

**INFORMATION AND COMMUNICATION TECHNOLOGIES (ICTs) COMPETENCY AMONG  
BIOLOGY TEACHERS IN COLLEGES OF EDUCATION IN KANO STATE, NIGERIA**

**BY**

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## Approval page

This research work on ‘‘Information and Communication Technologies Competency among Biology Teachers in Colleges of Education Kano State, Nigeria’’ has been read and approved as meeting the requirement of the Department of Science and Technology Education, Bayero University, Kano for the award of master’s degree in Science Education (M.Sc. ed. Biology).

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I certify that this dissertation was conducted, written and compiled by me and has not been presented wholly or partly for the award of any degree or publication elsewhere.

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## **Dedication**

I dedicated this work to my parent late Malam Yusuf Adamu, Umma Amina and late Hajiya Yahanasu, may Almighty Creator grant them *Al-jannatul Firdausi*.

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## **List of Abbreviations**

The following abbreviations are used in this study

3D: Three Dimensional Printing

AICC: Aviation Industry CBT (Computer-Based Training) Committee

ARPA: Advance Research Projects Agency

CAI: Computer Assisted Instruction

CAL: Computer Assisted Learning

CCK08: Connectivism and Connective Knowledge

CD-ROMs: Compact Disc Read-Only Memory

CISCO: Computer Information System Company

CMC: Computer Mediated Communication

DNA: Deoxyribose Nucleic Acid

GPS: Global Positioning System

ICT-CFT: Information and Communication Technology Competency Standard Framework

ICU: International Communication Union

IICBA: International Institute for Capacity Building in Africa

IMC: Integrated Marketing Communications

ISTE: International Society for Technology in Education

KSCE: Kenya National Examination Council

MOOCs: Massive Open Online Courses

MP3: Moving Picture Expert Group Layer-3 Audio

NCCE: National Commission for Colleges of Education (Nigeria)

NEPAD: New Partnership for African Development

NERC: National Educational Resource Center

NERD: National Educational Resource Department

NETs: National Educational Technology Standards

NITDA: National Information Technology Department Agency

OECD: Organization for Economic Cooperation and Development

OER: Open Educational Resources

P2PU: Peer-to-Peer University

PDA: Personal Digital Assistants also known as Handheld Devices

PDE: Personal Digital Entertainment Devices

PTDEF: Petroleum Trust Development Endowment Fund

RTVUs: Radio Television Universities

SCORM: Shareable Content Object Reference Model (a web-based e-learning standard)

SERC: State Education Resource Center

SMS: Short Messaging Service

UNESCO: United Nations Educational Scientific and Cultural Organization

USB: Universal Serial Bus

VoIP: Voice over Internet

## **Operational Definition of Terms**

**Biology Teachers:** They are teachers that prepare students for teaching careers in science education particularly biology, by offering both basic and advance courses in human biology, animal and plant sciences and education courses as well.

**Colleges of Education:** They are tertiary institutions responsible for the production of professional teachers who are equipped with skills and methodology of teaching in primary and junior secondary schools levels of education in Nigeria.

**Information and Communication Technologies:** Refers to the use of computer based communication technology that serve as a network to find information and this includes hardware and software , internet, broadcasting technologies (radio and television) and telephone that can be used for teaching and learning as well as information resources.

## **Abstract**

This study investigated the Information and Communication Technologies Competency among Biology Teachers in Colleges of Education Kano state, Nigeria. A total of 50 biology teachers from the three colleges of education in Kano state formed both the population and sample of the study. The researcher adopted descriptive survey research design for the study. The study is guided by 5 objectives, 5 research questions and 2 null hypotheses among which are: To find out whether ICT facilities are adequately available in the teaching of Biology in the Colleges of Education in Kano State, to determine also ICTs Competency among Biology Teachers in the Colleges of Education in Kano State. To what extent are the ICT facilities are provided in the Colleges of Education in Kano State? What are the levels of ICTs Competency among Biology Teachers in the Teaching of Biology in Colleges of Education in Kano State? For the null hypotheses one of which stated that there is no significance difference in ICT Competency between Biology Teachers from Federal and State Colleges of Education in Kano State. An adapted questionnaire tagged ICT and Colleges of Education (ICTCOE) and Check List (CL) were used to collect data. The reliability correlation coefficient index for (ICTCOE) was ascertained to be 0.782. The data collected was subjected for analysis using Mean scores and standard deviation which were used to answer the research questions while the two null hypotheses were tested at 0.05 level of significance using one-way Analysis of Variance (ANOVA) and t-test statistics. One finding among others from the study revealed that most of the ICTs facilities are not available, which consequently made it difficult for biology teachers to effectively utilize them or implement ICT facilities in their teaching activities. Based on the findings from the study, a number of recommendations were made for the improvement of ICTs competency and implementation in the teaching of biology. One of which is that Biology Teachers should be encourage by the College authorities to go for in-service training, seminars, workshops and conferences on ICTs competency in their teaching activities.

# CHAPTER ONE

## INTRODUCTION

### 1.1 Background of the Study

The rapid advances recently made in Information and Communication Technologies (ICTs) have important implications for us as biology educators. As we begin the 21<sup>st</sup> century it is almost impossible to imagine what ICTs will be like by the end of the century. We can already start to see how these advances are changing our ideas about traditional methods of teaching. Advances in ICTs will mean an enormous increase in the amount of information available to our students as they study their courses and as they move in to the work place, but this must not limit our expectations. If we wish to provide our students with a quality education in biology, we must consider more than mere transmission of information and facts. We must take account of what the educational research tell us about teaching and learning, in this regard we can employ ICTs better in future to change teaching and learning in biology more fundamentally by promoting such activities as networking communities of learning and research, interdisciplinary problems, and individualized learning.

Biology and all other sciences progress through a process of inquiry, rather than just building a body of factual information. The way we utilize ICTs informed by the research findings will be of vital importance to high quality biology education for our students. The internet can be used to create teaching and learning environments where students are allowed to explain and defend their thinking, opinions and decisions. At this juncture, the future looks very exciting from a biology point of view (Potyrala, 2002).

ICTs if thoughtfully implemented has the potential to profoundly influence teaching and learning in biology for the better. If we wish to gain the most benefit from the advances in ICTs,

we must ensure that its implementation follows sound pedagogical guidelines informed by educational research. This will require competency and profound changes in our attitudes as biology teachers. The integration of these technologies in teaching and learning environments will also provide us with great opportunities for own learning and professional development (Potyrala, 2003).

Nowadays, education undergoes the great transformation, when the overhead projector with power point slides are the latest equipment found at school has been reached and Information and Communication Technologies (ICTs) by products are working through the schools. Where by ICT integration is the topical requirement of everyday life and plays an important role in society globalization (Kubiatko, 2006).

Abdullahi (2013) assert that before the advent of ICTs, other instructional media were in use for effective teaching and learning processes. Instructional media is referred to anything that a teacher will use during teaching period, these instructional media could be used to communicate between a teacher and his students as they carry messages with an instructional intention. Instructional media also, could be seen as a broad variety of resource materials that provides genuine images for enriching curriculum contents and gradually enhance the educational process. These materials as well, may include living and non-living materials from the immediate environment that a teacher could use in order to make his explanation more easier, for example animals, small insects, plant leaves, piece of wood, stones, papers, metal scraps, the chalk board, printed materials such as charts, maps, diagrams, photographs, models and real things to sophisticated materials such as the audio and video machines, projectors and the computer.

He further stated that, visiting places inform of field trip or excursion within and outside the school could also, be regarded as instructional media. However, students under normal

circumstances are expected to see things happening physically and hear, because seeing makes one to believe and if they cannot do either then there is a problem to physical perception. Most educationist are in the view of supporting the good use of instructional media as they facilitate students learning more effectively, for example students that are being taught with well selected and sensibly utilized instructional materials will be learning more effectively than those who are being taught verbally (Abdullahi, 2013).

Teaching is an active process in which one person shares information with others to provide them with the information to make behavioural changes (Terressa, 2000). Teaching is not like other careers, it gives you the opportunity to influence young minds, to shape lives for the better. It will change your life too; you will find it intellectually stimulating, creative and endlessly varied. Every day brings a fresh challenge. You will also learn how to present, support, use modern multimedia tools, manage behavior, work in teams and learn how to make a difference to young people's mind. You will also have the opportunity to work with highly skilled and committed people and stand a chance to develop your own knowledge and skills. This shows that teaching is the ultimate profession, because without teaching there will be no other professions.

In addition, anyone who joins the teaching professions needs to be able to exploit the potential of information and communication technology (ICT) to meet their teaching objectives. The use of ICT in science lesson should always be used to support students efficiently, and trainees need to be able to explain why they have chosen to use ICT. For example, an animated simulation of the digestive system should be used because it is the most effective means of illustrating the functions of the organs. Therefore, the selection of appropriate ICT should be judged carefully, teachers must know how to structure students work with ICT to maximize their learning and make best use of available time (Teacher Training Agency, 1998).

Aina (2013) pointed out that method of teaching has gone beyond traditional method of talk and chalk method and no wonder Shedd (2004) suggested that any one preparing to become a teacher must incorporate technology in their class. Developed nations of the world are not taking science education with loose hands; they rely on it that is why they remain developed. For Nigeria in particular to attain the position of developed countries it cannot afford to joke with the development of science education as the case is presently, so there is need for positive change. However, to become great among the committee of nations, Nigeria must adjust her method of teaching and learning of science education from the traditional method of using talk and chalk. The world is now in the era of ICT where information is not restricted by time, space and channel (Ajayi and Ojo, 2010). That is to say teaching and learning is not restricted to classroom only, teaching and learning could be done in your bedroom, on sea and even in the air

Competence is defined as the ability to combine and apply relevant attributes to particular tasks in particular context. These attributes include high levels of knowledge, values, skills, personal dispositions, sensitivities and capabilities and the ability to put those combinations into practice in appropriate way (Commonwealth Department of Education, Science and Training, 2002) as cited in Hooker, Mwiyeria, and Verma (2011).

ICT competency or standards are descriptions of what a qualified teacher should know and be able to do with technology in educational settings. Competency with technology integration is the basis for effective change in teaching and learning environments. Teachers will need to lead by modeling effective ICT skills and life long learning strategies. Students will need to see their teachers applying technology in authentic and integrated ways that will enable students to be encouraged in problem solving, project collaboration and in creativity extending their abilities and capacities to learn and construct knowledge (Hooker,*et al.*, 2011)

Moreover, the development of every society depend on science and technology and for individuals to become fully integrated and contribute meaningfully in the modern world, they must be equipped with scientific knowledge and technical skills (Mari, 2006). Also, in view of (Omesewu, 2009; Awolaju, Akinloye, 2010) science education is very important to technological development of any nation because of its numerous benefits.

