students had low satisfaction in the mobile phone technology available on campus and also with how this technology was utilized in the universities.

4.5 Learning styles and use of mobile phone technologies

The third objective of this study was to establish the various types of learning styles and the role they play in promoting mobile phone technology education among science university students. Students were asked questions pertaining to how learning styles can be influenced by the use of mobile phones in learning. The results are presented in Figure 4.26.

![Figure 4.26: Distribution of students’ learning styles](image)

A student’s learning style is represented by a point in the four-dimensional space, with active/reflective, sensory/intuitive, visual/verbal and sequential/global. Thus, each student is described in four dimensions simultaneously. From Fig 4.26, the data showed that students, 357 (71.0%) preferred visual as compared to students 146 (29.0%) who preferred verbal. This study showed that more students learn from what they see than
from what they hear. According to Felder and Silverman (1988), many visual university students do not benefit from instruction, since little visual information is offered (Johnson, 2007) rather students mainly listen to lectures, take down notes and read text. According to Johnson and Broadley (2011), it was emphasized that visual learners have a preference of information presented in a pictorial fashion, in the form of illustrations, diagrams, flowcharts or non-interactive animations. It is an established belief that students learn better visually.

A number of students, 325 (64.6%) had a sensing preference while other students 178 (35.4%) preferred intuitive learning. When it came to processing information, a little more than half of the students, 315 (62.6%) had an active preference over students 188 (37.4%) who had a reflective one. At the understanding stage, majority of students, 349 (69.4%) preferred sequential as compared to students 104 (30.6%) who had a global perspective. This is consistent with research conducted by Graf et al (2007) who examined the distribution of learning preferences for each of the dimension. As a result, 57% of the students in the study were found to have an active preference while 58% a sensing preference. Students having a visual preference were found to be 87% and 56% having a global preference.

Similarly, in a study conducted by Franzoni & Assar (2009), a Felder and Silverman learning style questionnaire was given to 26 students, in which the results showed that more students were sensible (62%) than intuitive (38%), visual (85%) students were significantly observed while only 15% were verbal. In addition more students were also seen to be more active and sequential rather than reflective and global. Most students in
this study were observed to have the prevalent combination of sensitive/visual/active/sequential.

In a study with 123 university students conducted by Johnson & Broadley (2011), it was observed that those who were reported to be reading were seen to be more reflective. In contrast, students who were seen to be more active gave an account of using the internet to access maps and make calls. Also, students who were more likely to be intuitive reported using Twitter, blogs, photo sites and playing games online and those who reported using instant chat messaging were more likely to be verbal than visual in their learning style.

4.6 The influence of utilization of mobile phone technologies on the academic performance

The fourth objective of this study was to verify how usage of mobile phone technologies in learning science influences academic performance.

4.6.1 Influence of academic performance on use of mobile phones

Students were asked to fill items about academic performance. How the use of mobile phones can affect students’ academic performance is presented in Table 4.19, 4.20 and 4.21.
The data showed that more than ¾ of students believe that mobile phones would increase their academic performance, if used properly. Woodcock (2012) study supports the idea that mobile phones can be used to improve academic performance, especially if most students use these technologies for either managing their learning through group work, timetabling, searching for information or referencing. Therefore, mobile phones can be
used to support science learning. The mean and standard deviation of academic performance with mobile phone technologies is demonstrated in Table 4.20.

Table 4.20: Mean and standard deviation of academic performance with mobile phone technologies

<table>
<thead>
<tr>
<th>Performance</th>
<th>N</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valid N (listwise)</td>
<td>503</td>
<td>1</td>
<td>5</td>
<td>3.11</td>
<td>.682</td>
</tr>
</tbody>
</table>

Table 4.20 reveals that the mean and standard deviation of academic performance is seen to be 3.11 and 0.682 respectively. This indicates that the majority of students, who used mobile phones to support their learning, had a positive impact on their academic performance. Means that were greater than 3.49 indicated high performance in the use of mobile phone technologies while a mean below 2.49 indicated a low performance and a mean between 2.5 to 3.49 showed average performance. The scale for mobile phone usage is as follows;

Low performance = 1.0 – 2.49, Average performance = 2.5 – 3.49, High performance = 3.5 – 5.00. The level of performance of the students were determined to be 3.11, which falls between 2.5-3.49, indicating that mobile phone technologies influenced students’ performance averagely.

A cross-tabulation of GPA of students and the use of mobile phone technology for learning was conducted. The results were as summarized in Table 4.21.
Table 4.21: A Cross-Tabulation of GPA of students with mobile phone technologies

<table>
<thead>
<tr>
<th>Students’ GPA</th>
<th>Technologies</th>
<th>Very Often</th>
<th>Often</th>
<th>Occasionally</th>
<th>Rarely</th>
<th>Never</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Above 3.0</td>
<td></td>
<td>51</td>
<td>74</td>
<td>18</td>
<td>0</td>
<td>0</td>
<td>143</td>
</tr>
<tr>
<td>2.5-2.9</td>
<td></td>
<td>139</td>
<td>157</td>
<td>31</td>
<td>3</td>
<td>3</td>
<td>330</td>
</tr>
<tr>
<td>Below 2.5</td>
<td></td>
<td>13</td>
<td>14</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>30</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>203</td>
<td>245</td>
<td>51</td>
<td>4</td>
<td>4</td>
<td>503</td>
</tr>
</tbody>
</table>

The majority of students with a GPA from 2.5 and above indicated that mobile phone technologies had a positive influence on their academic performance. The bright students tend to value the use of technology in acquiring knowledge. Therefore, those with higher GPA’s were observed to be using mobile phone technologies more frequently while those with a lower GPA were not seen to be using mobile phone technologies as much.

Cross tabulation was employed in this study in order for data analysis to be more basic and easier to understand. Cross tabulation is straightforward and one of the most frequently used ways of indicating the presence or absence of a relationship (Bryman & Cramer, 2001). The use of mobile phones in science learning is displayed in Figure 4.27.
4.6.2 Utilization of mobile phones in learning science

![Figure 4.27: How students use their mobile phones](image)

<table>
<thead>
<tr>
<th>Activity</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emails</td>
<td>20</td>
</tr>
<tr>
<td>Sending/receiving text messages</td>
<td>17</td>
</tr>
<tr>
<td>Sending multimedia messages</td>
<td>8</td>
</tr>
<tr>
<td>Taking photos</td>
<td>6</td>
</tr>
<tr>
<td>Watching video clips</td>
<td>5</td>
</tr>
<tr>
<td>Listening to music</td>
<td>4</td>
</tr>
<tr>
<td>Listening to the radio</td>
<td>5</td>
</tr>
<tr>
<td>Browsing internet</td>
<td>10</td>
</tr>
<tr>
<td>Others</td>
<td>5</td>
</tr>
</tbody>
</table>

It is clear from the data in Figure 4.27 that the majority of respondents, 20 (26.7%) sent or received emails and only a few of students 2 (2.7%) send multimedia messages. A few students, 17 (22.7%) sent and received text messages while other students 10 (13.3%) used their phones for regular browsing. A group of few students, 5 (6.7%) indicated alarm, reminders, calculator, dictionary and stopwatch were the features they used most on their mobile phones.

According to Dean (2010), even though the mobile phone has many advanced features and has the capability to bring in information apparently anywhere, it is still just a phone, and phones are mainly about communicating with other people. It should come as no surprise, then, that text messaging 254 (93%) and emailing 252 (93%) were the two most commonly used functions on mobile phones among college and university students in United States, followed by reading news and books online as well as watching videos (Dean, 2010). A majority of students used mobile phones for emails as well as text messages. It is also not surprising that quite a number of students 250 (92%) used smartphones to search for information.
With regard to the use of mobile phones for the purpose of learning science, the responses were as summarized in Figure 4.28.

**Figure 4.28: The use of mobile phones in learning science**

The data presented in Figure 4.28 indicated that a substantial number of respondents, 20 (26.7%) use mobile phones in science learning by browsing/research and reading scientific information online. A few students, 4 (5.3%) used mobile phone to watch science videos on YouTube and social network collaboration. The remaining students, 8 (10.7%) used their phones for calculating figures, downloading information, office applications, conference calling via Skype and capturing information through ‘screen munches to read information anytime.’ These technologies can be used in science to calculate formulas, science research, using office application to write up science reports or give presentations on different topics in the sciences, discuss assignments with course mates through skyping and munching information for later reference.

Ways students use mobile phones to improve their academic performance is presented in Figure 4.29.
Figure 4.29: Ways mobile phones can improve academic performance

The analysis of data in Figure 4.29 indicated that a good number of students, 26 (34.7%) and 15 (20.0%) believed that searching for information as well as getting easier access to notes or downloading materials and resources respectively enhances academic performance. Only a few students, 2 (2.7%) thought that sharing files and notes through dropbox enhances their academic performance. A few students, 3 (4.0%) believed discussion through skyping and audio recording lectures also enhances academic performance.

Some students, 5 (6.7%) also believed that distribution of course content, scheduling, emailing to lecturers and taking pictures of experiments enhanced their performance. Students reported that they did the following activities on their mobile phones: texting (98%), web browsing (62%), checking personal calendar (61%), checking e-mails (58%), social networking (57%), playing games (51%), map software (47%), listening to audios (46%), watching videos (42%) and read books (11%) (JMU, 2012). Thus, students can use mobile phone technologies to support their learning, which in turn increases their academic performance.
Students were also asked the site they used often when seeking for information for assignments and reasons they used that site. Results are illustrated in Figure 4.30 and 4.31.

![Bar chart showing the frequency of site usage](image)

**Figure 4.30: Site students used frequently when searching for information**

It is clearly seen from Figure 4.30 that the majority of students, 31 (41.3%) used Google and 19 (25.3%) of them Yahoo. Webopedia had only 2 (2.7%) students using it to search for academic information. Whenever most students need information, their initial search is most likely to google the information. Many think the Google search engine is a time-saving approach to finding information needed. All students have to do is type the keywords and press the enter button and see numerous results within a matter of seconds (Oblinger & Oblinger, 2005).

When asked to give reasons why they preferred a specific site their responses were as presented in Figure 4.31.
Figure 4.31: Reasons for using site to search for information

The data in Figure 4.31 reveals that most students, 23 (30.7%) found that they used the site because it was informative while 15 (20%) of them thought the site to be easier to read or understand. A few students, 10 (13.3%) and 9 (12%) believed that the site was useful or fast and relevant. Others students observed these sites as an encyclopedic resource or a high quality of content. Google search was seen to be popular, which is not surprising, since this technology was seen to be user-friendly and has a wide range of relevant information in the area of science.

4.6.3 How mobile learning is viewed and the future it has in higher education

This study felt it was appropriate to appreciate how students viewed m-learning. This would give more in-depth information on how students understood the concept of m-learning. The responses were as presented in Figure 4.32 and 4.33.
From the Figure 4.32, out of 75 students, the majority of students, 25 (33.3%) believed that m-learning was a very convenient means for accessing information on any topic at any time or place while a few of students, 5 (6.7%) thought that m-learning broadened their scope of knowledge or saw it as a new trend of learning through technologies. In the case of others students, 12 (16.0%) perceived that m-learning enhanced learning and made it easier, increased access to information and promoted collaborative learning. Additionally, they said that m-learning was useful for gaining access to learning materials via mobile phones and as one student said “it involved better interaction between lecturers and students”. This idea was supported by a number of ICT coordinators as in the following excerpts:

**ICT coordinator 1:** Mobile devices are now ubiquitous among the young student population in Ghana because of their size, smart features and access to the Internet. I see a real potential for leveraging different kinds of technologies to facilitate education and to expand where, how, and when students learn and participate in educational activities without the restrictions of time and place. M-learning is a way of discovering new information, reference materials, tips and activities.
Yes, indeed this technology can be used to enhance educational experience outside the classroom. Students have the opportunity to access current and relevant information at a tip of a finger.

**ICT coordinator 2:** Mobile learning has a future in our part of the world. Mobile learning is not just phones, but it also includes tablets, PDAs and so forth. Most people have mobile phones, but it should be a smartphone and can be used as an educational tool in Ghana.

In this study, it was realized that all the students had a mobile phone, which in the majority of cases was a smartphone. Since, this is a tool that most students have, it should be used in science teaching and learning.

**ICT coordinator 3:** Basically, it has always been the student-lecturer contact. From my point of view, I wouldn’t say it is being used much in this institution. The technology phase has just caught up, and even if it is up and running, I don’t think it is being used so much for student-lecturer contact.

This technology is not being used during lectures, since there is no university policy governing the use of this technology during class hours. Therefore, for now, students and lecturers can use this technology beyond the classroom and have the opportunity of using mobile phones to support teaching and learning in science. These statements do support and give hope to the future importance of the mobile phone in a learning situation. In this digital era, mobile learning is indeed one of the major areas developing in the educational field. (Fazeena *et al*, n.d.).

A number of options were given to the sample of students about the future role of mobile phone technologies in science learning, which is outlined in Figure 4.33.
Figure 4.33: Future of mobile phone technologies in learning science

The results drawn from the data presented in Figure 4.33, depicted that quite a number of students, 12 (16.0%) felt that mobile phone technologies had a promising future. A few respondents, 5 (6.7%) believed that in the future, mobile phone technologies would be accepted and encouraged, increase participation or satisfaction and would be a platform for spreading information. Other students, 7 (9.3%) thought that the future of mobile phone technologies would increase collaboration, awareness of learning styles and teleconferencing. Students also envisioned more advance mobile phone technology and an increase in lecturer-student interaction.