Importance of ICT in our society today is enormous as understood by Adebayo (2010) observed that ICTs is indispensable part of contemporary society, because it allows access to information anywhere in the world, promote networking that is not restricted by boundary, language and culture, foster communities' empowerment and spread knowledge. Students who used ICTs gain different understanding of complex topics and concepts and are more likely to recall information and use it to solve problems outside the classroom (Apple Computer, 2002). ICTs also, have introduced a new era in traditional methods of teaching and offering new teaching and learning experiences to both teachers and students. Hence , Nigerian education environment should take advantage of this capability to provide easy access of information, since technologies enables the visualization of Educational materials in an innovative and realistic manner (Ololube, 2006).Additionally, teacher training is crucial using ICTs, because ICTs are tools that on the one hand can facilitate teacher training and on the other hand help them to take full advantage of the potential of technology to enhance students learning (UNESCO, 2003).

On the other hand, colleges of education encompassed the production of professional teachers who are equipped with skills and methodology of teaching in our primary and junior secondary school levels of education in Nigeria (Ebisine, 2014).Essentially, colleges of education are to provide full time courses in teaching, instruction and training and to conduct courses in education for qualified teachers. Also, noted by Anikweze (2001) as cited in Ebisine (2014) that colleges of education were to produce highly qualified non graduate professional

teachers for the primary and junior secondary levels of education. Therefore, to ensure colleges of education products attain the broad goals of tertiary education, as well as, ensure quality in the preparation of teachers, relevance and professionalism, there is need for optimal utilization of ICTs in teaching and academic quality assurance (Ebisine, 2014).

Kwaca(2007) noted that the most common problems associated with the effective implementation of ICT are lack of qualified ICT personnel, cost of equipment, management attitudes, inconsistent electric power supply, inadequate telephone lines particularly in rural areas and inclusion of ICT programs in teachers training curricula and at the basic levels of education. However, Pelgrum (2001) express an opinion that obstacles for ICT implementation includes the following: insufficient number of computers, teachers lack of knowledge or skills, difficult to integrate ICT to instruction, scheduling computer time, insufficient teacher time, not enough simultaneous access, not enough supervision of staff and lack of technical assistance.

Similarly, Lewis and Smith (2002) summarized these problems as limited equipment's, inadequate skills, minimal support, time constraints and the teachers own lack of interest or knowledge about computer. In Nigeria, most ICT facilities are not sufficient to enhance quality education to learners and teachers, even where it exist there are not sophisticated enough to stand the test of time like the ones acquired in developed countries (Tinuoye and Adogbeji, 2013). Also, (Nwosu and Ogbomo, 2012) stated that problems of quality and lack of resources are compounded by the new realities faced by higher education, institutions battle to cope with every increasing students numbers.

Furthermore, the view of (Tinuoye and Adogbeji, 2013) is that in Nigeria, electricity supply is irregular and this affectmost of the ICT operation in higher institutions and at homes, thus causing frequent damages of the existing ICT equipment which hinder ICT uses in enhancing quality education. Also, in the same vein, Ndukwe (2007), pointed out that all ICT

equipment, infrastructure and terminals depend on electricity supply, unless this vital sources is always available and reliable, Nigerians will not be able to fully enjoy the benefits that the digital revolution offers and that overcoming the energy crises is a major pre-requisite for Nigeria to achieve its vision 2020 of national transformation.

Notwithstanding, the specifications in the National Policy of Education by the Federal Government of Nigeria (1998, 2004). Nigeria as a nation came late and slowly into the use of ICT in all sectors of the nation's existence more especially in teacher education. And this is as a result of chronic limitations brought about by economic disadvantages and government policies. These factors have direct consequences on the educational development.

The purpose of using ICTs in teaching biology is to raise the standard of student's achievement and the quality of their learning. Therefore, in order to realize the potential of ICT to extend and enhance learning, science teachers particularly Biology teachers need to be competent users of computer system. To this end, the researcher deemed it necessary to embark on this study which is specifically concerned with Information and Communication Technologies Competency among Biology Teachers in Colleges of Education in Kano State, in order to determine the status of ICTs in colleges of education in Kano state.

## **1.2 Statement of the Problem**

level of ICT literacy, among academic staff and students in Nigeria colleges of education is still very low (Ololube, 2006). Also, most of the teachers in Nigeria at all levels do not have the needed experience and competence in the use of computers either for educational or industrial purposes, neither do they have the needed skills and knowledge in the use of common computer software (Yusuf, 2005). According to (World Bank, 2000) as cited by (Ololube, Ubogu and Ossai, 2007) empirical studies have indicated that even teachers who have competence in the

use of ICT do not integrate them in their teaching. In the same vein, Ololube (2006) also, pointed out that many Nigerian teachers have been unable to find out effective ways to use technology in their classroom or any other aspect of their teaching and learning life. The possible explanation of this lack of success by teachers is that the use of technology in the classroom has not been encouraging and teachers are not well trained in using ICTs in teaching as a means for educational sustainability.

In another study conducted by Ajayi (2008) on towards effective use of information and communication technology for teaching in Nigeria Colleges of Education revealed that the effective utilization of ICT in teaching and learning depends on the availability of these facilities and teachers competence in using them. Also, not much of digital technologies are used in pedagogical practices by teacher educators in Nigerian colleges of education and other institutions of higher learning, this is because most of institutions do not have the necessary ICT facilities for instructions and research neither do teacher educators possess the needed skills and competence for effective integration of ICT in classroom instructions (Agbatogun, 2006).

Therefore, in view of the above findings, this study is aimed to determine Information and Communication Technologies Competency among Biology Teachers in the Colleges of Education in Kano State.

### **1.3 Objectives of the Study**

- i. To find out whether ICT facilities are adequately available the Teaching of Biology in the Colleges of Education in Kano State.
- ii. To determine ICTs Competencies among Biolgy Teachers in the Teaching of Biology in the Colleges of Education in Kano State.

- iii. To determine differences in the ICTs Competency between Biology Teachers from Federal and State Colleges of Education in Kano State.
- iv. To find out gender differences( if any) in ICTs Competency among Biology Teachers in Colleges of Education in Kano State.
- v. To find out factors militating against the use of ICTs for the Teaching of Biology in the Colleges of Education in Kano State.

#### **1.4 Research Questions**

- i. To what extent are the ICTs facilities for the Teaching of Biology are provided in the Colleges of Education in Kano State?
- ii. What are the level of ICTs Competency among Biology Teachers in the Teaching of Biology in Colleges of Education in Kano State?
- iii. Is there any significant differences in ICTs Competency between Biology Teachers from Federal and State Colleges of Education in Kano State?
- iv. Is there any significant gender differences in ICTs Competency among Biology Teachers in the Colleges of Education in Kano State?
- v. What factors are militating against the use of ICTs in the Teaching of Biology in the Colleges of Education in Kano State?

#### **1.5 Null Hypotheses**

**H<sub>01</sub>:** There is no significance difference in ICTs Competency between Biology Teachers from Federal and State Colleges of Education in Kano State.

**H<sub>02</sub>:** There is no significance gender difference in the level of ICTs Competency among Biology Teachers in the Colleges of Education in Kano State.

## **1.6 Significance of the Study**

The findings of this study will be of great significance to a number of people involved in the process of teaching and learning such as the teachers who are complimentary to the curriculum contents, the federal and state government representatives, that is to say the ministry of education, science and technology officials, the curriculum planners, students and the professional bodies and associations (STAN, MDGs).

### ***Biology Teachers:***

To Biology teachers, the finding will encourage them to be utilizing ICT materials in the conduct of their lessons in biology than only using verbal instruction this is because effective use of ICTs make the lessons become clearer, understandable, presentable and easier to conduct.

### ***Federal and State Governments:***

With regards to the Federal and State governments as the effect is determined the official will now use the chance as they are financial controllers to purchase the ICTs materials and supply it to each school in sufficient numbers, since the effect identified, the need for seminars, workshops to the subject teachers on how to utilize ICTs should be conducted on the other hand.

### ***Curriculum Planners:***

The curriculum planners should design a syllabus on biology to suite the need of utilizing ICTs in carrying out biology lessons in the colleges of education in Kano state.

***Students:***

The students as being the ultimate users, benefits from utilizing ICT in attracting their attention becomes part of the lesson, as it make them easily understanding the content and help them also to recalled entry behavior.

***Professional Bodies and Associations:***

It will also be useful to professional bodies and associations such as Science Teachers Association (STAN), Millennium Development Goal (MDGs), State Education Resource Center (SERC), National Educational Resource Department (NERD), and other related bodies in training their prospective member on effective utilization of ICTs.

**1.7 Scope of the Study**

This research work is limited to three government own colleges of education in Kano state, because it is assumed that they are equally funded by the government. The study is aimed at determining Information and Communication Technologies Competency among Biology Teachers in the Colleges of Education in Kano State and the extent to which ICTs are being utilized by teachers in the Colleges of Education in Kano State. The study also, determined whether ICTs facilities are adequately available for the Teaching of Biology in the Colleges of Education in Kano State.

## **CHAPTER TWO**

### **REVIEW OF RELATED LITERATURE**

#### **2.1 Introduction**

This chapter presents a review of related literature on Information and Communication Technologies Competency among Biology Teachers in Colleges Education in Kano state. The review would be discussed under the following subheadings:

- Theoretical Framework
- Conceptual Framework
- ICTs Competency Model for Teacher Education
- Current Trends in Science Education
- History of ICT
- ICT Teacher Competency Standard Framework
- National Policies on the Use of ICTs in Teaching and Learning in Nigeria
- The Use of ICTs in Teaching and Learning Biology
- ICT and Teacher Education in Nigeria
- Factors Militating Against the Utilization of ICTs
- Review of Empirical Studies
- Implication of Literature Reviewed

#### **2.2 Theoretical Framework**

This study is anchored on constructivist learning theory developed by Swiss psychologist Jean Piaget (1969) and the Russian psychologist Lev Vygotsky (1978). Their study of cognitive development provided the foundation for the psychological theory of constructivism.

Constructivism ‘‘is the philosophy, or belief that learners create their own knowledge based on interactions with their environment including their interaction with other people’’ (Draper, 2002), and maintained by Alharbi (2014). The constructivists viewed learning as a search for meaning (Weeger and Pacis, 2012). According to Crotty (1998) the term constructivism refers to the epistemology considerations focusing exclusively on ‘the meaning-making activity of individual mind’. In this regard constructivism is used in this study as a theory to guide understanding of how Biology Teachers acquire effective skills in utilizing ICTs for teaching Biology in the Colleges of Education.

The justification for using these theories of learning is to provide basis for theoretical understanding on the ICTs Competency among Biology Teachers in the Colleges of Education in Kano State. The constructivists school of thought viewed learning as a search for meaning (Weeger and Pacis, 2012). Karagiorgi and Symeou (2005) asserts that ‘‘in a world of instant information, constructivism become a guiding theoretical foundation and additionally provide a theory of cognitive growth and learning that can be applied to several learning goals’’. Therefore, constructivist learning theory has been used to study the impact of ICTs in teaching-learning (Alharbi, 2014).

Constructivism has been proven effective in assisting teachers in meeting the challenge of improving student achievement (White-Clarks, DiCarlo and Gilchrist, 2008). Furthermore, constructivism involves developing the student as a learner through cooperative learning, experimentation and open-ended problems in which students learn on their own through the active participation with concepts and principles (Kearsley, 1994).

Another theoretical basis for this study is that constructivism continue to be relevant in today's world of ICTs in education and online education as well. The use of ICTs in teaching and online courses has slowly shifted the theoretical balance from behaviourism to constructivism

due to the increase use of educational technologies (Weegar and Pacis, 2012). They further added that instructors are often choose to utilize a combination of these two learning styles in an effort to best meet the teaching-learning styles for all students. Moreover, the current learning technique with the most support is more of blending the two theories, because they can be used in conjunction while utilizing ICTs. The constructivism has a point of view that is presently considered the more popular of the two theories in ‘education policies, education models and education practices focus on constructivism’ (Brown,2006).Teachers who utilize the constructivist theory of learning online can provide discovery learning as well as critical thinking activities through threaded discussions as well as problem based learning projects. These are activities that can be done asynchronously but can be a more powerful learning experience when done synchronously and collaboratively with other students and/or instructor. These types of activity require online instructors to understand the cyberworld in order for instruction to be effective (Weegar and Pacis, 2012).

Examples of constructivism can be found in a number of instructional designs. In an attempt to formulate a comprehensive adult learning theory Knowles (1973) developed a theory to address the needs of the adult learner. Knowles labeled the instructional design “andragogy”. Knowles' theory of andragogy is an attempt to develop a theory specifically for adult learning. Knowles emphasized that adults are self-directed and expect to take responsibility for decisions. Andragogy makes the following assumptions about the design of learning: (a) Adults need to know why they need to learn something; (b) Adults need to learn experientially; (c) Adults approach learning as problem-solving; and (d) Adults learn best when the topic is of immediate value. With the growing popularity of ICTs in online teaching-learning programmes, a growing emphasis on incorporating the constructivist approach, when implementing instructional technologies exists. Some examples of how to make this transition is to shift our focus from the

design of software packages (which act solely as storehouses of information) to an interactive problem-based environment in which the student is empowered to take charge of his or her own learning. The creation of these rich learning environments will include fully integrated courses complete with texts, reference sources, multimedia and communication (Shield, 2000).

The overall philosophy of these constructivist Piaget and Vygotsky on instructional design holds that learners impose meaning on the world, and so construct their own understanding based on their unique experiences. This coincides with ICTs competency among biology teachers in colleges of education, hence ICTs involves learning by practice as it gives opportunity to the teachers to develop these cognitive potentials leading to ICTs competency in teaching biology. To this end, if these theories of learning could be carefully selected and use they may enhanced teachers cognitive development towards optimal use of ICTs in their teaching practices.

## **2.3 Conceptual Framework**

### **2.3.1 Concept of ICT**

ICT which is the acronym for information and communication technology, it is defined as combination of computer, video, and telecommunication technologies as observed in the use of multimedia computers and networks and also services which are based on them (Van Damme, 2003). ICT also, refers to the use of computer based communications technology that serves as a network to find information. This includes computer hardware and software that can be used for teaching and learning and information resources (Goay and Wong, 2003). Blurton (2002) defined ICT as a diverse set of technological tools and resources used to communicate, create, disseminate, store and manage information. This technology includes computers, the internet, broadcasting technologies (radio and television) and telephone. However, Olubenga and Adebayo

(2010) also, defined ICT as collection, retrieval, use and storage and communicating information through the use of computers and microelectronic system.

According to Daniels (2002) ICTs have become within a very short time, one of the basic building blocks of modern society. Many countries now regard understanding ICT and mastering the basic skills and concepts of ICT as part of the core of education, alongside reading, writing and numeracy. However, there appears to be a misconception that ICTs generally refers to ‘computers and computing related activities’. This is fortunately not the case, although computers and their application play a significant role in modern information management, other technologies and/or systems also comprise of the phenomenon that is commonly regarded as ICTs. UNESCO (2002) report that information and communication technology (ICT) maybe regarded as the combination of ‘Informatics technology’ with other related technology, specifically communication technology.

Formerly, the term IT was used to mean ICT, the term which was synonymous with computer but as the passage of time, it covered other equipment created to enhance acquisition, storage and dissemination of information materials. Most of these equipments were initially confine to the vicinity of offices. Libraries in the course of time embraced the use of these equipments to carry out their day-to-day activities as usage was adapted to carry out some routine activities. Its functions does not end there. The current issue is the use of ICTs in the classroom by the teachers. This includes specifically the use of computers, Internet, telephone, digital camera, projector and many more. As the world continues to revolve around technology, teachers need to continue incorporating these new technologies into their teaching (Adeyinka, Adedeji, Toyobo, Adika and Adewuyi, 2007).

Informatics refers to the science dealing with the design, realization, evaluation, use and maintenance of information processing systems, including hardware, software, organizational

and human aspects, and the industrial, commercial, governmental and political implications of these. Informatics Technology on the other hand is defined as the technological applications (artifacts) of informatics in society (Olakulehin, 2007). He further stated that from a less technical viewpoint the term information and communication technology (ICT) refers to the range of technologies that are applied in the process of collecting, storing, editing, retrieving and transfer of information in various forms. The foregoing definition implies that a broad range of technological equipment such as computers, mobile telephones, MP3/MP4/WMA storage devices, file transfer protocols, satellites, World Wide Web and many more are used for information exchange among people for different purposes. These devices are capable of both synchronous and asynchronous communication formats, and the most advanced of these technological applications is the concept of multimedia, which refers to teaching and learning devices that include a combination of data manipulators e.g. video, CD ROMs, floppy disks etc which facilitates interactive communication between and among individuals. Given these descriptions of the components of ICTs, it should be clear why ICTs are considered a more robust and all-encompassing phenomenon than the popular narrowly held conception of mere application of computers in human activities. In view of Chen & Kee (2005) information and communication technologies are the backbone of the knowledge economy and in recent years have been recognized as an effective tool for promoting economic growth and sustainable development.

From the broad categorizations of the applications of ICTs defined above, the relevance of ICTs in education with specific reference to the professional development of teachers in Nigeria can be easily understood. (Hooker, Mwyeria and Verma, 2011) asserts that there are general ICT competencies, common to all users in education, regardless of the subject area. There are also specific competencies and skills which find expression more in specific subjects' areas and specialization of teachers and trainee-teachers. The general ICT competencies include

the general understanding of the basic building blocks of the computer systems, literacy in operating the computer and using the windows interface called windows explorer and other similar interfaces (e.g. Mackintosh or Apple). The understanding of word processing activity, usage of PowerPoint slides to enunciate aspects of their teaching activities, through to the application of basic features of spreadsheet packages or excel sheets and using facilities like Microsoft access to create databases for their students' records would comprise the general skills and abilities required of would-be teachers. This is the more popular view of what computer education portends in the existing teacher training process. Allteacher trainees are expected to have all these rudimentary skills in computerapplication irrespective of whether they specialize in the arts, sciences, or the social sciences.

They also, added that the specific ICT competency refers to the special skills a teacher trainee acquires in other to enhance the quality of the teaching and learning that takes place in the school. The special skills cannot be acquired without the general abilities, and the general abilities are not of much benefit if a teacher does not possess specific skills for applying ICTs in his teaching activities.

Olakulehin (2007) report that studies in ICT development in both developed and developing countries identify at least four broad approaches through which ICTs could be adopted for teacher training and professional development.

**Emerging → Applying → Infusing → Transforming**

Figure: 2.1 Model representing continuous series of approaches to ICT application for Teacher training and development.

The continuum model above indicates that the skills of teacher trainees flows from the emerging to the applying into the infusing and then culminates in the transforming processes of the educative activities which takes place in schools. The Emerging approach is the first stage of ICTs skills development in teachers, here the focus is on appreciation of technical functions,

components and general uses of ICTs, especially for education and training. This approach tends to be theoretical and the practical components involves the personal use of ICT such as the use of word processing to prepare worksheets, locating information on CD-ROMs or on the internet, or communicating with friends and family via e-mail. The emphasis here is on training of teachers in a range of tools and applications, and increasing teachers' awareness of the opportunities for applying ICT to their teaching in the future. The next level of the continuum model emphasizes the application of ICTs to teachers' subject areas.

In the applying approach, teachers use ICT for professional purposes, focusing on improving their subject teaching in order to enrich how they teach with a range of ICT applications. This approach often involves teachers in integrating ICT to teach specific subject skills and knowledge; beginning to change their methodology in the classroom; and using ICT to support their training and professional development. The infusing approach involves the inclusion of ICT in all aspects of teacher's professional lives in such ways as to improve student learning and the management of learning processes. The approach supports active and creative teachers who are able to stimulate and manage the learning of students, integrating a range of preferred learning styles and uses of ICT in achieving their goals. The infusing approach often involves teacher easily integrating different knowledge and skills from other subjects into project based curricula. Transforming teaching through ICTs involves teachers and other support staff in the school system regarding ICT as a natural part of everyday life of the system that they begin to look at the processes of teaching and learning in new ways. The emphasis changes from a teacher-centric to a learner-centric system where the teacher is seen as a 'guide by the side, rather than the sage on the stage', helping students as the facilitator of their learning experiences to construct new learning paradigms out of the various offerings that the school makes available to them. This shift in emphasis in learners needs also calls for new training needs on the part of

the teachers, where they would be imbued with such components of knowledge that prepares them to annex the potentials of ICTs in sourcing and disseminating information to their students.

### **2.3.2 ICT Tools and their Usage**

ICT is a term used to refer to technologies that are used in creating, accumulating, storing, editing and disseminating of information in various forms (Tinuoye and Adogbeji, 2013). ICT is also, described as a revolution that involves the use of computers, internet and other telecommunication technology in every aspect of human endeavor (Bandeke, 2006). These include internet access, electronic mail, CD-ROMs, telephone, online database, library services and fax machines (Nwosu and Ogbomo, 2012).

Reddi (2012) as cited in Tinuoye and adogbeji, (2013) group ICT use in education into two categories namely synchronous and asynchronous media or ICT.

1. Synchronous media require all participants to be together at the same time even though in different location. Examples of synchronous media are audio graphics, audio conferencing as in a telephone conference, broadcast radio and television, teleconferencing, computer conferencing such as chat and internet telephony.
2. Asynchronous media allow for participants in the learning process to be at different times and different places. Examples of asynchronous ICTs or media include audio and video tapes, CDs, e-mails, computer files transfers, virtual conferences, multimedia products, offline and web based learning formats.