The development of Wi-Fi networks placed at various points on university campuses signifies that the system’s backbone now makes it easier for lecturers and students to take up mobile phone technologies. Along these lines, mobile phones have become an ubiquitous feature in the lives of enlightened university students, who use their technologies to chat, message (through text or multimedia), take pictures and in recent times to also learn (McConatha et al., 2008). Since, students take their mobile phones with them everywhere, and most of these technologies are internet-connected, it would
only be reasonable to expect that these devices are brought into play for educational purposes, since it can be utilized in sending or receiving text, audio and video information as well as accessing web pages. It is unbelievable that universities will allow such a promising changing prospect pass them by without exploiting them to support teaching and learning (McConatha et al., 2008).

The ICT coordinators supported the promotion of m-learning in the universities as evidenced by the following quotes:

**ICT coordinator 1:** A contract was signed between this institution and the Chinese Company for the implementation of an ICT Based Distance Education Project. The proposed platform will provide both hardware and software solution which offers an online web presence and portable mobile solution. This will include the conversion of all the paper based textbooks into digital formats that will be accessible using the supplied internet enabled mobile device.

Institution should take the initiative of providing digital information, so that students get the opportunity to download this information unto their mobile phones for retrieval at a later time.

**ICT coordinator 2:** The future is bright; there will be so many educational applications. Soon, a student should be able to send an SMS and get information, such as financial status, academic standing and any other academic information with a code (such as registration number).

This institution is also taking the opportunity to provide information in digital form, so that students can access this information, be it financial, social or academic information.

**ICT coordinator 3:** The future is great if the mobile phone is enhanced. Enhanced features for video coverage, increased speed for fast downloading and increased storage space to store heavy materials. Keypad and screen should be slightly bigger.
With increased technologies, the mobile phone is a learning tool that will provide more learning experiences for all science students in the near future. This will allow students get more storage space, so that they can download much more information unto their phones. The comments from ICT coordinators show that the future in mobile phone technologies was a positive one. They also gave their suggestions on how mobile phone technologies will be used in their universities.

The relationship between level of satisfaction of mobile phone technologies and academic performance is presented in the Table below.

Table 4.22: Relationship between level of satisfaction of mobile phone technologies and academic performance of the student

<table>
<thead>
<tr>
<th>Level of Satisfaction</th>
<th>Pearson Correlation</th>
<th>Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sig. (2-tailed)</td>
<td>.495**</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>503</td>
</tr>
<tr>
<td>Performance</td>
<td>Pearson Correlation</td>
<td>.495**</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed)</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>503</td>
</tr>
</tbody>
</table>

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

Cohen (1988) explains that coefficient values less than 0.30 signify a small positive correlation while coefficient values between 0.30 and 0.49 signify a medium positive correlation. Values above 0.50 signify a large positive correlation between the variables.

A Pearson correlation was used to observe the relationship between level of satisfaction of mobile phone technologies usage and the academic performance of students.
It was revealed that level of satisfaction is significantly \((r=0.495, p<0.05)\) related to academic performance. Therefore, the null hypothesis \(H_0\) was rejected at 0.05 level of significance since \(p = 0.001\) between level of satisfaction and performance. This means that the more a student is satisfied with the use of mobile phone technologies the more his/her academic performance improves. With an \(r\) value of 0.495, this correlation was seen to be moderately strong. Using guidelines by Cohen (1988), the results from this study indicated that there was a positive, moderate correlation between level of satisfaction and performance. The findings are consistent with research that revealed that satisfaction has a positive effect on students’ academic performance. Dong and Lucey (2013) also confirmed that there is indeed a relationship between academic performance and students’ satisfaction.

The relationship between the use of mobile phone technologies and students’ academic performance is demonstrated in Table 4.23.
Table 4.23: Relationship between Mobile Phone Technologies used and academic performance of the student

<table>
<thead>
<tr>
<th></th>
<th>Academic Performance</th>
<th>Mobile phone Technologies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Academic Performance</td>
<td>Pearson Correlation</td>
<td>.333**</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed)</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>503</td>
</tr>
<tr>
<td>Technologies</td>
<td>Pearson Correlation</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed)</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>503</td>
</tr>
</tbody>
</table>

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

A Pearson correlation examined the relationship between the mobile phone technologies used and the academic performance of students. This revealed that mobile phone technologies is significantly (r=0.333, p<0.05) related to academic performance. Therefore, the null hypothesis Ho3 was rejected at 0.05 level of significance since p = 0.001 between the use of mobile phone technologies on academic performance. That is the more the student uses mobile phone technologies the more his/her academic performance will get better. With an r value of 0.333, this correlation was also observed to be moderately strong. This implies that the strength of relationship between mobile phone technologies and academic performance is moderately strong.
4.7 Factors influencing the use of mobile phone technologies by university students in science learning

The fifth objective of this study was to find if there were benefits and whether or not students faced any challenges when using mobile phone technologies in science. Students were asked to indicate the benefits and challenges of mobile phone technologies.

The results are shown in Table 4.24 and 4.25.
Table 4.24: Benefits of mobile phones to support learning science

<table>
<thead>
<tr>
<th>N= 503</th>
<th>Benefits</th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Uncertain</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Freq</td>
<td>%</td>
<td>Freq</td>
<td>%</td>
<td>Freq</td>
</tr>
<tr>
<td>1</td>
<td>Edutainment</td>
<td>18</td>
<td>3.6</td>
<td>23</td>
<td>4.6</td>
<td>52</td>
</tr>
<tr>
<td>2</td>
<td>Satisfaction</td>
<td>24</td>
<td>4.8</td>
<td>339</td>
<td>67.4</td>
<td>55</td>
</tr>
<tr>
<td>3</td>
<td>Academic</td>
<td>173</td>
<td>34.4</td>
<td>258</td>
<td>51.3</td>
<td>13</td>
</tr>
<tr>
<td>4</td>
<td>Learning style</td>
<td>104</td>
<td>20.7</td>
<td>142</td>
<td>28.2</td>
<td>47</td>
</tr>
<tr>
<td>5</td>
<td>Supportive environment</td>
<td>18</td>
<td>3.6</td>
<td>35</td>
<td>7.0</td>
<td>16</td>
</tr>
<tr>
<td>6</td>
<td>Academic information</td>
<td>53</td>
<td>10.5</td>
<td>378</td>
<td>75.1</td>
<td>10</td>
</tr>
<tr>
<td>7</td>
<td>Current issues</td>
<td>395</td>
<td>78.5</td>
<td>32</td>
<td>6.4</td>
<td>36</td>
</tr>
<tr>
<td>8</td>
<td>Motivation</td>
<td>97</td>
<td>19.3</td>
<td>238</td>
<td>47.3</td>
<td>64</td>
</tr>
<tr>
<td>9</td>
<td>Mixed methods</td>
<td>49</td>
<td>9.7</td>
<td>66</td>
<td>13.1</td>
<td>26</td>
</tr>
<tr>
<td>10</td>
<td>Visual effects</td>
<td>127</td>
<td>24.9</td>
<td>184</td>
<td>36.6</td>
<td>66</td>
</tr>
<tr>
<td>11</td>
<td>Student-centered instruction</td>
<td>0</td>
<td>0.0</td>
<td>66</td>
<td>13.1</td>
<td>0</td>
</tr>
<tr>
<td>12</td>
<td>Interactivity</td>
<td>0</td>
<td>0.0</td>
<td>0</td>
<td>0.0</td>
<td>0</td>
</tr>
<tr>
<td>13</td>
<td>Exchange of information</td>
<td>142</td>
<td>28.2</td>
<td>181</td>
<td>36.0</td>
<td>64</td>
</tr>
<tr>
<td>14</td>
<td>Information retrieval</td>
<td>152</td>
<td>30.2</td>
<td>271</td>
<td>51.1</td>
<td>44</td>
</tr>
<tr>
<td>15</td>
<td>Communication</td>
<td>127</td>
<td>25.2</td>
<td>265</td>
<td>52.7</td>
<td>35</td>
</tr>
</tbody>
</table>

From the Table, it was seen that majority of students were not aware that mobile phone technologies have numerous functions as well as benefits in learning. Majority of the students, 434 (81.5%) did not agree that mobile phone technologies can support a constructivist learning environment. A good number of students, 362 (72.0%) disagreed that mobile phone technologies can be used to provide mixed traditional methods while
437 (86.9%) of them did not agree these technologies could enhance student-centered instruction. Many of the students, 410 (81.5%) did not believe that mobile phone technologies could be used for edutainment purposes. A good number of students, 423 (81.3%) were aware that mobile phone technologies aided retrieval of academic information through the internet. Majority of students, 431 (85.7%) agreed that mobile phone technologies could be used for academic purposes while 392 (77.9%) of them believed that these technologies enhanced communication.

In a study by Economic Intelligence Unit (2008), out of 289 executives with 180 from higher institutions, the biggest benefit in using mobile phone technologies in academic settings was believed to be increase in students’ access to educational materials and reference resources. The mobile phone was viewed as an alternative channel for supporting different learning styles, enabling greater collaboration and facilitation of student-centered instruction.

Students’ perception of how mobile phones should be used at their university is shown in Figure 4.34.

![Figure 4.34: Students’ opinions on what mobile phones should be used for at their universities](image-url)
The data from Figure 4.34 shows that respondents, 28 (37.3%) would like to see mobile phones being used to get information on their courses whereas 18 (24.0%) students preferred that their mobile phones be used for discussing information with coursemates. A few respondents, 3 (4.0%) felt that receiving email notifications of their grades is what they would like mobile phones to be used for at their universities. Students, therefore, think that their mobile phones should be used for deciding what they need to do in order to be successful in the course.

According to research from a national survey conducted by Project Tomorrow (2009), students in grades 6–12 shared their views on how mobile phones should be used in their learning. If students were given the chance to use mobile phones they would use it in: communicating with their classmates or teachers via SMS, e-mail or instant messaging; working on projects with their classmates either at home or school; playing games for learning purposes; looking up information on the internet; taking notes or recording lectures for review and revision; receiving alerts or reminders about upcoming assignments and quizzes; having access to their school’s portal in uploading or downloading information and online textbooks.

When applied in education, mobile phone technologies have numerous benefits. ICT coordinators in various universities confirmed this.

**ICT coordinator 1**: It provides a simpler way of accessing current information, accelerating reinforcement of instruction and follow-up strategies, and improving efficiency. Students get the opportunity to learn at their own time and at their own pace.
They felt that the technology was certainly an effective learning tool that could be used to support educational experiences.

**ICT coordinator 2:** Accessing education anywhere anytime that is what m-learning is all about, and if so you are talking about mobile phones, a student can receive SMS notifications about exam timetable or change in venue or postponement of a venue for a class. Admission notification is also possible. Remove physical barriers for physically challenged people, so they can be anywhere and still get tertiary education.

The role of SMS in education was strongly emphasized and its many possibilities for teaching and learning were highlighted.

**ICT coordinator 3:** Easy access to lecturers, better communication between lecturers and students, communicate with colleagues to share ideas, download educational materials, such as text and videos, audio record missed lecturers and also research through Google. Modalities must be put in place, so that face-to-face interaction is still there.

Mobile phone technologies enhance communication between lecturers and students beyond the classroom. Therefore, ICT coordinators are aware of the numerous benefits of mobile phones and agreed that students needed to take advantage of them in order to support their learning in science.

The challenges of using mobile phone technologies to support science learning are presented in Table 4.25 and Figure 4.35.
Table 4.25: Challenges of using mobile phone technologies in learning

<table>
<thead>
<tr>
<th>Challenges</th>
<th>N= 503</th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Uncertain</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Freq</td>
<td>%</td>
<td>Freq</td>
<td>%</td>
<td>Freq</td>
<td>%</td>
</tr>
<tr>
<td>1 Small keypad</td>
<td>115</td>
<td>22.9</td>
<td>205</td>
<td>40.8</td>
<td>41</td>
<td>8.2</td>
</tr>
<tr>
<td>2 Plagiarism</td>
<td>126</td>
<td>25.0</td>
<td>206</td>
<td>41.0</td>
<td>112</td>
<td>22.3</td>
</tr>
<tr>
<td>3 Distractable</td>
<td>194</td>
<td>38.6</td>
<td>175</td>
<td>34.8</td>
<td>60</td>
<td>11.9</td>
</tr>
<tr>
<td>4 Cheating</td>
<td>156</td>
<td>31.0</td>
<td>220</td>
<td>43.7</td>
<td>49</td>
<td>9.7</td>
</tr>
<tr>
<td>5 Airtime Cost</td>
<td>192</td>
<td>38.2</td>
<td>214</td>
<td>42.5</td>
<td>54</td>
<td>10.7</td>
</tr>
<tr>
<td>6 Network Problems</td>
<td>233</td>
<td>46.3</td>
<td>199</td>
<td>39.6</td>
<td>40</td>
<td>8.0</td>
</tr>
<tr>
<td>7 Small Screen</td>
<td>140</td>
<td>27.8</td>
<td>225</td>
<td>44.7</td>
<td>67</td>
<td>13.3</td>
</tr>
<tr>
<td>8 Limited Network</td>
<td>224</td>
<td>44.5</td>
<td>201</td>
<td>40.0</td>
<td>45</td>
<td>8.9</td>
</tr>
<tr>
<td>9 Expensive</td>
<td>235</td>
<td>46.7</td>
<td>178</td>
<td>35.4</td>
<td>55</td>
<td>10.9</td>
</tr>
<tr>
<td>10 Internet Bandwidth</td>
<td>198</td>
<td>39.4</td>
<td>188</td>
<td>37.4</td>
<td>61</td>
<td>12.1</td>
</tr>
</tbody>
</table>

The challenges the majority of students believed they faced in regard to uses of mobile phones were cost of mobile phones 413 (82.1%), network problems 432 (85.9%), reliability of internet 386 (76.8%) and airtime cost 406 (80.7%). At the same time, majority of students from universities believed that plagiarism 332 (66.0%), cheating 376 (74.7%) and distractions 369 (73.4%) were great concerns in the use of new technologies. This is supported by some other findings (Economic Intelligence Unit, 2008) who reported the same negative challenges from a different study.