Teleconferencing as one of the ICT tool which is used in both formal and non-formal teaching and learning contexts as it facilitate both teacher-learner and learner-learner discussions as well as to access experts and other resource persons remotely. It is also used in open and distance learning; teleconferencing is a useful tool for providing direct instruction and learner

support and minimizing learner isolation (Tinio, 2002). He also, noted that the Indira Gandhi National Open University in India combines the use of print, recorded audio and video, broadcast radio and television and audio conferencing technologies. In addition, Tinio (2002) further noted that ICT can expand access to education in the following ways:

- **Anytime, anywhere:** One significant feature of ICTs is their ability to transcend time and space. ICTs make possible asynchronous learning or learning characterized by a time lag between the delivery of instruction and its reception by learners. For example online course materials may be accessed 24 hours a day, 7 days a week. ICT-based educational delivery (for example educational programming broadcast over radio or television) also dispenses with the need for all learners and the instructor to be in one physical location. In addition, certain types of ICTs, such as teleconferencing technologies, enable instruction to be received simultaneously by multiple geographically dispersed learners (i.e synchronous learning).
- **Access to remote learning resources:** Teachers and learners no longer have to rely solely on printed books and other materials in physical media housed in libraries and available in limited quantities for their educational needs. However, with the arrival of the internet and the World Wide Web, a wealth of learning materials in almost every subject and in a variety of media can now be accessed from anywhere at any time of the day and by unlimited number of people. And this is particularly important for many schools in developing countries and even some in developed countries that have limited and outdated library resources. In the same vein, ICTs facilitate access to resource persons, mentors, experts, researchers, professionals, business leaders and peers all over the world.

- Improving the quality of education and training is critical issue, particularly at a time of educational expansion: Here ICT can enhance the quality of education in several ways, by increasing learner motivation and engagement, by facilitating the acquisition of basic skills and by enhancing teacher training (Haddad and Jurich, 2012). The ICT tools are also, transformational tools which when used appropriately can promote the shift to a learner centered environment.
- Motivation to learn: ICT tools such as videos, television and multimedia computer software that combine text, sound and colorful moving images can be used to provide challenging and authentic content that will engage the student in the learning process. Interactive radio likewise makes use of sound effects, songs, dramatization, comic skits and other performance conventions to compel the students to listen and become involved in the lesson being delivered.
- Enhancing teacher training: ICT tools have also been used to improve access to and the quality of teacher training. For example, in China large-scale radio and television-based teacher education has for many years been conducted by the China Central Radio and TV University, the Shanghai Radio and TV University and many other RTVUs in the country (Carnoy, et al, 2002).

However, Millea,*et al.*, (2005) classify the following as ICT tools that a teacher will encounter during teaching interaction with learners of all ages. These tools would guide your thinking, planning and future questions about if, how, why and when to use different forms of ICT tools in your teaching:

**a) Web-based Tools and Applications for Managing Teaching and Learning**

- 1) Learning Management Systems: This is internet based software that deploys, manages, tracks and reports on interaction between the learner and the content, the learner and instructor.

They enable student's registration, they track learner progress, they record test scores and indicate course completions. They also, allow the instructor to assess student performance.

- 2) Students Management Systems: This may include financial, timetabling, student records and reporting. It may also, enable parent to review their child's performance online.
- 3) Digital Student Report Card Systems: This is a digitized system for transmitting student information. It can also, encapsulate real examples of a student's work from an e-portfolio.
- 4) Plagiarism Detection Systems: It examines digital text and by comparing nature and frequency of particular word strings, it provides feedback to educator on the likelihood that a particular piece of work has been plagiarized.
- 5) Online Collaborative Work Spaces: Is an online communication tool that enables collaboration. For example Bulletin board, email discussion lists.
- 6) Virtual Classroom Software Systems: This particular device delivers an interactive learning environment to students with a computer and internet connection. The software also, presents the student with a screen consisting of an instructional area, bordered by items such as class location, message board and many more.
- 7) E- portfolio's: This is an electronic (or digital) portfolio-digital storage which enable an individual to maintain an ongoing record of their work, achievements, awards and assessments.

#### **b. Learning and Teaching Tools:**

- 1) Interactive Whiteboards: This is a whiteboard surface that displays digital files from a computer via a data projector. It may function as a standard whiteboard. However, both the teacher and students may write on it and then digitize the marked up material.s

- 2) Personal Communication: This is a digital communication, which enables individuals to talk to one person or more. For example web forums, internet relay chat, SMS (short messaging service) on mobile phones.

**c. Mobile Delivery Devices:**

- 1) Storage Devices: This device is used for transferring electronic work between various devices and physical locations and to backup work. For example USB memory sticks.
- 2) Personal Digital Entertainment Devices (PDEs) and MP3 players: This device enables user to download, store and play audio, photo and video files and in many cases to take part in interactive activities.
- 3) Personal Digital Assistants (PDAs), (Also known as Handheld Devices): PDAs and pocket PCs allow input of data via a mini keyboard or equivalent; they usually include a calendar, organizer functions, and basic software functions such as word processing, email, spreadsheets, data storage and wireless capacity.
- 4) Mobile Phones: The mobile phones allow communication via photos, videos as well as text messaging.
- 5) Laptops: Is a mobile computer that is operated with a battery away from power source. Newer versions are now wireless and can connect to the internet in wireless hotspots.
- 6) Tablet PCs: Is a small screen of about (12") laptop PC in which data may be directly entered on to the screen with a special pen.
- 7) Gaming Devices: This device consists of a gaming console (for example Game boy) and games or a content delivery method.
- 8) Assistive and Adaptive Technologies: This is a technology that supports students with disabilities, such as screen readers and virtual pencils.

#### **d. Content Delivery Techniques:**

- 1) Podcasts:Podcasting is a technique of publishing audio files via the internet and it allow users to subscribe to a feed to receive new files automatically.
- 2) Vodcasts:This is a video on demand which is said to be the same concept as podcasting but with video files.
- 3) Blogs:Is a web-based journal or log book. Logs are chronologically ordered web-posting by an author or group of authors. They may be personal, individual records, group collaborations or representative of an institution.
- 4) Wikis:A Wiki or wiki is a website (or other hypertext documents collection) that allows users to add content on an internet forum, but also allows anyone to edit the content. “Wiki” also, refers to collaborative software used to create such a website. For example Wikipedia (e-encyclopedia), Wiki books.
- 5) Voice over Internet Protocol (VoIP):This is a tool that enables transmission of voice across the internet. For example skype.
- 6) Digital TV:Digital Tv is similar to analogue Tv but has the capacity to deliver rich multimedia learning experiences. Also, it enables interactivity.

#### **e. Other Devices, Concepts and Technologies:**

- 1) Moblogs and Photoblogs:This is a combination of the words blog and mobile. It also, means the capacity to post items to a blog using a mobile phone or other mobile device.
- 2) Digital Cameras:Digital cameras are used to stored film digitally.
- 3) Scanners:They enable the digitization of analogue content. The digital items can then be manipulated by software on the computer and stored.

- 4) Swarming (also called “meet up”): Here, people with a common interest come together quickly to experience or participate in an event. Mobile devices are often used to generate swarms. They may be used for educational, political or social reasons. For example learning swarms where by students come together for a learning event.
- 5) Peer-to-Peer Networking and Technologies: This is a network that allows two or more computers to share their resources, such as hard drives, CD-ROMs drives and printers. Also, it enables students and teachers to share files locally and internationally.

## 2.4 ICTs Competency Model for Teacher Education

This ICTs competency framework provides a holistic model which applies to all subjects and defines areas of ICTs competency organized in four clusters of competency encircled by four supportive themes. The themes that bound the curriculum as a whole are described briefly below and followed by the descriptions of the four core competency. This initiative was collaborative development by Davis (1999), Society for Information Technology (2002), International Society for Technology in Education (2002) and UNESCO (2001).

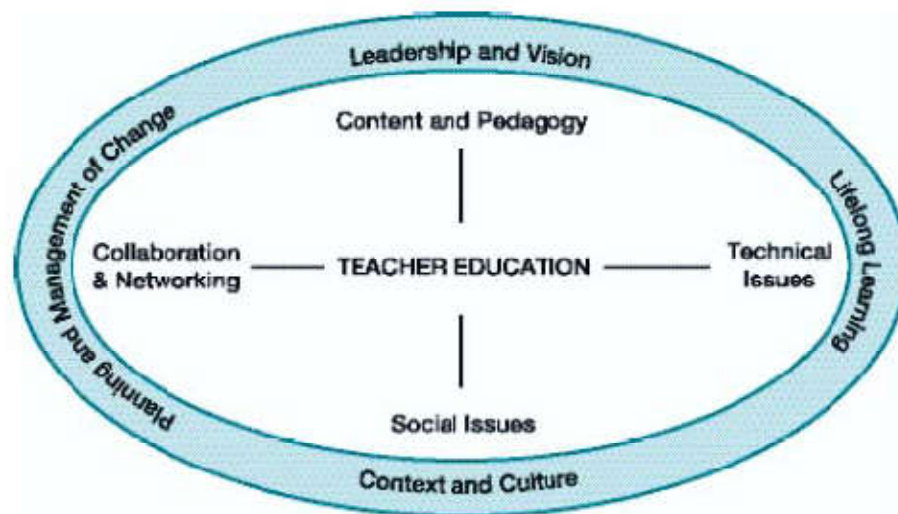


Fig:2.2 ICTs Competency Model for Teacher Education. Source Davis (1999).

**1. Context and Culture:** it identifies the culture and other contextual factors that must be considered in infusing technology into teacher education curriculum. It also, includes the use of technology in culturally appropriate ways and the development of respect for multiple cultures and contexts, which need to be taught and modelled by teachers.

**2. Leadership and Vision:** these are essential for the successful planning and implementation of technology into teacher education and require both leadership and support from the administration of the teacher education institutions.

**3. Lifelong Learning:** it acknowledges that learning does not stop after school. In common with the other themes, it is important that teachers and teacher preparation faculty model lifelong learning as a key part of implementation, and as an ongoing commitment to ICTs in teacher education.

**4. Planning and Management of Change:** is the final theme, born of today's context and accelerated by technology itself. It signifies the importance of careful planning and effective management of the change process.

These themes may be understood as a strategic combination of approaches that help teacher educators develop the four core competency. The core competency may be seen as clusters of objectives that are critical for successful use of ICTs as tools for teaching and learning:

(a) **Content and Pedagogy:** it focus on instructional practices of teachers and their knowledge of the curriculum. It requires that teachers apply ICT in their respective disciplines to support and extend teaching and learning.

(b) **Collaboration and networking:** this is communicative potential of ICT that extend learning beyond the classroom and necessitate the development of new knowledge and skills. The real power of ICT comes from new ways of communicating beyond the four walls of the classroom and by locating information from worldwide sources wherever these may be located. Through

collaboration and networking, professional teachers promote democratic learning within the classroom and draw upon expertise both locally and globally.

(c)**Social issues:**this implies that teachers can acquire an understanding of social issues,including the recognition and understanding of legal and moral codes such as copyright and intellectual property rights; participation in debates on the impact of ICT on society; and the use of ICT in the promotion of a healthy society. Awareness of such issues will lead to suitable application of ICT in pedagogy and development.