Figure 4.34 reveals some challenges encountered when using mobile phones in supporting learning science.
Figure 4.35: Challenges when using mobile phones in science learning

Figure 4.35 shows some of the challenges students faced when using mobile phones to support their science learning. Most students, 24 (32%) stated that limited storage capabilities was a major issue compared to 21 (18%) who believed the battery life was a major challenge. According to Adomi (2006), the greatest challenge encountered by students when using their mobile phone in Nigeria was frequent network failure, which attracted a high response of 71 (65.5%). From his findings, network failure occurred frequently and could last from a few minutes to several days.

A number of lecturers from the three universities were involved in this study. They were asked to give their views about the use of mobile phone in supporting teaching of science. The results are presented in figures and tables below.

4.8 Types of technologies used by lecturers to support teaching in science

The study sought to find out how lecturers used certain mobile phone technologies in supporting their teaching.

Data collected from their responses is presented in Figure 4.35.
Figure 4.36: Lecturers' use of mobile phone in support of teaching

The data in Figure 4.36 revealed that a substantial number of lecturers, 54 (76.1%) did not use mobile phones to support their teaching and a few lecturers 17 (23.9%) used mobiles in supporting their teaching. Similarly, in another study, only 2.8% of lecturers responded positively to the question regarding if they felt there was a need to use mobile phones to support their teaching. The study reported that 42.9% were unsure while 54.3% did not think mobile phones had any value for learning. The students on the other hand had completely opposite views, in which, 47% agreed that mobile phones were useful and 50% reported they were not sure.

An amazing finding was that 60% of teachers had never caught a glimpse of, heard or even read anything about successful innovative uses of mobile phones in teaching and learning as compared to 60% of students who had (Averianova, 2012). On the contrary, 34% out of 542 teachers reported that they had used sophisticated mobile phones for learning or teaching (Peachey, 2010). It means that lecturers in Ghana need to embrace opportunities brought about by the Digital era, so that they are not left behind. They need to explore the numerous ways mobile phones can be used to support teaching and learning.
Ways lecturers use mobile phones in teaching is presented in Figure 4.37.

![Figure 4.37: Ways lecturers use mobile phones in teaching](image)

The data presented in Figure 4.37 indicates that a substantial number of respondents, 54 (76.1%) did not use mobile phones in teaching, but a few used them to access the internet, text messaging and downloading information as well as send emails to their students about assignments. This was not surprising though as Prensky (2004) has reported that most lecturers are ‘digital immigrants,’ who found that mobile phones had limited screen and button size.

He concluded that most lecturers were uncomfortable with the use of mobile phones in teaching and learning. The next interest was to find out why majority of lecturers did not use mobile phones in their teaching. It is important for educators to understand their students’ needs and preferred learning styles. Therefore, lecturers (digital immigrants) need to consider that students (millennials or digital natives) have preferred learning styles that are greatly influenced by the presence of technology (Oblinger, 2004; Prensky, 2001).
The reasons why lecturers did not use mobile phone technologies for educational purposes are shown in Figure 4.38.

![Figure 4.38: Reasons why lecturers do not use mobile phones to support their teaching](image)

The results drawn from the data presented in Figure 4.38 depicted that out of 54 respondents, most lecturers 23 (42.6%) believed that mobile phones caused a distraction while other lecturers 12 (22.2%) and 10 (18.5%) did not know how to use mobile phones to support teaching while others used laptops instead. A few lecturers 1 (1.9%) and 3 (5.6%) believed that mobile phones do not fit current mode of teaching and expressed concern that the screen was relatively small making it difficult for them to see information. Most lecturers believed that mobile phone technologies could affect the mental focus and concentration ability in students' academic life (Pandey, 2011).

Lecturers, who for centuries have been the core of learning in the classroom, are increasingly seeing students who are distracted and not able to stay focused (Bouchard, 2011).

With regards to the use of mobile phones usage in the lecture room, this is what ICT coordinators had to say:
**ICT coordinator 1:** Course length being too long. Students would not want to spend 30 minutes staring at their mobile phones. Students do not have long periods of free time to take part in a learning activity on their mobile phone.

Digital information should be in bits, so that learners will be able to assimilate this information. This information should be in a way that students will spend between 10 – 15 minutes looking at the digital data from the smartphone.

**ICT coordinator 2:** It presupposes that students must go to class with mobile phones. It can serve as a distracting factor. Individual lecturers have their own policies in the regard of using mobile phones in class. Workable polices must be looked at so that both lecturers and students will know how to behave.

The comment places emphasis on the need for a university policy, so that students will be able to use this technology within and beyond the classroom.

**ICT coordinator 3:** Battery life, Keypad (alpha and numeric, scrolling), small screen and students get irrelevant materials from the Internet.

The size of this technology may make it difficult to read digital information on the mobile phone. Students might also obtain inappropriate materials or information that is not needed from the Internet. ICT coordinators are therefore aware of the challenges of using mobile phones that negatively influence educational experiences.

Students were asked to suggest some ways they would like the lecturers to use mobile phones to support teaching and learning. The results are shown in Figure 4.39.
Figure 4.39: How lecturers should use mobile phone technologies to support teaching

Figure 4.39 reveals that some students, 10 (13.3%) supposed that communicating with students and allowing them to browse in class enhances the role of the lecturer. A few students, 9 (12.0%) and 7 (9.3%) hold the view that lecturers should be aware of the many possibilities of mobile phones as well as embrace the benefits of using this technology. Majority of students, 28 (37.3%) believe that lecturers should allow them to audio record lectures, encourage them to use interactive group discussions, promote the use of social networks and virtual classrooms as well as deliver lectures through mobile phones. Students believe that the use of mobile phone technologies for these purposes would enhance the role of the lecturer.

ICT coordinators also gave their views in support of mobile phones as educational resources. They felt that mobile phone technologies and other technologies at the various universities should be exploited to optimize teaching and learning. This is what they had to say:
**ICT coordinator 1:** As a coordinator of this institution I will be working within ICT unit to support activities that will be responsible for content management system, instructional materials and distribution of information, development of online and mobile applications to facilitate teaching and learning, research and administration.

Certainly ICT coordinators play a critical role in the use of mobile phone technologies for teaching and learning. ICT coordinators should work closely with educational authorities to implement university policies on the use of mobile phone technologies in teaching in learning in tertiary institutions.

**ICT coordinator 2:** Negotiating for tablets and smartphones for staff and students, responsible for getting university Google apps for education and policy formation on campus in mobile learning.

The ICT coordinator feels that each university can assist its lecturers to acquire mobile technology more cheaply. Such technology should have mobile applications, increased storage capacity as well as larger screen and keypad. This would help in decreasing some of the challenges of mobile phones.

**ICT coordinator 3:** Establish the right conducive environment. Mobile phones should have greater bandwidth, more educational packages should be available and the addition of more enhanced apps to make it more comfortable for students to use.

Mobile learning environment should be helpful and beneficial to students so that they can be encouraged to use of educational packages in order to enhance learning experiences. Judging from the comments the ICT coordinators gave, one is able to appreciate the important role they play in the use of mobile technology in education.

Table 4.26 presents data concerning how lecturers use mobile phone technologies to support their teaching.
Table 4.26: How lecturers use mobile phone technologies to support their teaching

<table>
<thead>
<tr>
<th>Mobile phone technologies used by lecturers</th>
<th>Very Often</th>
<th>Often</th>
<th>Occasionally</th>
<th>Rarely</th>
<th>Never</th>
</tr>
</thead>
<tbody>
<tr>
<td>N=71</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1  Sending Emails</td>
<td>8</td>
<td>11.3</td>
<td>3</td>
<td>4.2</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10</td>
<td>14.1</td>
<td></td>
<td>30</td>
</tr>
<tr>
<td>2  Textual materials</td>
<td>6</td>
<td>8.5</td>
<td>7</td>
<td>9.9</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td></td>
<td>13</td>
<td>18.3</td>
<td></td>
<td>33</td>
</tr>
<tr>
<td>3  Contact</td>
<td>28</td>
<td>39.4</td>
<td>16</td>
<td>22.5</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
<td>4.2</td>
<td></td>
<td>9</td>
</tr>
<tr>
<td>4  SMS Notifications</td>
<td>18</td>
<td>25.4</td>
<td>15</td>
<td>21.1</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8</td>
<td>11.3</td>
<td></td>
<td>14</td>
</tr>
<tr>
<td>5  Online submissions</td>
<td>1</td>
<td>1.4</td>
<td>8</td>
<td>11.3</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td></td>
<td>17</td>
<td>23.9</td>
<td></td>
<td>31</td>
</tr>
<tr>
<td>6  Up-to-date information</td>
<td>30</td>
<td>42.3</td>
<td>17</td>
<td>23.9</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
<td>5.6</td>
<td></td>
<td>12</td>
</tr>
<tr>
<td>7  Course Materials</td>
<td>6</td>
<td>8.5</td>
<td>3</td>
<td>4.2</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>11</td>
<td>15.5</td>
<td></td>
<td>47</td>
</tr>
<tr>
<td>8  Reading materials online</td>
<td>30</td>
<td>42.3</td>
<td>16</td>
<td>22.5</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7</td>
<td>9.9</td>
<td></td>
<td>13</td>
</tr>
<tr>
<td>9  Encouragement</td>
<td>18</td>
<td>25.4</td>
<td>18</td>
<td>25.4</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8</td>
<td>11.3</td>
<td></td>
<td>15</td>
</tr>
<tr>
<td>10 Bluetooth</td>
<td>1</td>
<td>1.4</td>
<td>1</td>
<td>1.4</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9</td>
<td>12.7</td>
<td></td>
<td>55</td>
</tr>
</tbody>
</table>

A few lecturers, 44 (61.9%) used their mobile phones to contact their students, 47 (66.2%) get current information from the internet as well as 46 (64.8%) of them read materials online. Most lecturers, 13 (18.3%) did not download materials using their mobile phones. Majority of lecturers, 9 (12.6%) did not encourage submissions of assignments online while 9 (12.6%) of them did not use mobile phone to upload course materials online. A good number of lecturers, 11 (15.5%) did not use their mobile phones to send emails. Only a few lecturers 2 (2.4%) were conversant with the use of Bluetooth for academic purposes. Lecturers use mobile phone technologies on average. At least
some lecturers are aware of the possibilities that come with using mobile phone technologies in education.

In another study, Mtega et al (2012) found that all of the lecturers made calls and sent text messages so as to alert students and communicate with colleagues on academic issues. Lecturers used the Internet through their mobile phones to download and read scholarly materials or articles, to access and read textbooks online and to support teaching and learning. The majority of lecturers used the Internet from their mobile phones in accessing online dictionaries, searching library catalogues and sharing information resources with others (Mtega et al, 2012). These lecturers were observed to have a high patronage in the use of technologies to supplement educational experiences.

But in this study, lecturers were not using mobile phone technologies as much as one would expect given that they have access to the technology. This could be due to the fact that most of the lecturers are still not comfortable with the use of these technologies and therefore prefer not to use these types of technologies when teaching their students. This is indeed serious because the single biggest problem facing education today is the unwillingness of lecturers to use new technologies in education. Lecturers, therefore, are struggling to teach students who are already conversant and using these technologies in learning (Prensky, 2001).

It was also noticed that some of the lecturers who said they did not use mobile phone technologies to support their teaching, were actually using these phone technologies. However, they were not actually aware that they were using it. Some lecturers were seen
mostly using mobile phone technologies to search for information on the internet for their lectures, which is a mobile phone technology that supports teaching.

The mean and standard deviation of mobile phone technologies used by lecturers is presented in the next Table.

**Table 4.27: Mean and standard deviation of mobile phone technologies used by lecturers**

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mobile phone technologies</td>
<td>71</td>
<td>1</td>
<td>5</td>
<td>2.93</td>
<td>0.900</td>
</tr>
<tr>
<td>Valid N (listwise)</td>
<td>71</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4.27 shows that the mean and standard deviation of mobile phone technologies is seen to be 2.93 and 0.900 respectively. This implies that some of the lecturers used mobile phones occasionally to support their teaching in one way or another. Means that were greater than 3.49 indicated high usage of mobile phone technologies while a mean below 2.49 indicated a low usage and a mean between 2.5 to 3.49 showed average usage.

The scale for mobile phone usage is as follows;

Low usage = 1.0 – 2.49, Average usage = 2.5 – 3.49, High usage = 3.5 – 5.00.

The level of usage by lecturers was determined to be 2.93, which falls between 2.5-3.49, indicating the rate of use of mobile phone technologies by lecturers was average.
A Cross-Tabulation of lecturers’ gender with mobile phone technologies is presented in Table 4.28.

Table 4.28: A Cross-Tabulation of Gender of lecturer with mobile phone technologies

<table>
<thead>
<tr>
<th>Mobile phone technologies used by lecturers</th>
<th>Very often</th>
<th>Often</th>
<th>Occasionally</th>
<th>Rarely</th>
<th>Never</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender of lecturer</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>4</td>
<td>16</td>
<td>28</td>
<td>14</td>
<td>2</td>
<td>64</td>
</tr>
<tr>
<td>Female</td>
<td>0</td>
<td>1</td>
<td>4</td>
<td>2</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>Total</td>
<td>4</td>
<td>17</td>
<td>32</td>
<td>16</td>
<td>2</td>
<td>71</td>
</tr>
</tbody>
</table>

It was observed in Table 4.28 that male lecturers used mobile phone technologies more frequently than female lecturers. To determine if there was significant difference between male and female lecturers, an independent samples test was conducted.

Table 4.29 shows the results.
Table 4.29: Independent Samples Test on mobile phone technologies used by lecturers according to gender

<table>
<thead>
<tr>
<th>Mobile technologies used by lecturer</th>
<th>Levene's Test for Equality of Variances</th>
<th>t-test for Equality of Means</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equal variances not assumed</td>
<td>.830, Sig: .535</td>
<td>.429, .237, .285</td>
</tr>
</tbody>
</table>

A T-test was conducted to determine differences in gender regarding how university lecturers utilized mobile phone technologies. Table 4.29 revealed that statistically ($p > 0.05$, $t = 0.658$), there was no significant difference in the use of mobile phone technologies between male and female lecturers. Therefore, the null hypothesis $H_0$ was not rejected at 0.05 level of significance since $p = 0.394$. Further analysis revealed that there was no difference in male and female lecturers with regard to use of mobile phone technologies to support their teaching.

To examine the differences in lecturers’ use of mobile phone technologies in the various universities, the One-Way ANOVA test was conducted. Results presented in Table 4.30 and 4.31.
Table 4.30: Descriptives on how lecturers use mobile phone technologies in the various universities

<table>
<thead>
<tr>
<th>Mobile phone technologies used by lecturers</th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Std. Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>UG</td>
<td>17</td>
<td>2.76</td>
<td>.903</td>
<td>.219</td>
</tr>
<tr>
<td>UCC</td>
<td>17</td>
<td>2.71</td>
<td>.686</td>
<td>.166</td>
</tr>
<tr>
<td>KNUST</td>
<td>37</td>
<td>3.11</td>
<td>.966</td>
<td>.159</td>
</tr>
<tr>
<td>Total</td>
<td>71</td>
<td>2.93</td>
<td>.900</td>
<td>.107</td>
</tr>
</tbody>
</table>

Table 4.30 shows that the means of UG, UCC and KNUST were calculated to be 2.76, 2.71 and 3.11 respectively. KNUST was observed to have a higher mean than the other two universities.

ANOVA of the use of mobile phone technologies by lecturers in the various universities is presented in Table 4.31.

Table 4.31: ANOVA on the use of mobile phone technologies by lecturers amongst the universities

<table>
<thead>
<tr>
<th></th>
<th>Sum of Squares</th>
<th>Df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>2.492</td>
<td>2</td>
<td>1.246</td>
<td>1.565</td>
<td>.217</td>
</tr>
<tr>
<td>Within Groups</td>
<td>54.156</td>
<td>68</td>
<td>.796</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>56.648</td>
<td>70</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
It is observed from Table 4.31 that statistically (p>0.05, F=1.565), there is no significant difference in the use of mobile phone technologies by lecturers in the various universities. Therefore, the null hypothesis Ho4b was not rejected at 0.05 level of significance since p = 0.217. Therefore, this revealed that there is no difference in how lecturers use mobile phone technologies among the three universities. Thus, lecturers in all three universities, use the mobile phone technologies in the same way.

The relationship between number of years in profession and mobile phones used by lecturers is presented in Table 4.32.

**Table 4.32: Relationship between number of years spent lecturing and technologies used by lecturers**

<table>
<thead>
<tr>
<th>Number of years spent lecturing</th>
<th>Lecturers’ use of Technologies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearson Correlation</td>
<td>1</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.160</td>
</tr>
<tr>
<td>N</td>
<td>71</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Lecturers’ use of Technologies</th>
<th>Number of years spent lecturing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearson Correlation</td>
<td>.160</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.181</td>
</tr>
<tr>
<td>N</td>
<td>71</td>
</tr>
</tbody>
</table>

A Pearson correlation examined the relationship between the number of years spent lecturing and a lecturer’s use of technologies. It emerged that the number of years spent lecturing is not significantly (r=0.160, p>0.05) related to lecturers’ use of mobile phone technologies. Therefore, the null hypothesis Ho4c was not rejected at 0.05 level of significance since p = 0.181. This is to say that the number of years spent lecturing has no
effect on the way lecturers’ use mobile phone technologies. With an r value of 0.160, this correlation was seen to be weak.

The level of significance was observed to be greater than 0.05 (p>0.05). Therefore, there is no statistically significant difference in the lecturers’ use of mobile phone technologies and the number of years they spent in the profession. This is to say that the number of years spent in the profession has no effect on the way lecturers’ use mobile phone technologies. As a result, using new technologies is not restricted to younger lecturers, but is also accepted widely within the more mature established teaching community (Peachey, 2010). The results confirm, therefore, that the number of years in the profession does not have any influence on how lecturers use mobile phones.

Descriptives and ANOVA of the use of mobile phone technologies by lecturers amongst the universities according to their qualification are presented in Table 4.33 and 4.34.

Table 4.33: Descriptives of the use of mobile phone technologies by lecturers according to qualification

<table>
<thead>
<tr>
<th>Technologies used by lecturer</th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Std. Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>PhD</td>
<td>35</td>
<td>2.94</td>
<td>.998</td>
<td>.169</td>
</tr>
<tr>
<td>MPhil</td>
<td>27</td>
<td>2.89</td>
<td>.751</td>
<td>.145</td>
</tr>
<tr>
<td>MSc/MEng</td>
<td>9</td>
<td>3.00</td>
<td>1.000</td>
<td>.333</td>
</tr>
<tr>
<td>Total</td>
<td>71</td>
<td>2.93</td>
<td>.900</td>
<td>.107</td>
</tr>
</tbody>
</table>
The group of lecturers with a PhD qualification reported a mean (M = 2.94) with a standard deviation (SD = 0.998) while the group of MPhil qualification reported a mean (M = 2.89) with a standard deviation (SD = 0.751) and the group of MSc/MEng qualification reported a mean (M = 2.93) with a standard deviation (SD = 0.900). Therefore, there is no difference in the use of mobile phone technologies according to lecturers’ qualifications.

Table 4.34: ANOVA on the use of mobile phone technologies by lecturers amongst the universities according to qualification

<table>
<thead>
<tr>
<th>Technologies used by lecturer</th>
<th>Sum of Squares</th>
<th>Df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>.096</td>
<td>2</td>
<td>.048</td>
<td>.057</td>
<td>.944</td>
</tr>
<tr>
<td>Within Groups</td>
<td>56.552</td>
<td>68</td>
<td>.832</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>56.648</td>
<td>70</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4.34 presented results for an ANOVA test. The results revealed that (p>0.05, F=0.057). Therefore, the null hypothesis Ho4d was not rejected at a 0.05 level of significance since p = 0.944. It means that there was no difference in the use of mobile phone technologies according to the qualifications of the lecturer.

Information concerning the quality of education when mobile phone technologies are utilized is demonstrated in Table 4.35.
Table 4.35: Quality of Education when using mobile phone technologies to support learning

<table>
<thead>
<tr>
<th>Quality</th>
<th>N= 71</th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Uncertain</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Freq</td>
<td>%</td>
<td>Freq</td>
<td>%</td>
<td>Freq</td>
<td>%</td>
</tr>
<tr>
<td>1 Supplementary</td>
<td>9</td>
<td>12.7</td>
<td>27</td>
<td>38.0</td>
<td>20</td>
<td>28.2</td>
</tr>
<tr>
<td>2 Learning Style</td>
<td>3</td>
<td>4.2</td>
<td>16</td>
<td>22.5</td>
<td>26</td>
<td>36.6</td>
</tr>
<tr>
<td>3 Organization</td>
<td>3</td>
<td>4.2</td>
<td>15</td>
<td>21.1</td>
<td>25</td>
<td>35.2</td>
</tr>
<tr>
<td>4 Access to information</td>
<td>33</td>
<td>46.5</td>
<td>22</td>
<td>31.8</td>
<td>13</td>
<td>18.3</td>
</tr>
<tr>
<td>5 Difficult Concepts</td>
<td>9</td>
<td>12.7</td>
<td>13</td>
<td>18.3</td>
<td>27</td>
<td>38.0</td>
</tr>
<tr>
<td>6 Motivation and</td>
<td>4</td>
<td>5.6</td>
<td>21</td>
<td>29.6</td>
<td>24</td>
<td>34.8</td>
</tr>
<tr>
<td>Participation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7 Collaboration</td>
<td>13</td>
<td>18.3</td>
<td>31</td>
<td>43.7</td>
<td>17</td>
<td>23.9</td>
</tr>
<tr>
<td>8 Communication</td>
<td>22</td>
<td>31.0</td>
<td>34</td>
<td>47.9</td>
<td>9</td>
<td>12.7</td>
</tr>
<tr>
<td>9 Preparation</td>
<td>17</td>
<td>23.9</td>
<td>21</td>
<td>29.6</td>
<td>24</td>
<td>33.8</td>
</tr>
<tr>
<td>10 Pace</td>
<td>10</td>
<td>14.1</td>
<td>19</td>
<td>26.8</td>
<td>27</td>
<td>38.0</td>
</tr>
<tr>
<td>11 Up-to-date information</td>
<td>22</td>
<td>31.0</td>
<td>27</td>
<td>38.0</td>
<td>18</td>
<td>25.4</td>
</tr>
<tr>
<td>12 Critical thinking</td>
<td>2</td>
<td>2.8</td>
<td>14</td>
<td>19.7</td>
<td>29</td>
<td>40.8</td>
</tr>
<tr>
<td>13 Quality of Education</td>
<td>6</td>
<td>8.5</td>
<td>23</td>
<td>32.4</td>
<td>28</td>
<td>39.4</td>
</tr>
</tbody>
</table>

A few lecturers, 55 (78.3%) believe that mobile phone technologies could only be used for accessing information, 44 (62.0%) collaboration, 49 (69.0%) getting up-to-date information, 38 (53.5%) preparation as well as 56 (78.9%) communication. The rest of the lecturers did not have any idea of the influence mobile phone technologies had on the
quality of education, when it came to learning style 26 (36.6%), organization 25 (35.2%),
difficult concepts 27 (38.0%), motivation and participation 24 (34.8%) as well as critical
tinking 29 (40.8%) and overall quality of education 28 (39.4%). Thus, lecturers were
not aware of the full potential of using mobile phones in education. This may be one of
reasons they did not want to use these technologies in supporting teaching. It is vital that
lecturers play their role in supporting the quality of education by utilizing mobile phone
technologies in teaching and learning science (Daniel, 2008).

Data involving the mean and standard deviation of quality of education with mobile
phone usage is shown in Table 4.36.

**Table 4.36: Mean and standard deviation of quality of education with mobile phone
usage**

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quality of education</td>
<td>71</td>
<td>1</td>
<td>5</td>
<td>2.70</td>
<td>.782</td>
</tr>
<tr>
<td>Valid N (listwise)</td>
<td>71</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4.36 shows that the mean and standard deviation of quality of education with
mobile phone technologies is seen to be 2.70 and 0.782 respectively. This implies that
majority of lecturers were uncertain on how mobile phone technologies can influence the
quality of education. Therefore, lecturers must be more aware of the potential of using
mobile phone technologies to support their teaching. This can be ensured by training
lecturers through workshops and seminars so that they will have the opportunity to use
these technologies. Means that were greater than 3.49 indicated high perceptions while a mean below 2.49 indicated a low perception and a mean between 2.5 to 3.49 showed uncertainties (average perception). The scale for mobile phone usage is as follows;
Low perception = 1.0 – 2.49,  Average perception = 2.5 – 3.49,  High perception = 3.5 – 5.00. The level of lecturers’ perception of mobile phone technologies and its influence on the quality of education was determined to be 2.70, which falls between 2.5-3.49, indicating that lecturers were not certain about the potential in using mobile phone technologies to enhance quality of education.

Discussion and overall findings will be discussed in the following sub-section.

4.9  Discussions of Findings
Quantitative data was obtained through questionnaires from lecturers and students. These were the main sources used in answering the research questions. However, qualitative data was used in order to provide more support to quantitative results. This allowed for triangulation of data and discussion of results with more depth.

4.9.1  Types of mobile phone technologies available to support learning
Many students reported using mobile phone technologies to support learning. Students reported using their mobile phones as calculators, dictionaries, organizers and social networks. Students also were using their mobile phones for accessing information through the web and downloading applications to make science concepts clearer. You Tube videos were not being utilized in science learning, implying that students need to be sensitized on how technology can positively affect their learning.
Mobile phones can be used to support learning by enhancing class assignments or projects, studying for quizzes and getting lecturers’ assistance after classes with areas not understood in class (Docksai, 2009). This will help learners gain a better understanding of complex science concepts. SMS and MMS were used in some studies for students’ interactivity beyond the classroom which involved after-class discussions (Market et al., 2006). In this study, most students were seen to be using messaging through SMS, but MMS is still relatively a new mobile technology in Ghana. Therefore, students should be more aware of the potential of using this technology to support their learning.

Many useful mobile technologies were observed. Students were seen to be using these technologies often. Science students on their own initiative were found to be using mobile phone technologies to assist them in learning. Students were utilizing these technologies to access science materials and organize educational resources. Students were using these technologies informally (outside the classroom) and believed that learning with mobile phones was beneficial to their learning.

**4.9.2 Influence of mobile phones on level of students’ academic satisfaction in learning science**

When lecturers are properly trained to efficiently integrate technology into their instruction strategies then students are likely to be more satisfied with their education (Wurst et al, 2008). In a research, out of 963 respondents, 20% of them were very satisfied overall with technology, while 12% of students were extremely satisfied and 6% of them responded as being satisfied. Majority (87%) of students were either highly
satisfied or satisfied with the ICT facilities available on campus. Also, 67% of the students expressed they were quite satisfied with the network bandwidth (JMU, 2012).