(d)**Technical issues:**includes technical proficiency and the provision of both technical infrastructure and technical support for ICTs competency throughout the curriculum.

Nevertheless, you should notice that there is a clear link between the model and practice of Vygotsky (1978), Piaget (1969), Brunner (1976) and Kolb (1984) and this will enable you as a teacher or instructor to develop and build a range of effective strategies to enhance your teaching practice and students learning by using ICTs creatively. The model will also assist policy makers, course developers, teacher educators and other professionals who are charged with developing the use of ICTs in teacher education.

## **2.5 Current Trends in Science Education**

The scientific world view is a lens through which blurry facts about the world come into sharp focus. It is not enough for us to have scientific content knowledge. As long as we remain unaware of the usefulness of scientific knowledge, how it can be critically examined, that knowledge is just a blur without value. By embracing scientific inquiry and committing ourselves to instituting our students with understanding of the role of science and the benefits that authentic scientific investigation can provide, we can hope to equip them for a future where they are empowered and able to explore and challenge what they see (Gaffney, 2005).

Science is a systematic enterprise that creates, builds and organizes knowledge in the form of testable explanations and predictions about the universe (Heilborn, 2003). However, contemporary science is typically sub-divided into the natural sciences which study the material world, whereas the social sciences study people and societies, and the formal sciences like mathematics. The formal sciences are often excluded as they do not depend on empirical observation (Editorial Staff, 2008a). Other disciplines which use science like engineering and medicine may also be considered to be applied sciences (David, 2007).

From classical antiquity through the 19<sup>th</sup> century, science as a type of knowledge was more closely linked to philosophy than it is now and in fact, in the west the term “natural philosophy” encompassed fields of study that are today associated with science such as physics, astronomy, medicine among many others (David, 2007). Furthermore, in the 17<sup>th</sup> and 18<sup>th</sup> centuries scientists increasingly sought to formulate knowledge in terms of laws of nature. Over the course of 19<sup>th</sup> century, the word “science” became increasingly associated with the scientific method itself, as a discipline way to study the natural world. It was in the 19<sup>th</sup> century that scientific disciplines such as physics, chemistry and biology reached their modern shapes. The same time period also, included the origin of the terms “scientist” and “scientific community”, the founding of scientific institutions and increasing significance of the interactions with society and other aspects of culture (Cahan, 2003).

Science in broad sense existed before the modern era and in many historical civilizations. (David, 2007). Modern science is distinct in its approach and successful in its results. However, modern science now defines what science is in the strictest sense of the term (Cohen, 2010). In addition, science in its original sense is a word for a type of knowledge, rather than a specialized word for the pursuit of such knowledge. In particular, science is one of the types of knowledge which people can communicate to each other and share. For example, knowledge about the

working of natural things was gathered long before recorded history and led to the development of complex abstract thinking. This shown by the construction of complex calenders techniques for making poisonous plants edible and building such as the pyramids (Heilborn, 2003).

Indeed science is important for our society, even if a society does not realize it. But few people would contest that science has brought many advances to society. Modern life could not be imagined without science, yet in every activity, in every field, science is present. Technology also is driven by science. Both science and technology have changed the shape of mankind. Science is important in communications, medicine, transportation, the automobile industry, in pharmacy and cosmetics, in computing. In fact science is everywhere. Unfortunately also, in the weapon industry. And very importantly science has a place in mankind cultural heritage; science is part of mankind's history. The economic impact of science in mankind history is indeed very important for society, and indeed science should appreciate it. Science should also show its economical aspect and as such there should be ways to measure both its cost to society and the economic benefits derived from the scientific activity. Although not often publicized, there have been numerous Ecometrics studies trying to describe the scientific activity in terms of standards economical parameters. Evidence from two studies which were carried out by the Committee on Economic Development and the Science Committee of the United States congress, conclude that the economic return of investment in science has been of the order of 30% per year, consistently over the last 50 years. This is to be compared with the return of investment in more traditional activities, which is of the order of 10% per year when the economy is in period of growth. In addition, the GPS navigation system is another importance of science. As such the GPS system would not be possible without both an understanding of the General Theory of Relativity and the discovery of Atomic Clocks. By the year 1995 the GPS market amounted to 2300 million and employed more than 100,000 people. Today these figures have skyrocketed. Astronomy is also a

science that is close to society, this has always been so from the very earliest times and is still so. However, astronomy will show students the importance of mathematics, physics, chemistry, geology, engineering or even biology and medicine (Rodriguez, 2007).

### **2.5.1 Biology as Discipline in Science**

Biology is a branch of science that deals with the study of living things. It studies any species that is considered to be alive, including minute bacteria that are made up of a single cell. Biology is also, a science which aims to discover how the systems of an organism work, how organism behaves in their environment, how species have evolved and how different ecosystems affect one another. Biology is important because it allows people to understand the diversity of life forms and their conservation and exploitation. Also through various biological discipline's, people obtain knowledge about living organisms, including the origin, growth, evolution, structure, distribution and function of these organisms. However, biology implies an essential responsibility for the welfare and protection of all living things. It studies all living things and how organisms interact in the biosphere. This is important because it enables people to know the behavior of and functions of each population that interacts with individuals from other populations or communities. Biology discovers also, how the specific aspect of the biosphere affects and benefit from the behaviors of particular population (Regina, 2014).

The 1910s saw important work in the biological sciences that often had both immediate and long-term consequences. Building on the base provided by the Austrian Botanist Gregor Mendel, who in the mid 19<sup>th</sup> century had shown that ‘‘ hereditary factors’’ in plants were passed on to their progeny in predictable ways. Thomas Hunt Morgan and his colleagues published the first chromosome map in 1911. The diagram identified the location of five sex-linked genes from the salivary glands of the fruit fly (*Drosophila*). However, Morgan found that the genes were arranged like beads on a necklace. In 1919 he also, published his physical basis of heredity and

by the decades end almost two thousands genes had been mapped, setting the stage for future advancement (Coleman, 1977).

Advances in microscopy also, had a profound impact on biological thinking. In the early 19<sup>th</sup> century, a number of biologist pointed to the central importance of the cell. Then in 1838, Schleiden and Schwann began promoting the now universal ideas that:

- The basic unit of organisms is the cell and
- that individual cells have all characteristics of life although, they opposed the idea that
- all cells come from the division of other cells.

Thanks to the work of Robert Remark and Rudolf Virchow, however, by the 1860s most biologist accepted all the three tenets of what come to be known as cell theory (Sapp, 2003).

The human genome project was the first step in aglobalized effort to incorporate accumulated knowledge of biology into a functional, molecular definition of the human body and the bodies of other organisms. The discovery of the physical representation of heredity come along with evolutionary principles and and population genetics. In the 1940s and early 1950s, experiment pointed to DNA as the component of chromosomes that held the trait carrying units that had become known as genes. A focus of on new kinds of model organisms such as viruses and bacteria along with the discovery of the double helical structure of DNA in 1953 by American Biologist James Watson and English Physicist Francis Crick, marked the transition to the era of molecular genetics. From the 1950s to present times, biology has been vastly extended in the molecular domain. Furthermore, the genetic code was cracked by HarGobind Khorana, Robert W. Holley and Marshall Warren Nirenberg after DNA was understood to contain codons. Finally, the Human Genome Project was lunched in 1990 with the goal of mapping the general human genome. This project was essentially completed in 2003 (Noble, 2003).

Biology studies the origin of diseases such as the etiology of cancer, infections, functional problems and finally designs treatments. Another importance of biology it affects the discovery and production of medicines, it is important for human reproduction because it explain the process and finds methods of resolving reproduction problems, biology also is essential for the development and enhancement of useful traits in the human species. It is important by selecting new agricultural breeds and plants that improve the nutritional value of food. Biology investigates the environmental factors that threaten human existence. Biology also, can aid in the prevention or cure of diseases and add tools for managing the environment. And biology can leads to knowledge that helps individuals to improve life and its quality ( Nahle, 2004).

The advent of Additive Manufacturing, otherwise known as three-dimensional 3D printing, is driving major innovations in modern biology and many areas such as engineering, manufacturing, art and medicine as recent advances have enabled 3D printing of biocompatible materials, cells and supporting components into complex 3D functional living tissues and organs suitable for transplantation. Compared with non-biological printing, 3D bioprinting involves additional complexities, such as the choice of materials, cell types, growth and differentiation factors and technical challenges related to the sensitivities of living cells and the construction of tissues. However, addressing these complexities requires the integration of technology from the fields of engineering, biomaterials science, cell biology, physics and medicine. In addition, 3D bioprinting has already been used for the generation and transplantation of several tissues, including multilayered skin, bone, vascular grafts, tracheal splints, heart tissues and cartiliganous structures. Other application of 3D printing include developing high-through put 3D-bioprinted tissue models for research, drug discovery and toxicology (Sean and Anthony, 2014).

In the same vien, 3D-bioprinting contribute to significant advances in the medical fields of tissue engineering by allowing for research to be done on innovative materials called

biomaterials. Biomaterials are the materials adapted and used for printing three-dimensional objects. Some of the notable bioengineered substances such as Alginate is an anionic polymer with many biomedical implications including feasibility, strong biocompatibility, low toxicity and stronger structural ability in comparison to some of the body's structural materials (Crawford, 2015).

Engineers are also, exploring other option such as printing micro channels that can maximize the diffusion of nutrients and oxygen from neighbouring tissues (Cooper, 2015). In addition, the Defense Threat Reductio Agency based in USA, aims to print mini organs such as heart, liver and lungs as the potential to test new drugs more accurately and perhaps eliminate the need for testing in animals (Cooper, 2015). Although, currently there are no distinct regulations for bioprinting, so researchers at academic institutions, research laboratories and private companies like Advance Solutions and Organovo which are testing pharmaceuticals and tissue assembly are experimenting with bioprinting until they are told otherwise (Lyndsey and Jason, 2015).

## **2.6 History of ICT**

The world and aspects that constitute life on earth have change since the beginning of time and will continue to change, with new forms emerging and old ones refashioned. New socio-cultural settings will continue to emerge as generations go by.

“Though evolution, according to biologists, archaeologists and anthropologists, characterized the history of life since millennia, there were also some relatively speaking rapid and striking forces that transformed cultural, economic, social and political conditions of human existence” (Bekele, 2004: 4). Also, as observed in the world today, these changes have and will

be dominated by the innovators or the early adopters of the change while those who are not informed or cannot immediately afford will embrace such changes too late.

One of these recent changes is the emergence of Information and Communication Technologies (ICTs), during the second half of the 20<sup>th</sup> century in which the computer and the internet are now being highly used to procure, process, store, communicate and apply information/knowledge. With the emergence of this information age the world has become a global village with global interconnectedness, with internal and international borders becoming bridges. Moreover, many societies in the developed as well as in the developing countries are using these devices to build up knowledge as a new weapon for rivalry and growth, for example fighting against poverty, access to education and health services, transformation and modernization of the economy, the government and the entire society (Hare, 2007).