According to JMU (2012), the overall satisfaction of software downloads was seen to continue to grow at 54%. From this study, it was seen that when lecturers use mobile phone technologies to support their teaching, students seemed to derive more satisfaction from the learning of science. The more satisfied the students are, the better they are likely to perform. Therefore, when lecturers use these technologies, it encourages students to also use it, hence positively influencing their academic performance.

4.9.3 The role learning styles play in promoting mobile phone technology in science education

Ally (2004) pointed out that since more learners are active, m-learning environments should ensure students get the chance to communicate and collaborate with other students through mobile phones. Learners who are reflective can obtain information about the topic while working independently. With the intuitive learner, situations where a mobile guide can be used to examine a certain topic are preferred (Oblinger & Oblinger, 2005). Comparably, situations where sensitive learners will be given the opportunity to review teaching material, anywhere and anytime can benefit them. Additionally, visual learners in m-learning environments can be encouraged with pictures, presentations and diagrams whereas verbal learners can use audio outputs of discussions, speeches as well as written text that can be read (Franzoni & Assar, 2009).

Most students are active and prefer learning by doing rather than being told what to do. Thus, an m-learning environment should be created for these students to browse the
Internet and fidget (touch and play) with their mobile phones. These learners should also be encouraged to explore the Internet to learn something new and learn through self-discovery as well as taking the initiative to learn new tools. This environment should allow students to work in groups and teams with peers, using collaborative tools. In general, these students are more likely to prefer learning in a supportive environment in groups (Oblinger & Oblinger, 2005).

Most university students prefer visuals, just as shown in this study. Due to the prevalence of technology in students’ lives most students feel comfortable in the media-rich environment. Living in this multimedia environment, the students need to be provided with more rich visual effects which can be provided through mobile phone technologies. These students are also likely to search for interactive materials from YouTube.com (Oblinger & Oblinger, 2005).

According to Franzoni & Assar (2009), sensitive learners should be encouraged to use forums, since they prefer content that is detailed and includes problem-solving and laboratory exercises as well as concept memorization. Intuitive learners should also be encouraged to use forums. It is appropriate for them to also add wikis and emails as media because these types of learners prefer content that is innovative and oriented towards theories (Franzoni & Assar, 2009).

The data on learning styles and mobile use has a lot of implications for lectures. Electronic presentations, videos and animations would favor the visual learner, since they like to visualize their information through forms of images, diagrams and other visual
representations. With verbal learners, content should be presented orally or through textual representations, therefore chats, blogs and forums would be appropriate for them. Learners with active learning styles tend to have discussions and group presentations with others, hence, electronic presentations, digital magazines and digital newspapers would be more suitable for these types of learners (Franzoni & Assar, 2009).

Reflexive learners prefer to work on their own; meaning that content should be related to their personal experiences. Ebooks would be more relevant for such learners. Finally, sequential learners like content that is in a step-by-step fashion so that they can think logically. Audio conferences would therefore be appropriate for such learners. Internet research would be suitable for global learners, since they are seen to favor content that is written in big leaps. They solve problems quickly, but are not able to explain how they did it (Franzoni & Assar, 2009). Additionally, according to Saeed et al (2009), it was concluded that active learners favor social bookmarks whiles reflective, sequential and verbal learners like podcasts better as compared to sensing learners who have a preference of email. Intuitive and global learners, on the other hand, prefer blogs, while visual learners would be comfortable with video podcasts. Having said that, university courses should provide a range of instructional strategies with mobile phone technologies to make sure all learning styles are well catered for.

Various mobile phone technologies can be integrated in the learning environment and these include audio recordings, audio conferencing, animations, graphics, simulations, forums, blogs, emails, chat (Messenger), digital newspapers and magazines, eBooks, slideshows, web pages, internet research, audio or video podcasts and web Seminars.
These technologies can be used to provide for the various learning styles of students in this Digital Age (Franzoni & Assar, 2009). Hence, depending on the type of students’ learning style appropriate mobile phone technologies should be adapted to suit learner needs so as to assist in supporting their learning experiences.

Since, most students were observed to have a combination of visual/active/sensitive and sequential learning style, there needs to be more emphasis on types of mobile phone technologies that would support this combination of learning style. For that reason, in designing activities, the learning style combination should be taken into consideration.

4.9.4 Academic performance

A survey was conducted with 82 students who used m-learning. The students’ academic performance was improved since the learning environment given to the students was more independent. As a result, students used mobile phone technologies as it provided them with new and effective ways of learning (Wendeson et al, 2010).

This research showed that students, who had higher GPAs, were those students who used mobile phone technologies more frequently for learning. More students, therefore, should be encouraged to use these technologies in order to enhance their learning experiences as well as to improve their academic performance. Thus, in designing educational mobile applications, the science content should be created in such a way that they support students’ learning.
4.9.5 Types of mobile phone technologies available to support teaching

Although both students and lecturers had commented that the mobile phone is a major distraction during lectures, still more than 40% of the students still used this device during class (Burns & Lohenry, 2010). Therefore, educators in Ghana must take a critical look at the possibilities in which technology can be used during lectures that will highly benefit their learning experiences. Prensky (2008) observed that lecturers need to shift from mere lecturing to approaches that gave students a chance to learn to be more active participants through use of technology. Another study in two British universities involved a survey of 160 undergraduate students followed by in-depth interviews with eight students and lecturers and it was revealed that students’ attitudes to technology-mediated learning appear to be influenced by the methodology adopted by their lecturer (Margaryan et al., 2011).

Therefore, it is clear that lecturers definitely play a major role in students’ use of mobile phone technologies in education. If more lecturers were to use such technologies to support their teaching, students would be more encouraged to also use mobile phone technologies for their learning. Most lecturers see mobile phones to be more of a distraction, when used during lectures. But, Williams and Pence (2011) have made a positive suggestion that can help manage students’ attention when using mobile phones in class.

Educators are thus, encouraged to create time when students can be allowed to use their mobile phones during class hours. Although it is very demanding for the older generation to draw nearer to the younger generation regarding experience with new technologies,
lecturers must still endeavor to incorporate these powerful technologies into the classroom environment (Williams & Pence, 2011).

From the results in this research, students were observed to be utilizing mobile phones for educational purposes more than their lecturers. This was also seen in a study done in a Japanese university with business students. A survey of mobile phone utilization and attitudes towards mobile phones as educational tools was conducted among 64 third year business students and 40 lecturers in one of the Japanese universities. The survey revealed a difference between students and lecturers in the way they used their mobile phones.

While 96% of students regularly exchanged text messages, only 48% students and 32% of lecturers almost never sent or received messages respectively. Sixty-four percent of students and only 17% lecturers listened to sound files. Also, 96% of students and only 30% of lecturers accessed the Internet from their phones. Therefore, this survey concluded that lecturers were less active than students in employing the several functions of mobile phones such as access of internet, communication through messaging and ability to listen to audio (Averianova, 2012). Thus, it is vital that lecturers take the opportunity to use mobile phone technologies in education.

4.10 Chapter Summary

This chapter included demographic information on both students and lecturers. The student questionnaire involved sections that relate to mobile phone technologies, academic satisfaction, learning style and academic performance. The lecturer
questionnaire contained sections that pertain to mobile phone technologies and quality of education. Descriptive and inferential statistics were used in data analysis.

The interpretations were made in the form of tables and figures followed by discussions on the findings with the support of literature that was reviewed. In general, the results indicate that mobile phone technology has a lot of potential in bringing about improved learning and performance. The mobile phone is small and affordable, but a powerful device for learning. As a result, this can be one device to certainly watch in the near future.

The next chapter draws conclusions according to results of the study and makes some recommendations for further researches.
CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

The purpose of the study was to investigate the utilization of mobile phone technology on enhancing student satisfaction, learning style and performance of university science students in Ghana. This chapter presents a summary of findings and conclusions drawn from the study. It makes recommendations for action and suggests areas for further study to improve upon the utilization of mobile phones in learning.

5.2 Summary of the Findings

The composite results of this study suggest that adding mobile phone technology to support teaching and learning will have a positive impact on science education. The results of the data analysis provided a number of findings with respect to the influence of mobile phone technologies on student satisfaction, learning style and academic performance of university students.

All students and lecturers were found to possess a mobile phone and most were internet-compatible devices. Only a little bit more than half actually used the internet on their phone. The most common mobile phone model used among both students and lecturers was Nokia. Less than 50% were found to be having a smartphone. MTN was the service provider among most students and lecturers.

When students were asked how mobile phones affected their science learning, majority of students believed mobile phone technologies had a positive impact. Most students were
seen to be using different types of mobile phone technologies beyond the classroom to support the learning of science. It was also observed that students used these technologies often.

Satisfaction had a positive effect on the academic performance of students. Most students were dissatisfied with mobile phone technologies in their universities. There was a moderately positive relationship between satisfaction and academic performance. Most students searched for information on the Internet to support their learning.

Majority of students, who used mobile phones in learning, did so mostly to conduct research, send SMS and participate in social networks as well as make normal calls. Some students used their phones to read science news, books and articles online. Majority of the students utilized science dictionaries and calculators available on their mobile phones. Only very few students utilized office applications or You Tube videos on their mobile phones.

There was also a moderately positive relationship between technologies and academic performance. Students from KNUST were also observed to be using mobile phone technologies more frequently than the other two universities. Students between the ages 27 - 31 seemed to be using mobile phone technologies more than the other age groups. It was also noticed that students who used mobile phone technologies were seen to have a GPA 2.5 or above.

The major benefits of students using mobile phone technologies to support science learning were that these technologies were popular for retrieving information, increasing
communication while at the same time acting as a channel for supporting various learning styles. Various challenges were faced by students with regard to use of mobile phone technologies for learning purposes. Students believed that the screen and keypad were relatively small, there were frequent network problems and the cost of both these devices and airtime were quite expensive. Both students and lecturers were convinced that mobile phones used during lecture time caused distractions.

5.3 Conclusions
The student survey presented relevant background information about the existing situation of student owning mobile phones and its use for learning purposes. The findings reveal that mobile phone technologies offer university students new and stimulating learning opportunities. With the ever increasing technology, this is likely to grow and have a greater influence on learning at the university level. Conclusions were organized according to research questions and were supported by either quantitative data or a combination of both quantitative and qualitative data. Based on the findings of the study, the following conclusions were made:

What are the various types of mobile phone technologies available for science university students and how frequently are they using these technologies?

Firstly, majority of students used mobile phone technologies to support their learning. The technology was used for text messages, research, emails, social networks and scientific dictionary or calculator. Unfortunately, not many of the science students used the mobile phone technology YouTube even though it would be useful for science
students to be encouraged to use this powerful technology as a learning tool. They can used to observe science demonstrations and gain a simplified understanding of complicated concepts.

Students used these technologies frequently. Most students appreciated that mobile phones have a great potential for educational purposes. These technologies assisted students in being more prepared before classes as well as supplementing and reinforcing material beyond the classroom. Mobile technologies helped in giving students a better understanding of concepts they would have otherwise found difficult to learn.

There is no significant difference in the use of mobile phone technologies in science and students’ gender. This hypothesis was not rejected since the gender had no influence on the way male or female students used mobile phone technologies. Male and female students used mobile phone technologies in the same way. There is no significant difference in the use of mobile phone technologies in science and students’ universities. This hypothesis was rejected. A students’ university had an influence in the way that mobile phone technologies were used. KNUST is a university that was seen to be more technology-based than the other universities. Therefore, it was not a surprise to see more students from that university using mobile phone technologies.

There is no significant difference in the use of mobile phone technologies in science and students’ age. This hypothesis was rejected. The use of mobile phone technologies was influenced by age. Those between the ages of 27-31 used these technologies more than the other age groups. This was rather surprising given that this age group was considered to be ‘digital immigrants.’ Even then, there is the possibility that students from this age
group have realized the many possibilities of mobile phones in learning and therefore are embarking on the utilization of this technology to its full potential.

*To what extent are students academically satisfied with the use of mobile phone in learning science?*

Secondly, majority of students were not satisfied with the way mobile phone technologies were being used for learning. This could be because lecturers were not aware of the potential of mobile phone technologies and it has been reported that some lecturers found them distracting rather than helpful. This explains why they may not use these technologies to support teaching. There is no significant relationship between students’ academic satisfaction and the use of mobile phone technologies in science by university students. This hypothesis was rejected. As a result, it was revealed that satisfaction positively affected the academic performance of students. It can be argued that when a student is satisfied, he or she is more likely to improve his or her academic performance. Therefore, it is important to increase the satisfaction of students through the use of mobile phone technologies as this lead to positive academic performance.

*What is the role the various types of learning styles in influencing the use of mobile phone technology for learning among science university students?*

Thirdly, a good number of students had visual, sensing, active and sequential learning preferences. Therefore, various types of mobile phone activities were suggested depending on the type of learning style the learner had. This assisted students in supporting their learning experiences with the use of mobile phone technologies.
Table 5.1: Types of mobile phone technologies based on students’ learning styles

<table>
<thead>
<tr>
<th>Dimension of Felder’s learning style</th>
<th>Learning style dominant in Ghanaian science students in public universities</th>
<th>Suggested mobile phone technology from this study for Ghanaian science students in public universities based on their learning style</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active/Reflective</td>
<td>Active</td>
<td>Internet research, group presentations, discussion forums</td>
</tr>
<tr>
<td>Sensing/Intuitive</td>
<td>Sensing</td>
<td>Simulations, games</td>
</tr>
<tr>
<td>Visual/Verbal</td>
<td>Visual</td>
<td>YouTube videos, video podcasts, animated or pictorial presentations</td>
</tr>
<tr>
<td>Sequential/Global</td>
<td>Sequential</td>
<td>Email, audio conferences, podcasts</td>
</tr>
</tbody>
</table>

What influence does the utilization of mobile phone technology have on academic performance of science university students?