However, the role of media in our time is especially large. The second half of 20<sup>th</sup> century is often called “media era”. Multimedia (including some ICT methods and tools) assist people during their free time as they are the main source of social information and communication, but also are good tools of learning and intellectual work of mankind. And let’s remember the saying “who has information has an authority”. (Or information is power!). It means that media are 4<sup>th</sup> kind of authority (the fourth estate) besides legislative, executive and judicial authorities.

The first time in history when visual media was used for teaching was introduced by J. A. Komesnski in the book “OrbisSensualiumPictus” (1658). In the USA the guide for teachers: “How to use slides in school teaching” was edited in 1906. Also in the 1950, Skinner developed programming teaching, but in Poland only “technical teaching aids” were introduced. In Germany “media pedagogics” started to play an important role in home and school education. And now we are living in the information society, where people use information tools mostly for

communication and international integration. Thus all societies have to have easy and fast access to the contemporary media (multimedia) to receive and create information.

In a report by EU, (2005) countries of the world such as Austria, Finland, Sweden, Denmark and UK teachers and students have a generally positive attitude towards e-learning and relatively advanced IT competences.

### **2.6.1 ICT in Africa**

The penetration rate of ICT in Africa is a good starting point for assessing the levels of supply and demand of information requirements. Africa is still behind the rest of the world in terms of ICT usage. This limits the opportunities to include the poor (Sciadas, 2005). And therefore negatively affects the democratic potential of ICT. The gap in terms of broad band subscriptions and internet usage between Africa and the rest of the world continues to leave Africa largely behind other regions. Indeed, in terms of the broad band divide, in 2010 in Africa 0.2 of every 100 inhabitants had a fixed broad band subscription, whilst in Europe and America the correlating numbers are respectively 23.9 and 15.5 (ICU, 2010). Also, in terms of the number of internet users, in 2010 in Africa 9.6 of every 100 inhabitants used the internet, where by in Europe and America respectively 65 and 55 did. (ICU, 2010). Added to this very low penetration rate, the financial burden is another obstacle to wider internet use. Indeed, even for the few segments of the population who can access the internet, their usage is constrained by the high costs of international bandwidth (Dobra, 2012).

The internet has become an available bridge for Africans to regroup and discuss social, political, cultural and economic issues facing them at home and abroad. However, the internet started in America with an initiative from president Dwight D. Eisenhower who saw the need for an Advance Research Projects Agency (ARPA) that would carter for America's computer

networking and communication in 1957 (Gromov, 1995, Mc Comic, 2002) cited in Langmia (2005). This computer networking and communication was used mainly by giant organizations like the military and the government. It was not until the early 1990s that the internet actually becomes commercialized. It then become a communication medium between persons. Computers all over the world could then be able to receive data and sounds from other computers stationed in other countries. And computer mediated communication (CMC) become very popular for interpersonal communication. It was now very possible for people to use the internet to send and receive e-mail messages. Thus, the internet helped tremendously in reducing mobility and making the world a global village (Langmia, 2005).

However, in June 2003, at the African submit of the world economic forum held in Durban, South Africa, the New Partnership for African Development (NEPAD) launched the e-schools, initiative, which was intended to equip all African high schools with ICT equipment's including computers, radio and television sets, phones and fax machines, communication equipment's, scanners, digital cameras and copiers among other things. This means that to connect African students to the internet and impart ICT skills to them in order harness ICT to improve, enrich and expand education in African countries (Aginam, 2006), as cited by (Apagu and Wakili, 2015).

### **2.6.2 ICT in Nigeria**

The pace of adoption of new IT has been very fast; it is markedly more rapid than that of earlier revolutionary technologies such as the steam engine or electric motor. But in Nigeria information is rather a recent phenomenon. Telecommunications which is the oldest element had a modest beginning with the first trunk telephone service between two towns in 1923 (Ofulue, 1980) as cited in Ogunsola and Aboyade (2005). It was not until the 1950s that substantial

expansion began with the introduction of VHF radio systems, 116 manual and five automatic telephone exchanges.

In 1984 a single profit oriented limited liability company called NITEL was established. Under the NITEL, the number of automatic switching centers in Nigeria grew to 227 in July 1986. Also, the national telex network grew to a total capacity of 12,800 lines with only one international exchange having 1500 trunks. By this time the transmission media for toll and trunks included terrestrial microwave, coaxial cable, and domestic satellite (Unchidiuno, 1986). But it must be realized that more attention was paid to communication with the outside world than the development and enhancement of the internal telecommunications system.

The Lanlate Satellite Earth Station, that is the Nigeria's first international satellite communication gateway, which has become operational in March 1971 with one antenna (Lanlate I) tracking the Indian Ocean INTELSTAT satellite. The second antenna called Lanlate II which was added in December 1975. And it operates with the Atlantic Ocean satellite. By the end of 1986 the two antennas provided a total of 417 circuits namely 248 in the Atlantic Ocean Region and 169 in the Indian Ocean Region. Another international earth station has been built at Kujama in Kaduna state with these facilities; most of Nigeria's external telecommunications, including telephone, telex, facsimile and television have been by satellite.

In the same vein, some organizations have ventured out for developing their own networks. The greatest achievements recorded were those of the Nigerian National Petroleum Corporation (NNPC), which in 1990 installed a digital communications network which was regarded as the largest in Africa. It is a hybrid network of fiber optic and coaxial cables. The turnkey system interconnects all the vital sites and offices of the NNPC, and provides facilities for automatic voice dialing, teleconferencing and transmission of data, facsimile and telex. Nevertheless, a truly national network is most desirable solution, but this is not yet insight.

Moreover, Nigeria had a late start in the use of computers, but a start has been made, the growth in use has been quite remarkable. Also, a tremendous response was given to the computer market by the growing interest in microcomputers in the past decade. And the computer installations are widely distributed in higher institutions, government departments and agencies, banks, commercial establishments and industries. It must be realized that the private sector has, however, risen to a position of dominance in the use of computers (Ogunsola and Aboyade, 2005).

Educationally, the availability of ICT resources plays a major role in provision of quality teaching and learning. It is known fact that an effective teaching and learning stimulate intellectual curiosity and offer a sense of enjoyment that will move the students from the passive role of recipient of information to active role of builder knowledge (Oki, 2007). In the same vein (Ezinwa and Azuka, 2004) observed that ICT have become a critical tool for professional training. The sooner learners know how to use ICT the easier they can find their way to capture the newest techniques of data acquisition and transformation of knowledge (FGN, 2004) Affirms that no educational system can rise above the quality of its teachers, and this is more critical at colleges of education where teachers who teach our students for life long are trained. Therefore, schools have to be equipped with necessary ICT in order to provide next generation with needed tools and resources for access and utilization.

ICT utilization in teaching and learning is becoming glaring vital owing to its effect in acquisition of knowledge and skills (Ngwu, 2014). Dawes (2001) is in the view of ICT has the potential to support education across the curriculum and provide opportunities for effective communication between teachers and students (OECD, 2001), underlined ICT use as a necessity for improving quality in teaching and learning. In line with this the Federal Government of Nigeria in partnership with Nigeria Communication Commission (NCC) has made effort to

provide laptops to all the teacher educators in Federal Colleges of Education in Nigeria. And this is in a bid to integrate the use of ICT facilities by teacher educators in teaching and learning in our school system.

The integration of ICTs can help revitalize teachers and students, this can help to improve and develop the quality of education by producing curricular support in difficult subject areas (Ngwu, 2014). In addition, the most critical factor in the successful integration of ICT into education is the extent to which teachers with required knowledge and skills to utilize ICT effectively (Ezinwa and Azuka, 2004). So to achieve these objectives, teacher educators need to be provided with the innovative materials such as the ICT resources (Oki, 2007). He also, maintained that the ICT resources that are needed for day to day functioning of the schools includes the old ICTs like radio, television, telephone and the new ICTs resources such as computers, satellite, the internet and wireless technology.

## **2.7 ICT Teacher Competency Standard Framework**

Hooker,*et al.*, (2011) they reported that various national and regional standard are being piloted through this initiative, the ICT-CFT developed by UNESCO. The standards represent a new teacher development paradigm, based on on a broad understanding of what teachers and learners need to know, do, and learn in a rapidly evolving knowledge society. These are:

### **1. United States of America: ISTE NETs for Teachers Achievement Rubric**

The International Society for Technology in Education (ISTE) have released National Educational Technology Standards (NETs) design for student teachers, administrators, technology facilitators and leaders in the United States. The NETs standards for Teachers Achievement define the fundamental concepts, knowledge, skills and attitudes that teachers require for applying technology in educational setting. The NETs six standard areas are

designed to be general enough to be customized to fit state, university or district guidelines and yet specific enough to define the scope of a particular component. In this regard, performance indicators for each standard provide specific outcomes to be measured when developing a set of assessment tools.

## **2. Australia: ICT Competency Framework for Teachers**

In 2002, the Department of Education, Science and Training published a proposal, *Raising the Standards: A proposal for the development of an ICT Competency Framework for Teachers*. The framework proposes five sets of standards for different ICT teacher development targets and entry points:

- Beginning Teachers with modest skills and experience in pedagogy and ICT use require ‘basic ICT standards’.
- Practicing Teachers who are beginning users of ICT range of pedagogy and experience but modest ICT competence require ‘basic standards’
- Practicing Teachers who are accomplished users of ICT require ICT standards which encourage teachers to develop professionally and support them to take on leadership and transformative and innovator roles.
- School Leaders require ICT standards to encourage and support their roles as effective leaders and managers, to foster appropriate role modeling and the development of a vision to support staff.
- Teacher Educators require ICT standard to inform their own practice as teachers and to provide effective role models for their students.

### **3. European Union (EU): Competency and Qualifications Framework (Etqf)**

The Teacher Competency and Qualifications Framework in the use of ICTs in Education (Etqf) are designed to help teachers identify their own ICT competencies and the degree to which they can integrate ICT in teaching and learning. It is based on the UNESCO ICT Competency Standards for Teachers and has integrated an “introductory” level to the continuum of approaches for integrating ICT in educational delivery.

### **4. Africa Region: Development of ICT –enhanced Teacher Standard for Africa**

The International Institute for Capacity Building in Africa (IICBA) has been conducting regional workshops since 2009 for the development of ICT-enhanced Teacher Standards for Africa that are focused on:

- Identifying teacher competencies applicable in the African context.
- Developing a framework of ICT-enhanced teacher standards for Africa
- Validating the developed framework at regional level

### **5. Global: UNESCO ICT-Competency Framework for Teachers**

The ICT Competency Framework for Teachers (ICT-CFT) were designed by UNESCO and launched in 2008 to help educational policy-makers and curriculum developers identify the skills teachers need to harness technology in the service of education. In addition, the competency standards were developed in cooperation with CISCO, Intel and Microsoft as well as the International Society for Technology in Education (ISTE).