Fourthly, students who used mobile phone technologies more frequently were reported to have improved academic performance. This could be because this technology makes it easier to have access to information that can be read every time and everywhere. In this case, students have information at the tip of their finger and with just the click of a button. There is no significant relationship between academic performance and utilization of mobile phone technology in science by university students. This hypothesis was rejected as it was shown that the correlation between technologies and academic performance were found to be moderately strong. This suggests that the more the student
used these mobile phone technologies in learning, the more their academic performance improved.

What are the types of mobile phone technologies available for lecturers to support teaching of science and how often are they using these technologies?

Another conclusion is that many lecturers did not use mobile phone technologies to support teaching. A follow up question was able to reveal that majority of lecturers were accessing up-to-date information and reading materials online through their mobile phones. This follow-up seemed useful and made them aware of the instructional possibilities of the mobile phone technology.

The realization that this technology was being utilized in teaching by lecturers is important in this process. These lecturers did not realize that they were using mobile phone technologies in teaching. They were all at the initial effort and generally needed to make greater use of the technology to assist their teaching.

There is no significant difference in the use of mobile phone technologies and lecturers’ universities. This hypothesis was not rejected. When it comes to lecturers, the university where they are affiliated did not influence the use of mobile phone technology. There is no significant difference in the use of mobile phone technologies and lecturers’ number of years spent lecturing. This hypothesis was not rejected. The number of years spent in the profession did not have an effect on how lecturers used mobile phone technologies. This was rather surprising for it would have been thought that the younger lecturers would take the lead in using this innovative technology in teaching.
There is no significant difference in the usage of mobile phone technologies and a lecturers’ qualifications. This hypothesis was not rejected. Whether the lecturer had a PhD, MPhil or MSc/MEng, the use of mobile phone technology is the same among these groups. It would have been thought that those with MSc/MEng would be more conversant with the use of mobile phone technologies in teaching than those with other qualifications.

**What are the benefits and challenges that influence mobile phone usage by university students in science learning?**

This study also observed that students received many benefits and also faced challenges in the use of mobile phone technologies. The major benefits were increased satisfaction, increase in access to current information, increased motivation, enhanced communication and information exchange. Students reported that they experienced network problems, limited storage space, battery life, airtime cost and cheating. Therefore, there is need for institutions to implement a university policy to offset some of the drawbacks of using these technologies in teaching and learning, in order to use mobile phones properly and to its full potential.

**How would the model be designed to assist students and lecturers use mobile phone technologies to support teaching and learning science?**

This research provided greater understanding of students’ practices and attitudes towards learning through mobile phone technologies. The new knowledge will be useful for institutions and lecturers in promoting use of mobile phones in teaching and learning. It
also offers an insight into the type of mobile phones that students have and what they can
do with them, but it also takes into consideration that there is always constant upgrading
of the quality of the mobile phones. This means that activities can be designed so that a
larger number of students can support their learning through these technologies.

Three aspects stand out for effective use of mobile phone for instruction. First, is the
availability of sophisticated phones. Second, is the guidance from the lecturers and third,
the initiative of the student. With the rapid advancement of the mobile phone industry,
more affordable and flexible phones for learning are on the way and it is important if both
lecturers and students can orientate themselves to take advantage of this technology.
There are many types of mobile phones that are less expensive to obtain and therefore
introducing the mobile phone as a low-cost teaching and learning tool is quite possible.

5.3.1 The proposed model representation of learning science by students
using mobile phone technologies

In this section, the researcher makes an attempt in merging the findings of this study in
order to construct an original contribution to the area of ICT education. The model is a
major contribution to this study, because it will form a foundation as well as a point of
reference for other researchers working on how mobile phones can enhance educational
goals. It is expected, therefore, that researchers working in this area, especially those at
the tertiary level will make improvement to this model, so that it may form a solid basis
for the use of mobile phone technologies in learning at universities.
A model for effective mobile phone instructional use for learning science in universities is presented in the next section. It starts with the mainstream section which outlines the relationship or links with the key variables.

**Mainstream Step**

In the initial step, it is ideal for both lecturers and students to have access to mobile/smart phones. The results of this study have shown that indeed many students have acquired and put to use a variety of mobile phones. It is also noted that the more sophisticated the phones the better the facilitation and utilization in fostering improved academic performance. It means that once these phones are available, lecturers should be willing to use the devices to support their teaching. Fuchs and Woessman (2004) used data from the PISA that demonstrated a strong and significantly positive correlation between the availability of technologies and the academic performance of students. Therefore, availability of mobile phone technologies is important.

**Figure 5.1: Mainstream step to a model for utilizing mobile phones technologies to support science learning**

In the initial step, it is ideal for both lecturers and students to have access to mobile/smart phones. The results of this study have shown that indeed many students have acquired and put to use a variety of mobile phones. It is also noted that the more sophisticated the phones the better the facilitation and utilization in fostering improved academic performance. It means that once these phones are available, lecturers should be willing to use the devices to support their teaching. Fuchs and Woessman (2004) used data from the PISA that demonstrated a strong and significantly positive correlation between the availability of technologies and the academic performance of students. Therefore, availability of mobile phone technologies is important.
Step Two

In the second step, when students and lecturers have internet-compatible mobile phones, they are able to access educational information, material and resources through wireless networks or hotspots available on campus. With internet access, the student and lecturer are able to retrieve information in the form of ebooks, audio, video as well as MMS. It is known that lecturers may not be conversant or comfortable with the use of some mobile phone technologies in teaching. This could be due to the small keypad, small screens and also their lack of skills or poor attitudes.

Students must also be ready to utilize these technologies in order for their learning to be effective. This would help a student improve his/her academic performance. Students
and lecturers are able to interact with each other through emails. Science games can also be downloaded and used for educational purposes. When these technologies are utilized they increase collaboration and interaction among lecturers, students and the content. The content stored by more sophisticated phones can be enormous, such as ebooks, video demonstrations, tutorials and audios.

**Step 3**

![Diagram]

**Figure 5.3: Step three to a model for utilizing mobile phones technologies to support science learning**

The third step indicates how students and lecturers use the mobile phone technologies in science learning. Most students use these technologies before or after lectures, since most lecturers do not allow students to use their phones during lecture hours. Only a few
lecturers use mobile phones to support their teaching and they do so before class in preparation for their lectures.

Satisfaction is basically divided into two dimensions. The academic dimension involves the teaching methods, constructivist environment, team work, group assignments and discussions. Facilities include wireless network infrastructure available on the university campuses and internet connected mobile phones. When looking at performance, the researcher also looked at satisfaction. Therefore, the more satisfied a student is with mobile phone technology usage on campus; the more likely the academic performance will be positively influenced.

**Final Step**

![Diagram](image)

**Figure 5.4: Simplified final step to a model for utilizing mobile phones technologies to support science learning**
The final stage showed the relationships and interaction between lecturers, students, other students and the use of mobile phone technologies to support teaching in order to increase satisfaction to improve academic performance. Mobile phones can be a major disturbance when used in class, if students use this technology inappropriately. Furthermore, there needs to be a policy in order for students to use the technology not only beyond the classroom, but also within the classroom environment.

To enhance learning performance, lecturers need to support their students by allowing them to bring their mobile phones in class while at the same time permitting them to openly and freely access information that will enhance learning activities, methods and quality of learning. Students have the interest of using mobile phone technologies for educational purposes both inside and outside the classroom. Students need to be taught how to properly utilize and navigate mobile phone resources for educational advancement. Lecturers can give students task-oriented activities through mobile phone technologies. Students can get information from other students through collaborative learning and can also work on their own through independent study or individualized learning.

5.4 Recommendations

Based on the findings and conclusions of the study, the following recommendations were made. The recommendations are considered in two sections: Policy recommendations and recommendations for further research.
5.4.1 Policy Recommendations

For a better outcome of mobile phone use, one needs to use an upgraded type of phone. The following will be required;

i. A well resourced mobile learning facility centre needs to be established within the universities, where staff and students who lack experience with using mobile phone technology will be trained and have the opportunity to use these technologies to support educational experiences. This could be a project in public universities, which allow lecturers and students to appreciate smartphones. A follow-up with some training on the appropriate use of mobile phones in teaching and learning can be important. The use of these mobile phone technologies will also increase the satisfaction of students.

ii. Students should take a more active role in the learning process and take an interest in using mobile phone technologies to improve educational experiences. Science students should be encouraged by their lecturers to make more use of chat rooms, such as viber and whatsapp for group discussions, share images through Bluetooth for explaining scientific concepts and processes, use videoconferencing for face-to-face group discussions, read eBooks and download scientific materials from the internet.

iii. Science lecturers should encourage students in the use of mobile phone technologies in their learning. These technologies can provoke the interest of the students and make science learning more interactive. As a result, science lecturers should explore different ways in which mobile phone technologies can be used in
teaching and learning. For example, mobile phone learning through tutoring, games, quizzes, podcasts (audio/video) and e-books. This will make students more aware of the possibilities of these technologies and therefore will try to exploit their full potential.

To engage students effectively and meaningfully, science lecturers should provide course content and other learning materials online, so that students will get the opportunity to download this information onto their phones in order to access it at anytime or anywhere instantaneously. This will allow students to be fully prepared before lectures as well as supplementing and reinforcing information that has already been taught in class. Lecturers can also formulate automatic alerts to their students on important information, such as quiz dates, additional required readings as well as links to helpful websites. These mobile phone technologies will go a long way in supporting students’ learning, therefore increasing their academic performance.

iv. Curriculum planners and policy makers should consider students’ learning styles in the use of mobile phone in science learning. Instruction should be designed in such a way so as to connect with multiple learning styles that are appropriate through mobile phones. Lecturers have a role in identifying their students’ learning styles hence should encourage matching mobile phone technologies and resources to these styles. This includes integrating sound, visuals, music and games into the learning environment.
v. Content developers and programmers should come together to design and develop educational mobile phone applications that can be used in learning various topics in science in order to provide tools for authoring, manipulation and communication. These applications should be simple for easy navigation for both students and lecturers. A rubric for selecting applications should be developed and distributed to lecturers so as to provide specific criteria for effective learning. An online database should be established to provide relevant educational applications for lecturers and students.

An opportunity should be given to lecturers to discuss each mobile application so that suggestions can be made in how to effectively use the application in science learning. This is especially supportive in science courses where there are several complicated concepts. The interactive elements of the applications on the mobile phones will permit students to develop a better understanding of these complex concepts. The ICT coordinators in each of these universities should coordinate all these activities for better monitoring and implementation. This will assist in improving students’ academic performance.

5.4.2 Recommendations for Further Research

This study helped identify the influence that mobile phone technologies have on university science students’ satisfaction, learning styles and academic performance in Ghana. This is a growing area and would recommend that more research be considered.

i. The study was limiting in that it only investigated level 400 students from three Ghanaian public universities in only the area of Science and Mathematics. More
research should be done in the areas of Business, Arts, Education and Social Sciences as well as other fields or disciplines for comparison.

ii. Future research may want to include private institutions and explore differences based on availability of resources and training in the use of technology.

iii. Future research could consider in-depth qualitative studies so as to add more information on how students use mobile phone technologies in learning and how it improves their academic performance.

iv. Further research should be conducted through a quasi-experimental study using a pretest-posttest design. This design would provide more insight and give a better understanding on the use of mobile phones to improve academic performance inside the classroom.

v. Longitudinal studies should be investigated into with the aim of providing researchers with the prospect of examining whether the lecturers’ and students’ perceptions of mobile phone technologies undergo change and whether the positive effects on students’ academic performance would hold over time.

5.5 Chapter Summary

This chapter summarized the main findings, conclusions based on the findings as well as recommendations for both policy and further research. It is hoped that some scholars in Ghana and other African countries will research more on this topic in order to enrich the findings highlighted in this text.

The next section concludes with the reference list and a variety of instruments. The consent letters and introductory letters as well as other appendices were also presented.
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APPENDIX

APPENDIX A

QUESTIONNAIRE FOR 4TH YEAR SCIENCE UNIVERSITY STUDENTS

I am conducting a research on the use of mobile phone technology and how it can enhance academic performance of science university students. You have been selected to participate by responding to this questionnaire. Please respond to the questionnaire as appropriate by ticking or provide information where necessary. Any information provided would be treated as confidential.

INSTRUCTIONS: Please tick (✓) where applicable and provide answers where appropriate.

PART A: DEMOGRAPHICS

1. Name of University ____________________

2. Gender a) Male ( ) b) Female ( )

3. Age in years
   a) Below 21 ( )
   b) 22-26 ( )
   c) 27-31 ( )
   d) 32 and above ( )

4. Which area are you pursuing at the University?
   a) Botany/Environmental Science ( )
   b) Biochemistry ( )
   c) Chemistry ( )
   d) Computer Science/Information Technology ( )
   e) Mathematics ( )
   f) Physics ( )

5. Currently, what is your Grade Point average (GPA)?
   a) More than 3.0 ( )
   b) Between 2.5-2.9 ( )
   c) Less than 2.5 ( )
   d) I don’t know ( )

6. Do you own a mobile phone? Yes ( ) No ( )

7. i) Do you have Internet access on your phone? Yes ( ) No ( )
ii) Is Wi-Fi available on your phone?
   Yes ( )   No ( )   I don’t know ( )

8. i) Which phone model/make do you use most? Select one.
   a) Blackberry
   b) LG ( )
   c) Nokia ( )
   d) Samsung ( )
   e) Techno ( )
   f) Others, please specify____________________ ( )

   ii) What is your main reason for using that phone model/make?
       ___________________________________________________________
       ___________________________________________________________

iii) What type of phone do you use?
   a) Basic/Ordinary mobile phone ( )
   b) Smartphone ( )
   c) I don’t know the type of phone I use ( )

9. i) Which of the following service providers do you prefer most? Select one.
   a) Airtel ( )
   b) Expresso ( )
   c) Glo ( )
   d) MTN ( )
   e) Tigo ( )
   f) Vodafone ( )

   ii) What is the main reason for using that service provider?
       ___________________________________________________________
       ___________________________________________________________

10. How do you think mobile phones can impact your learning in science at your university?
    a) Negatively
    b) No change
    c) No idea
    d) Positively
PART B: WHICH TYPES OF MOBILE PHONE TECHNOLOGIES ARE AVAILABLE FOR SCIENCE STUDENTS?

The following statements are expressions of respondents’ opinions concerning use of mobile phones technologies. Please tick (✓) where applicable.

<table>
<thead>
<tr>
<th>Mobile phone technologies</th>
<th>Never</th>
<th>Rarely</th>
<th>Occasionally</th>
<th>Often</th>
<th>Very often</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I use text messaging (SMS) to interact with my colleagues about important information for class.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. I listen to audio recordings of lectures or class discussions.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. I search for information online from my phone.</td>
<td></td>
<td></td>
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<tr>
<td>4. I send and/or receive emails from my course mates about assignments and discussions on my phone.</td>
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<tr>
<td>5. I make and receive calls about important information for my class.</td>
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<tr>
<td>6. I read news, books and articles to get information for my classes online from my phone.</td>
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<tr>
<td>7. I use social networks such as Facebook for educational purposes on my phone.</td>
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<tr>
<td>8. I use office applications (Word, Excel and PowerPoint) directly from my phone.</td>
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<tr>
<td>9. I use dictionary/thesaurus/calculator applications that is available on my phone.</td>
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<tr>
<td>10. I use my personal organizer for noting important dates and setting reminder alarms for meetings.</td>
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<tr>
<td>11. I generate content or artifacts by taking photographs of diagrams, experiments and projects in science.</td>
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<td>12. I access and download science learning materials directly from my phone.</td>
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<td>13. I copy down notes from other students directly onto my phone.</td>
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<tr>
<td>14. I use Bluetooth available on my phone to transfer important documents and other information.</td>
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<tr>
<td>15. I use discussion boards and chat rooms for collaborating with my course mates on group assignments. Eg. Skype</td>
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<tr>
<td>Mobile phone technologies</td>
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<tr>
<td></td>
<td>Never</td>
<td>Rarely</td>
<td>Occasionally</td>
<td>Often</td>
<td>Very often</td>
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<tr>
<td>16. I use mobile phones with java support to help me exchange information about lecturers time table, class assignments and reference resources anytime the need arises.</td>
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<tr>
<td>17. I receive notifications (class cancellations, change of lecture venue, change in time of lectures, class and exam schedules) on request.</td>
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<tr>
<td>18. Downloading and watching science demonstrations videos for learning.</td>
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</tbody>
</table>
**PART C: TO WHAT EXTENT ARE STUDENTS SATISFIED WITH THE USE OF MOBILE PHONE TECHNOLOGIES IN LEARNING SCIENCE?**

The following statements are expressions of respondents’ opinions concerning satisfaction with mobile phone technologies. Please tick (✓) where applicable.

<table>
<thead>
<tr>
<th>Satisfaction</th>
<th>Strongly satisfied</th>
<th>dissatisfied</th>
<th>Uncertain</th>
<th>Satisfied</th>
<th>Strongly satisfied</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I am satisfied with the collection and integration of data for science research reports.</td>
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<tr>
<td>2. The science mobile applications available on my mobile phone is appropriate for my learning.</td>
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<tr>
<td>3. I am satisfied with strength of wireless networks.</td>
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<tr>
<td>4. My mobile phone is appropriate for expanding my horizon of information related to my courses in science.</td>
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<tr>
<td>5. I am satisfied with the interactivity between lecturers and students (with questions and discussions).</td>
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<tr>
<td>6. I am satisfied with the way mobile phones increases access to current and important information.</td>
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<tr>
<td>7. I am satisfied with the use of YouTube videos to demonstrate Experiments in science.</td>
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<tr>
<td>8. I am satisfied with how mobile phones are being used for students’ group discussions and presentations.</td>
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<tr>
<td>9. I am satisfied with the use of mixed traditional classroom (Face-to-face + internet assisted instructions).</td>
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<tr>
<td>10. I am satisfied with the bandwidth and reliability of wireless internet on campus.</td>
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<tr>
<td>11. I am satisfied with my instructors sending science lecture notes and assignments to me online.</td>
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<tr>
<td>12. I am satisfied with using of video podcasts to demonstrate areas I would not have otherwise understood.</td>
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<tr>
<td>13. I am satisfied with the use of audio recordings on my phone to capture lectures and discussions.</td>
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</tbody>
</table>
PART D: WHAT ROLE DOES LEARNING STYLES HAVE ON THE USE OF MOBILE PHONE TECHNOLOGIES?

The following statements are expressions of respondents’ opinions concerning their learning style. Circle either "A" or "B" to indicate your answer. Please choose only one answer for each question. If both "A" and "B" seem to apply to you, choose the one that applies more frequently.

<table>
<thead>
<tr>
<th>INPUT</th>
<th>Visual</th>
<th>Verbal</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I prefer to get new information in the form of</td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td></td>
<td>A) pictures, diagrams, charts and maps</td>
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<tr>
<td></td>
<td>B) written directions or verbal information</td>
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<tr>
<td>2. In a book with lots of pictures and charts, I am likely to</td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td></td>
<td>A) look over the pictures and charts carefully</td>
<td></td>
</tr>
<tr>
<td></td>
<td>B) focus on the written text.</td>
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<tr>
<td>3. When someone is showing me data, I prefer</td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td></td>
<td>A) charts or graphs</td>
<td></td>
</tr>
<tr>
<td></td>
<td>B) text summarizing the results</td>
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<tr>
<td>4. I remember best</td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td></td>
<td>A) what I see</td>
<td></td>
</tr>
<tr>
<td></td>
<td>B) what I hear</td>
<td></td>
</tr>
<tr>
<td>5. I like lecturers who</td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td></td>
<td>A) put a lot of diagrams on the board</td>
<td></td>
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<tr>
<td></td>
<td>B) spend a lot of time explaining</td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>PERCEPTION</th>
<th>Sensitive</th>
<th>Intuitive</th>
</tr>
</thead>
<tbody>
<tr>
<td>6. I prefer the idea of</td>
<td>A</td>
<td>B</td>
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<tr>
<td></td>
<td>A) certainty</td>
<td></td>
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<td></td>
<td>B) theory</td>
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<td>7. I find it easier</td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td></td>
<td>A) to learn facts</td>
<td></td>
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<td></td>
<td>B) to learn concepts</td>
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<tr>
<td>8. I would rather be considered</td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td></td>
<td>A) realistic</td>
<td></td>
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<td></td>
<td>B) innovative</td>
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<tr>
<td>9. I prefer courses that deals with</td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td></td>
<td>A) facts and real life situations</td>
<td></td>
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<tr>
<td></td>
<td>B) ideas and theories</td>
<td></td>
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<tr>
<td>10. I prefer courses that emphasize</td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td></td>
<td>A) concrete material (facts, data)</td>
<td></td>
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<tr>
<td></td>
<td>B) abstract material (concepts, theories)</td>
<td></td>
</tr>
<tr>
<td>PROCESSING</td>
<td>Active</td>
<td>Reflective</td>
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<tr>
<td>------------</td>
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<td>------------</td>
</tr>
</tbody>
</table>
| 11. I am more likely to be considered  
   A) outgoing  
   B) reserved | A | B |
| 12. I understand something better after I  
   A) try it out  
   B) think it through | A | B |
| 13. I would rather first  
   A) try things out  
   B) think about how I’m going to do it | A | B |
| 14. I prefer to study  
   A) in a study group  
   B) alone | A | B |
| 15. In a study group working on difficult material, I am more likely to  
   A) jump in and contribute ideas  
   B) sit back and listen | A | B |

<table>
<thead>
<tr>
<th>UNDERSTANDING</th>
<th>Sequential</th>
<th>Global</th>
</tr>
</thead>
</table>
| 16. It is more important to me that a lecturer  
   A) lay out the material in clear sequential steps  
   B) give me an overall picture and relate the material to other subjects. | A | B |
| 17. Once I understand  
   A) all the parts, I understand the whole thing  
   B) the whole thing, I see how the parts fit | A | B |
| 18. When solving problems in a group, I would be more likely to  
   A) think of the steps in the solution process  
   B) think of possible consequences or applications of the solution in a wide range of areas | A | B |
| 19. I tend to  
   A) understand details of a subject but may be fuzzy about its overall structure  
   B) understand the overall structure but may be fuzzy about details | A | B |
| 20. When considering a body of information, I am more likely to  
   A) focus on details and miss the big picture  
   B) try to understand the big picture before getting into the details | A | B |
PART E: WHAT INFLUENCE DOES THE USE OF MOBILE PHONE TECHNOLOGIES HAVE ON STUDENTS’ ACADEMIC PERFORMANCE IN LEARNING SCIENCE?

The following statements are expressions of respondents’ opinions concerning the use of mobile phone technologies to enhance performance. Please tick (✓) where applicable.

<table>
<thead>
<tr>
<th>Performance</th>
<th>Very Poor</th>
<th>Poor</th>
<th>Satisfactory</th>
<th>Good</th>
<th>Very Good</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. The mobile phone helps me with my class assignments for my science courses.</td>
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<tr>
<td>2. The mobile phone helps me prepare for my science quizzes.</td>
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<tr>
<td>3. Mobile phones fostered interaction and teamwork between me and my course mates.</td>
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<tr>
<td>4. Mobile phones increases my interaction with the science content.</td>
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<tr>
<td>5. Mobile phones make it easier for me to communicate with my science lecturers.</td>
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<tr>
<td>6. Mobile phones have specific science mobile applications, such as scientific games, that aid in my critical thinking and learning.</td>
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<td>7. Mobile phones with scientific, educational software have increase my performance scores in the university.</td>
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<tr>
<td>8. Mobile phones increase my motivation to learn science.</td>
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<tr>
<td>9. Mobile phones helps me increase access to learning materials and educational resources.</td>
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<td>10. Mobile phones have been beneficial to my study process.</td>
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<td>11. Mobile phones provides enhancement materials to supplement the textbook.</td>
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<td>12. Mobile phones enable me to accomplish learning tasks more quickly.</td>
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<tr>
<td>13. Mobile phones increase my creativity.</td>
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</tbody>
</table>
PART F: WHAT ARE THE BENEFITS OF USING MOBILE PHONES IN LEARNING SCIENCE?

The following statements are expressions of respondents’ opinions concerning challenges encountered when using mobile phone technologies in learning. Please tick (√) where applicable.

<table>
<thead>
<tr>
<th>Benefits</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Uncertain</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Mobile phones can be used for edutainment purposes through text messaging, sending emails, playing games and surfing the internet.</td>
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<tr>
<td>2. Mobile phones will increase my satisfaction at the university.</td>
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<td>3. Mobile phones will increase my academic performance at the university.</td>
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<td>4. It offers another channel for supporting learning styles.</td>
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<td>5. Mobile phones will provide students with a supportive environment for collaboration.</td>
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<tr>
<td>6. Mobile phones will help me with obtaining academic information anytime the need arises.</td>
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<tr>
<td>7. Mobile phones will help me to keep abreast with current issues.</td>
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<tr>
<td>8. Mobile phones will increase my motivation to learn.</td>
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<tr>
<td>9. Mobile phones can initiate self discovery and learning something new.</td>
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<tr>
<td>10. Mobile phones can enhance the presentation of learning through visual effects.</td>
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<td>11. Mobile phones can facilitate student-centered instruction.</td>
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<tr>
<td>12. Mobile phones can increase the interactivity between students and materials.</td>
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<tr>
<td>13. Mobile phones can increase exchange of information with lecturers.</td>
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<tr>
<td>14. Through mobile phones students can easily retrieve information for research.</td>
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<tr>
<td>15. Mobile phones can increase communication.</td>
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</tbody>
</table>
PART G: WHAT ARE THE CHALLENGES IN THE USE OF MOBILE PHONES IN SCIENCE LEARNING?

The following statements are expressions of respondents’ opinions concerning challenges encountered when using mobile phone technologies in learning. Please tick (✓) where applicable.

<table>
<thead>
<tr>
<th>Challenges</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Uncertain</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. The keypad is too small making it hard to type.</td>
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<tr>
<td>2. There is potential increase in plagiarism (cut-copy-paste).</td>
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<tr>
<td>3. Students will be more distractible in classroom, therefore, students tend to lose focus when using mobile phones.</td>
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<tr>
<td>4. There is potential cheating on homework and exams.</td>
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<tr>
<td>5. Increase of poor reading and writing skills amongst students.</td>
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<tr>
<td>6. There are frequent network problems with service providers.</td>
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<tr>
<td>7. The cost of recharge cards/airtime is too high.</td>
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<tr>
<td>8. Sometimes, there is limited area of network.</td>
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<tr>
<td>9. The screen is relatively small making it difficult to see some information.</td>
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<tr>
<td>10. Smartphones are too expensive to afford.</td>
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<tr>
<td>11. The charge on internet bundles is quite high.</td>
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</table>

THANK YOU VERY MUCH FOR COMPLETING THIS QUESTIONNAIRE.
APPENDIX B

QUESTIONNAIRE FOR 4th YEAR SCIENCE UNIVERSITY LECTURERS

I am conducting a research on the use of mobile phone technology and how it can enhance academic performance of science university students. You have been selected to participate by responding to this questionnaire. Your honesty and co-operation will go a long way in helping to accomplish the goal of this study. You are requested to give personal opinions and answers. Please respond to the questionnaire as appropriate by ticking or provide information where necessary. Any information provided would be treated as confidential.