However, the framework was created by crossing three approaches to ICT integration in education (Technology Literacy, Knowledge Deepening and Knowledge Creation) with six

components of educational system (Policy and Vision, Curriculum and Assessment, Pedagogy, ICT, Organisation and Administration and Teacher Professional Development).

### UNESCO ICT Competency Framework for Teachers Framework

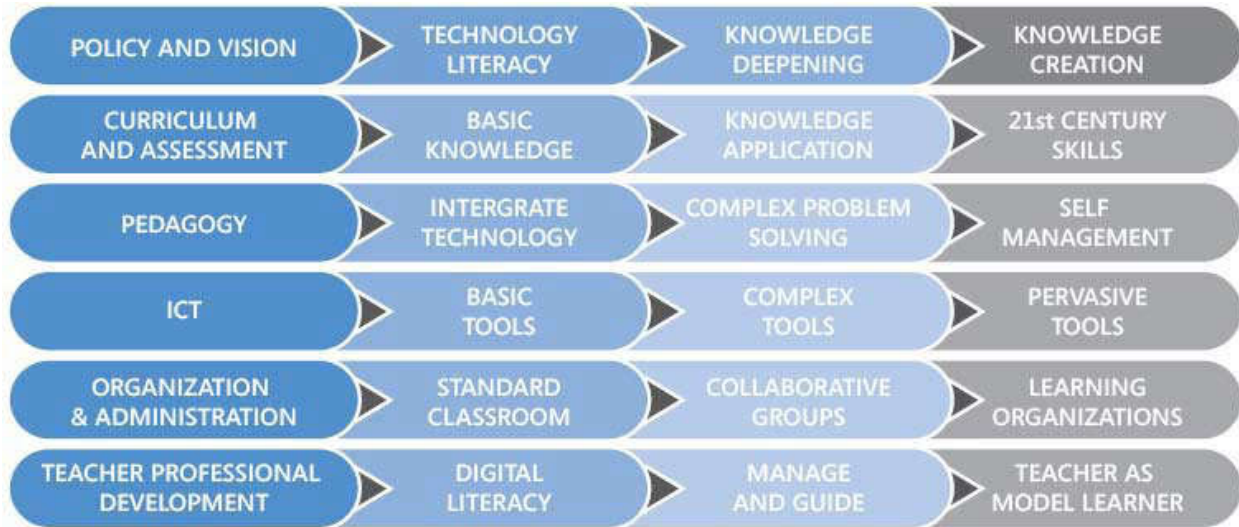


Figure: 2.3 Model representing UNESCO ICT Competency Framework for Teachers Framework

*Source: UNESCO 2008.*

### 2.8 National Policies on the Use of ICTs in Teaching and Learning in Nigeria

Nigeria started implementing its policy in April 2001 after the Federal Executive Council approved it by establishing the National Information Technology Department Agency (NITDA), the implementing body. The policy empowers NITDA to enter into strategic alliance and joint ventures and to collaborate with the private sector to realize the specifics of the country's vision of "making Nigeria an IT capable country in Africa and a key player in the information society by the year 2005 through using IT as an engine for sustainable development and global competitiveness". But this vision is yet to be fulfilled (Agyeman, 2007).

Below are some of the objectives of Nigeria's ICT policy as highlighted by Agyeman, (2007):

- To ensure that ICT resources are readily available to promote efficient national development.
- To guarantee that the country benefits maximally and contributes meaningfully, by providing the global solutions to the challenges of the Information.
- To empower Nigerians to participate in software and ICT development.
- To encourage local production and manufacture of ICT components in a competitive manner.
- To establish and develop ICT infrastructure and maximize its use nationwide.
- To empower the youth with ICT skills and prepare them for global competitiveness
- To integrate ICT into the mainstream of education and training.
- To create awareness and ensure universal access in promoting ICT diffusion in all sectors of national life.
- To create an enabling environment and facilitate private sector (national and multinational) investment in the ICT sector.
- To encourage government and private sector joint venture collaboration.
- To develop human capital with emphasis on creating and supporting a knowledge-based society.
- To build a mass pool of ICT literate manpower using the NYSC, NDE and other platforms as a train-the- trainer scheme for capacity building.

Nevertheless, Nigeria's education ministry is yet to design its ICT policy for education. The ministry's ICT department was created in February 2007. Also, several different initiatives by government agencies and the private sector to introduce and promote ICTs in education are underway. The drawback to these programs is the generally sporadic and insufficient supply of electric power in the urban areas (Agyeman, 2007).

However, in another policy over view, ICT in Nigeria is currently administered under three main policy documents. The National Mass Communication policy of 1990, the National Telecommunications Policy of 2000 and the National Policy for information Technology 2000. These documents, as well as other disparate ICT policies and government pronouncements, will potentially be consolidated in terms of new policy which is currently at the draft stage. The draft National ICT Policy of 2012, was released in January 2012 by the Ministry of Communication Technology (MCT). This draft National ICT Policy articulates the nation ICT objectives as a ‘‘knowledge-based globally competitiveness society’’ by 2020 (Ministerial Committee on ICT Policy Harmonization, 2012, p.12). Towards achievements of this objective, the draft policy provides for 16 policy focus areas, and ambitiously list 103 strategic actions which the government proposes to undertake. The 16 focus area includes infrastructure development, broad band access, spectrum management, regional collaboration, universal access, research, national security, software and hardware and local manufacturing. Also, according to the draft policy, these strategic actions would be carried out through an expanded ministry, responsible for ICT, which would become the coordinating ministry responsible for ICT development and oversight in Nigeria. In addition to this, there would be elimination of the current multiple regulatory bodies, and creation of converged regulator to oversee the entire ICT sector with the converged regulator under the direction of the expanded ministry. However, the draft National Policy is, thus, highly aspirational but at the same time, the document is not completely clear on how the government would implement all its high ambitions, and is silent on a number of important issues, including standards, open data, accessibility and competition. Also, there is a suggestion in the draft policy that the regulatory autonomy guaranteed for Nigerian Communication Commission (NCC) and to a lesser extent the National Broadcasting Commission (NBC) under the old institutional arrangements would if the draft policy is approved be limited or even abolished (Odufuwa, 2012).

### **2.8.1 ICT Integration and the Nigerian National Policy on Education**

Considering the influence of information technology in all sector of the society (Onasanya, et al, 2010), the government and other stakeholders of the education industry in Nigeria consider the integration of ICT in the nations education system at all levels of learning a necessity (FRN, 2004). This consideration was in recognition of:

- The prominent role of education as a viable instrument for the attainment of national development (FRN, 1998).
- The training and development of Nigerian youths into becoming responsible citizens, capable of contributing meaningfully to the socio-economic, political and the overall wellbeing of the society as adult (Okam, 2002).
- The training and development of required manpower as desired by the society to man and all sectors of the economy (Garba and Alademerin, 2014).

The government consideration for ICT integration in Nigerian educational practices is to empower and strengthen the competence of the education industry towards meeting up with these responsibilities (Yusuf, 2005). Particularly, that of producing ICT literate citizens that can effectively fit into the contemporary information technology has become an integral part of the society (Nwachukwu, 2006).

However, in pursuit of this consideration, the Federal Ministry of Education in conjunction with the National Educational Resource Center (NERC) working on government directive to introduces computer science as a core and compulsory subject in Nigerian primary and junior secondary schools. Computer labs were also built and equipped in most of the federal schools across the nation through Education Tax Fund (ETF) intervention program. In line with this, candidates with Nigeria Certificate in Education (NCE) and specialization in computer

science were recruited to teach the subject in primary schools while university graduate with B Ed; B Sc. Ed and B Sc. (computer science) were also, recruited to teach the subject in junior secondary schools (Garba and Alademerin, 2014).

Basic Computer knowledge was introduced into Polytechnics, Colleges of Education and Universities as a compulsory course unit for all students under the general studies department. The course is aimed at exposing students towards acquiring basic knowledge, skills and applications of word processing excel access and database management. Also, computer assisted instruction was introduced as a compulsory course unit in educational technology for all pre-service teachers in Nigerian Colleges of Education. Furthermore, certificate in computer appreciation of promotion in addition to publication for all serving academic staff in Polytechnics, Colleges of Education and Universities, and a compulsory requirement for all candidates seeking employment as academics in all institutions of higher learning. This paves way for series ICT standalone courses and workshops were organized and sponsored by both Federal and States Government respectively for teachers at all levels consistently since 1990s. Following these development, the government in 2004 come up with a revised edition of the National Policy on Education, in cooperating the integration of ICT in education as part of the policy. Also, the policy makes it compulsory for academic staff in all institutions of higher learning to integrate ICT in their pedagogical practices. Emphasis is particularly made on the integration of ICT in teacher education programs. The emphasis was to ensure that, pre-service teachers trained in Nigerian Universities and Colleges of Education acquire the contemporary skills and competence needed for teaching with technology in the present information. Consequently, this policy provides desktop computers for office use and laptops to academic staff in Federal Universities, Colleges of Education and Polytechnics in batches. However, additional computer labs, cable and wireless internet service as well as e-libraries were

provided for students use by the respective management of the institutions through Education Trust Fund (ETF) and Petroleum Trust Development Endowment Fund (PTDEF). Directives were also, given to private and state institutions to suites as requirement for accreditation (Garba and Alademerin, 2014).

Despite these resources and efforts, yet the level of technology integration in Nigerian Educational System at all levels is still very low (Abba, 2012).Ololubeet *al.*, (2007) as cited in (Ifeoma and Ndidi, 2010) noted that the ICT policy resource for Nigeria was provided for planning, research and evaluation purposes. The policy is aimed at addressing innovation, entrepreneurship, development, strategies and the digital divide in Nigeria. While ICT has much to offer, it has failed to deliver on these aims across Nigerian higher institutions. A lot of time and effort has been invested in developing the policy, and its implementation has not been impressive.

Furthermore, it is in the pursuance of the need to access international best practices that the Federal Government reviewed the National Policy on Education (1998) to the current one (NPE, 2004) to accommodate the introduction of ICT into the school system in keeping with the dynamics of social change and its demand on education. Also, colleges of education prepare teachers that feed the primary and secondary school levels of education in Nigeria with manpower demands. It is at this level that they should have their first encounter with technology in the classroom, and this they will put to use when eventually they leave school and are gainfully employed as teachers in the primary and secondary schools. Moreover it is in this light that the training of student teachers, who are expected to drive the new ICT in an advanced educational system, is brought afore. The advancement in which ICT resources offer in higher education, can be evident through accessibility to quality resource materials and instructional delivery. This can only be attained when it is drastically integrated into the instructional process

in the teacher education system. The productive instructional delivery enhances learner's creative and intellectual development through the use of ICT facilities, for example in the use of multimedia images, graphics, audio, text and motion for high quality learning (Jude and Dankaro, 2012).