INSTRUCTIONS: Please tick (✓) where applicable and provide answers where appropriate.

PART A: DEMOGRAPHICS

1. Name of University ______________________

2. Gender  
   a) Male ( )  
   b) Female ( )

3. Which department do you belong?  
   a) Botany/Environmental Science ( )  
   b) Biochemistry ( )  
   c) Chemistry ( )  
   d) Computer Science/Information Technology ( )  
   e) Mathematics ( )  
   f) Physics ( )

4. How long have you been lecturing at the university?  
   a) 1-4 yrs ( )  
   b) 5-9 yrs ( )  
   c) 10-14 yrs ( )  
   d) Above 15 yrs ( )

5. What is the highest level of qualification that you have?  
   a) PhD ( )  
   b) M. Phil ( )  
   c) M. Sc/M.Eng ( )

6. Do you own a mobile phone?  
   Yes ( )  
   No ( )
7. i) Which model/make do you use most? Select one.

a) Blackberry ( )
b) LG ( )
c) Nokia ( )
d) Samsung ( )
e) Techno ( )
f) Others, please specify____________________ ( )

ii) What is your main reason for using that phone model/make?
__________________________________________________________________________

__________________________________________________________________________

iii) What type of phone do you use?

a) Basic/Ordinary mobile phone ( )
b) Smartphone ( )
c) I don’t know the type of phone I use ( )

8. i) Which of the following service providers do you prefer most? Select one.

a) Airtel ( )
b) Expresso ( )
c) Glo ( )
d) MTN ( )
e) Tigo ( )
f) Vodafone ( )

ii) What is the main reason for using that service provider?
__________________________________________________________________________
__________________________________________________________________________

9. Do you use mobile phones in supporting your teaching? Yes ( ) No ( )

10. i) If Yes, in what way are you using it?
__________________________________________________________________________
__________________________________________________________________________
__________________________________________________________________________
ii) If No, what is the reason for not using mobile phones in supporting teaching?

PART B: WHICH TYPE OF MOBILE PHONE TECHNOLOGIES ARE AVAILABLE FOR LECTURERS TO SUPPORT TEACHING OF SCIENCE?

The following statements are expressions of respondents’ opinions concerning the how lecturers use mobile phone technologies to support their teaching in science. Please tick (✓) where applicable.

<table>
<thead>
<tr>
<th>The use of mobile phone technologies by lecturers</th>
<th>Never</th>
<th>Rarely</th>
<th>Occasionally</th>
<th>Often</th>
<th>Very Often</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I send emails to my science students to discuss subject content and attach course outline and other important information from my phone.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>2. I access and download textual materials, audio and video clips for my class directly from my phone.</td>
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<tr>
<td>3. I use my mobile phone to contact my students for important information.</td>
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<tr>
<td>4. I use text messages to send notifications (class cancellations, change of lecture venue, change in time of lectures and other administrative duties).</td>
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<tr>
<td>5. I encourage students submit their assignments online from their mobile phone.</td>
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<tr>
<td>6. I have course materials such as slides, lecture notes and practice quizzes available on my mobile phone.</td>
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<tr>
<td>7. I use the internet available on my mobile phone to get up-to-date information for a class.</td>
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<tr>
<td>8. I read news, books and articles online directly from my mobile phone in order to gather more information on topics treated in class.</td>
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<tr>
<td>9. I use online science dictionaries on my mobile phone to get definitions for my class.</td>
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<tr>
<td>10. I use Bluetooth to share materials with my students, since it is a quicker way to send information to my students.</td>
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</tr>
</tbody>
</table>
**PART C: HOW CAN MOBILE PHONES ENHANCE THE QUALITY OF EDUCATION?**

The following statements are expressions of respondents’ opinions concerning quality of education with mobile phone technologies. Please tick (✓) where applicable.

<table>
<thead>
<tr>
<th>Quality of education with mobile phone use</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Uncertain</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Mobile phone is useful as a supplementary to teaching.</td>
<td></td>
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<tr>
<td>2. Mobile phones is better than traditional instruction since it allows teaching suited to the students’ learning style.</td>
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<tr>
<td>3. Mobile phones help me organize my work better.</td>
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<tr>
<td>4. Mobile phones enhances easier access to information anywhere and anytime.</td>
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<tr>
<td>5. Text messaging is useful as an instructional tool in class.</td>
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<tr>
<td>6. Text messaging increases understanding of difficult concepts, by putting information in bits for easier assimilation.</td>
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<tr>
<td>7. Mobile phones can increase motivation and participation in class.</td>
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<tr>
<td>8. Mobile phones increase collaboration between students.</td>
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<tr>
<td>9. Mobile phones increases communication between the lecturer and the student.</td>
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<tr>
<td>10. Mobile phones can help students be more prepared for class by easily accessing information before class.</td>
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<tr>
<td>11. Mobile phones provides students with the opportunity to work at their own pace.</td>
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</tr>
<tr>
<td>12. Mobile phones allow students to get access to up-to-date information through the Web.</td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

THANK YOU VERY MUCH FOR COMPLETING THIS QUESTIONNAIRE
APPENDIX C

STUDENT QUESTIONNAIRE ON REFLECTION OF MOBILE PHONE USE IN SCIENCE LEARNING

I am conducting a research on the use of mobile phone technology and how it can enhance academic performance of university students. You have been selected to participate by responding to this questionnaire. Please respond to the questionnaire by providing information below the questions. Any information provided would be treated as confidential.

1. What is your view on m-Learning?

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

2. Which feature do you mostly use on your mobile phone?

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

3. How do you use mobile phones in learning science?

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

4. State one way you think mobile phones can help improve your academic performance at the university?

________________________________________________________________________
________________________________________________________________________

5. Which mobile application do you often use on your phone that facilitates your learning in science?

________________________________________________________________________
6. a) Which site do you use the most to source information for assignments?

b) Why do you prefer to use the site mentioned in a)?

7. Which main role should lecturers play to encourage the use of mobile phone technologies at your university?

8. Which is the major challenge you face in using mobile phones to support your science learning?

9. What do you think is the future of using mobile phone technology in learning science at your university?

10. Which opinion do you have on how mobile phones should be used for at your university?

THANK YOU FOR PARTICIPATING
APPENDIX D
ICT COORDINATORS INTERVIEW SCHEDULE

I am conducting a research on the use of mobile phone technology and how it can enhance satisfaction, learning style and performance of university students. You have been selected to participate. Any information provided would be treated as confidential.

1. What are your views about m-Learning as we apply in the Ghanaian context? The mobile phone will receive the largest growth or benefit from m-learning. What do you think about this statement? Explain.

2. What are the educational implications of using mobile phone technologies in learning?

3. What drawbacks do you think mobile phones can bring to students’ learning?

4. What is the future of mobile phone technology usage in learning at your university?

5. What role will you play to encourage this type of learning through mobile phone technologies?

THANK YOU FOR YOUR TIME
### APPENDIX E

#### LIST OF PUBLIC UNIVERSITIES IN GHANA

<table>
<thead>
<tr>
<th>Institution</th>
<th>Coat of Arms</th>
<th>Nickname</th>
<th>Location(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>University of Ghana</td>
<td><img src="image" alt="Legon Coat of Arms" /></td>
<td>Legon</td>
<td>Legon, Greater Accra, Ghana</td>
</tr>
<tr>
<td>Kwame Nkrumah University of Science and Technology</td>
<td><img src="image" alt="KNUST Coat of Arms" /></td>
<td>KNUST</td>
<td>Kumasi, Ashanti, Ghana</td>
</tr>
<tr>
<td>University of Cape Coast</td>
<td><img src="image" alt="Cape Vars Coat of Arms" /></td>
<td>Cape Vars</td>
<td>Cape Coast, Central, Ghana</td>
</tr>
<tr>
<td>University of Education, Winneba</td>
<td><img src="image" alt="UEW Coat of Arms" /></td>
<td>UEW</td>
<td>Winneba, Central, Ghana</td>
</tr>
<tr>
<td>University for Development Studies</td>
<td><img src="image" alt="UDS Coat of Arms" /></td>
<td>UDS</td>
<td>Tamale, Northern, Ghana</td>
</tr>
<tr>
<td>University of Mines and Technology</td>
<td><img src="image" alt="UMAT Coat of Arms" /></td>
<td>UMAT</td>
<td>Tarkwa, Western, Ghana</td>
</tr>
</tbody>
</table>

APPENDIX F

MAP OF GHANA

APPENDIX G

LIST OF MOBILE PHONE SERVICE PROVIDERS IN GHANA

<table>
<thead>
<tr>
<th>Mobile Phone Service Providers</th>
</tr>
</thead>
<tbody>
<tr>
<td>MTN</td>
</tr>
<tr>
<td>TiGO</td>
</tr>
<tr>
<td>Vodafone</td>
</tr>
<tr>
<td>Airtel</td>
</tr>
<tr>
<td>Expresso</td>
</tr>
<tr>
<td>GLO</td>
</tr>
</tbody>
</table>
Dear Respondent,

I am a post graduate student in the School of education at Kenyatta University, Kenya. The purpose of this research is to gather information on the influence of mobile phone technologies on science students’ academic performance in selected Ghanaian public universities. The results of this survey will be important since it forms a basis for formulating ways of using mobile phone technologies to support learning in science.

You have been selected to provide relevant information for this study. Please understand that your participation is voluntary and there is no penalty for choosing not to participate in this research. Please be assured that your responses will be held confidentially and are intended only for the purpose of this study. There are no known risks if you decide to participate in this study. Please read each question carefully and follow instructions preceding each section. You are encouraged to be honest with your responses and answer all the questions in the questionnaire.

Kindly sign below, if you are willing to participate in the study.

--------------------------------------------

Thank you for participating in the study.

Yours faithfully,

Rosemary Twum
APPENDIX I

COVERING LETTER FOR LECTURER QUESTIONNAIRE

Dear Respondent,

I am a post graduate student in the School of education at Kenyatta University, Kenya. The purpose of this research is to gather information on the influence of mobile phone technologies on science students’ academic performance in selected Ghanaian public universities. The results of this survey will form a basis for formulating ways of using mobile phone technologies to support learning in science.

You have been selected to provide relevant information for this study. In answering the questions, you are assured that your responses will be treated confidentially and responses are intended only for the sole purpose of this study. Please, you have the right to stop participating in the research at any time and you will not be penalized for doing so. Please read each question carefully and follow instructions preceding each section. You are encouraged to be honest with your responses and answer all the questions in the questionnaire. You are kindly requested to fill the questionnaire in one week time.

If you have any questions regarding this study, please contact me at 0244-648897 or email rosiemarie212@yahoo.com.

Kindly sign below, if you are willing to participate in the study.

--------------------------------------------

I am appreciative for your participation as I understand that the demands on your time are significant. Thank you for your participation in this study.

Yours faithfully,

Rosemary Twum
APPENDIX J

INTRODUCTORY LETTER FROM UNIVERSITY OF CAPE COAST

KENYATTA UNIVERSITY
Department of Educational Communication & Technology
P.O. Box 43844 Nairobi, Kenya. Tel. 8710901-00100 Ext: 57329 or Cisco 3740
Website: www.ku.ac.ke
email: chairman-comtech@ku.ac.ke

Our Ref: E83F/24653/11
Your Ref:

TO WHOM IT MAY CONCERN

RE: INTRODUCTION LETTER FOR ROSEMARY TWUM
REG. E83F/24653/2011

This is to inform you that Rosemary Twum is a PhD student at Kenyatta University,
School of Education in the Department of Educational Communication and Technology.

She has successfully defended her proposal on the topic, “Utilization of Mobile Phones
learner support systems in enhancing satisfaction, learning style and performance of
university students in Ghana”.

Any assistance accorded to her will be highly appreciated.

Yours faithfully,

DR. M. KIO
Chairperson, Department of Educational Communication & Technology

MK/k
APPENDIX K

INTRODUCTORY LETTER FOR KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY

KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY

OFFICE OF THE REGISTRAR

DR/GEN/SF.1/VOL.15 5TH NOVEMBER, 2012

HEAD OF DEPARTMENTS
COLLEGE OF SCIENCE

RE - INTRODUCTION LETTER FOR ROSEMARY TWUM
REG. E83F/24653/2011

This is to introduce MS. ROSEMARY TWUM, a PhD student from Kenyatta University, School of Education.

She is conducting a research for her PhD Dissertation on the topic “Utilization of Mobile Phones learner support systems in enhancing satisfaction, learning style and performance of University students in Ghana.”

Any courtesy extended to her would be appreciated.

Thank you.

K. Owusu Tabi
AG. DEPUTY REGISTRAR (GENERAL)
For REGISTRAR
APPENDIX L

INTRODUCTORY LETTER FROM UNIVERSITY OF GHANA

My Ref. No.: .........................................................

29th October, 2012

TO WHOM IT MAY CONCERN

The bearer of this note, Ms. Rosemary Twum, a PhD student at Kenyatta University, School of Education in the Department of Educational Communication and Technology, Nairobi, Kenya is seeking permission to administer questionnaires to students and staff of the University.

I would be grateful for any assistance that could be accorded her.

(J. M. BUDU)
REGISTRAR

UNIVERSITY OF GHANA

Tel: (+233-21) 500383 Direct
(+233-21) 500381
Fax: (+233-21) 500383
Ext. 6114 Registrar
Ext. 6029 Secretary
E-mail: registrar@ug.edu.gh