## **2.9 The Use of ICTs in Teaching and Learning Biology**

Biology and all other sciences progress through a process of inquiry, rather than just building a body of factual information. Despite the apparent benefits of the use of ICT for educational purpose, studies showed that in many cases the learning potential of ICT is deprived as many teachers are still not fully ICT literate and do not use it in their teaching. Studies on teacher's readiness for ICT generally suggest that there is still a long way to go before schools in the region will be able to take full advantage of the opportunities provided by 21<sup>st</sup> century technology (Ya'acob *et al*, 2005; So and Paula, 2006). Barak (2006) also, reveals that while teachers exploit ICT for their own learning, they are cautious about integrating advanced technology in stimulating students learning and making school studies relevant to real-life contexts, they do not think that ICT is preferable for class-based instruction for promoting cooperation and reflection in learning.

However, a review of 219 studies on the use of technology in education consistently found that students in technology rich environment experienced positive effects on performance in all subject areas (Look, 2005). In particular, Becta (2003) pointed out that ICT provide fast and accurate feedback to students and speed up computations and graphing, thus freeing students to focus on strategies and interpretation. Barak (2004) also, pointed out that the use of ICTs in education would promote deep learning and allows schools to respond better to the varying needs of the students.

The last two decades have witnessed a worldwide proliferation of Information and Communication Technologies (ICTs) in the field of education (Zupanec, *et al*, 2014). ICT is not only a backbone of the information society, but also an important catalyst and a tool for inducing educational innovation that changes the learning style of students (Pelgrum, 2001). Also, a factor that determines educational innovation in general are said to be the teachers, as they are the users of ICT facilities for educational development, since technology does not have an educational value in itself, it becomes important when teachers apply it in the learning process (Tezci, 2009). In the same vein, various learning models that support ICT resources are widely used in advanced countries around the world such as Austria, Finland, Sweden, Denmark and UK (EU, 2005).

There are so many applications of ICT in teaching and learning science subjects such as Biology, Chemistry, Physics, Mathematics, Geography, and Agriculture depending on the knowledge of the user, however, Collis and Moonen as cited in Nguyen, Williams and Nguyen (2012) classify these applications in classroom teaching includes the learning resources, instructional organization of learning and communication. Also, the classification makes use of educational software, computer-based testing system, e-mail system, internet, telephone, radio and many more. One of such teaching model is Computer Assisted Instruction (CAI) which provides interactions among students and a teacher inform of text or in multimedia form and this includes photographs, videos, animations, speech and music. In addition, this model (CAI) involves questions posed by teachers to students and returned feedback simultaneously based on the students responses (Aina, 2013).

Therefore, the use of Computer Assisted Instruction (CAI) in the teaching of Biology involves computers which help students visualize objects that are difficult or impossible to view. For example computers can be used to display human anatomy that is the internal structure of

human and animal cells. However, software have already been developed which show actions of microorganisms such as viruses, bacteria and fungi and a lots more whereby if a teacher were to teach such part, a part from the danger poses to both the teacher's and student's health and these microorganisms cannot be well learnt without seen them in action. Also, a law is already promulgated in some part of the world like US, UK, Sweden and many more advanced countries of the world against killing animals for experimental purpose instead a model and computer animations could be used by both teachers and students for experiment in Biology. Many plants and animals and insects in entomology cannot be found here in Nigeria, yet they must be learnt by students, with ICT all these are available to students as if they are in real forms. The CAI tools, like the word processors, spreadsheets, and database, is used to collect, organize, analyze and transmit information between teachers and their students. CAI is also, used to facilitate communication among students and even beyond classroom experience to distant students and teachers (Aina, 2013).

In addition, Computer Assisted Learning (CAL), is another educational technique that uses computers as an environment in which learning occurs, strengthening the learning period and the students motivation and it can be useful also for students to improve their learning speeds. This educational technique (CAL) is formed by combining a computer technology and learning principles by one self (Hancer and Tuzeman, 2008). However, the research results of many authors around the world have confirmed that the CAL technique in teaching Biology contributes to its greater effectiveness (Cepniet *al*, 2006; Efe and Efe, 2011; Katircioglu and Kazanci, 2003; Yusuf and Afolabi, 2010) and greater motivation of the students (Ferrer, 2002, Kubiatio and Halakova, 2009; Mckinomet *al*, 2000; Yu, 2008) in comparison to traditional teaching.

Nevertheless, CAL teaching technique cannot be applied without a sufficient number of computers in the classroom, this is possible reason for its minimal and inadequate representation in Biology teaching and the teaching of other subjects is the poor technological equipping of our schools (Drakulic, *et al*, 2011).

### **2.9.1 TeachersSkills and Willingness of ICT Use in Teaching**

Skills and the willingness of teachers refer to have the Knowledge andskill of ICT and teachers who ready to use ICT in teaching and learning (Osman and Ahmed, 2003). To achieve a comprehensive teaching by using ICT, teachers need to be convinced of the importance and benefit of ICT use in teaching and learning. Indeed, teachers should be given adequate training to use ICT tools effectively and efficiently. Findings also, showed that teachers who have attended training courses in English and ICT were more efficient, capable at using computers and willing to implement the teaching of science in English compared to teachers who have no training (Saamad, 2003).

Cook and Finlayson (1999) indicated that the increased use of ICT in the community provided opportunities for students to gain experience that will encourage them in learning. They also added that if the use of ICT in teaching and learning produced favorable effects, teacher will be more confident of the education system in the future. In another study (Norzita, 2004) revealed that the minimum level of the skill of using computers and ICT amongst teachers in teaching and learning of science was high. However, (Sutherland *et al*, 2004) stated that ICT will enhance learning if teachers plan to incorporate them into learning activities carefully, in lesson but it will in turn, becomes useless without good plans. Therefore, students must be encouraged to understand the process involved. Becker (2001) suggests that teacher's expertise in ICT is an important factor in its successful use in lessons. Government has provided materials and facilities

such as laptops, LCDs, CDs, guide books, textbooks, reference books and activity books to help teachers in teaching. Therefore, teachers were encouraged to take advantages of ICT in teaching and learning in order to produce a big impact in education field (Romai Nor, 2003).

In the same vein, Lim (2005) found that the use of ICT in teaching and learning allows students to be active in finding information and build knowledge from information obtained by the chance to cross-link between knowledge of subjects without restricted by time and distance. Fun (1990) also, conducted a study on the attitudes of the form six students during computer-aided activities in Geography classes. The result of the study showed that students have positive attitudes towards the use of computer which was considered as an effective technique of teaching and learning pedagogy by students. Also, in view of Kubiak (2010), the results of student's attitudes toward ICT use in teaching and learning science such as Biology subject among high school students were based on statistical evaluation. Students seemed to be interested in using ICT in the science subjects. The same study also, concluded that ICT can enhance students learning in science from early age.

In another review, Myers and Halpin (2002) asserted that attitudes of both students and teachers towards ICT use were a major predictor of future classroom use. It therefore, appears that teachers and students attitudes may influence adoption of ICT in teaching and learning Biology. Use of ICTs such as computer technology and internet is intended to enable teachers to facilitate learning more effectively and enhance students understanding of concepts which are expected to translate in to expansion of knowledge and improved examination outcomes. Though, in a different study, the use of ICT in Biology has not produced desired outcomes in schools which offer computer studies in Rachuonyo South District of Kenya where average performance of student in K.C.S.E. Biology Examination dropped from 6.7 to 4.10 between

2007 and 2009 despite the adoption of the use of new ICTs such as computer technology and internet in 2005 (Omelloet *al*, 2013).

### **2.9.2 Teachers Gender and ICTs Use**

Gender issues have been put under serious consideration in all development initiatives in Nigeria. However, science education is one of such areas of development. Actually any nation that does not take education of her citizenry very serious will not experience any meaningful development (Okereke and Ugwegbulum, 2014). They further stated that gender can be seen as the society constructed responsibility attributes to males and females by the various societies. Obasi (2004) refers to gender as many social and cultural characteristics, qualities, behaviors and roles which different societies ascribed to males and females in the society.

Differences in gender and the use of ICTs have been reported in several studies. However, studies concerning teachers gender and ICTs use have cited female teachers low levels of computer use due to their limited technology access, skills and interest (Volman and Van Eck, 2001). Other research studies on gender differences and the use of ICTs revealed that male teachers used more ICTs in their teaching and learning processes than their female counterparts (Kay, 2006; Wozney, Venkatesh and Abrami, 2006). Similarly, Markauskatie (2006) investigated gender differences in self reported ICT experience and ICT literacy among first year graduate trainee teachers. The study revealed significant differences between males and females in technical ICT capabilities, situational and longitudinal sustainability. By the end of the study it was found that males score was the highest.

In another study conducted by Jamieson-Proctor, Burnett, Finger and Watson (2006) on teachers integration of ICTs in schools in Queensland State. The findings of the study revealed that out of the result from 929 teachers female teachers were found to be integrating technology

in their teaching less than the male teachers. But the situation was found to be different in Mid-Western US basic schools where by Breisser (2006) found that females self-perceptions about technology competence improved while males self-perceptions about technological dominance remained unchanged in lego-logic project. In the same vein, Adams (2002) revealed that females teachers applied ICTs more than the male teachers. Yukselturk and Bulut (2009) find out that gender gap has reduced over the past years, but presently a greater number of females than males have used internet and web 2.0 technologies.

On the contrary, some studies revealed that gender variable was not a predictor of ICTs integration into teaching (Norris, Sullivan, Poirot and Soloway, 2003). Furthermore, in a study conducted by Kay (2006), he found that male teachers had relatively higher levels of computer attitude and ability before computer implementation, but there was no difference between males and females regarding computer attitude and ability after the implementation of the technology. He also, claims that quality preparation on technology can help lessen gender inequalities.

### **2.9.3 Online Flat Forms for ICTs Utilization in Teaching and Learning**

One of the online flat forms developed for ICT utilization in the teaching and learning are Massive Open Online Courses (MOOC) which are online courses aimed at unlimited participation and open access via the web. MOOCs which was first introduced in 2008 and emerged as a popular mode of learning online in 2012 (Laura, 2014). In addition, to traditional course materials such as filmed lectures, readings and problem sets, MOOCs provide interactive user forums to support community interactions between students, professors and teaching assistants (TAs). Also, MOOCs are said to be the recent and widely research development in distance education (Bozkurt *et al*, 2015).

Before the Digital Age, distance learning appeared in the form of correspondence courses in the 1890s-1920s and later radio and television broadcast of courses and early forms of e-learning, the year 2000s saw changes in online or e-learning and distance education, with increasing online presence, open learning opportunities and the development of MOOCs (MOOC, 2015).

However, the first MOOCs emerged from the open educational resources (OER) movement. The term MOOC was coined in 2008 by Dave Cormier of the University of Prince Edward Island in response to a course called Connectivism and Connective Knowledge (also known as CCK08). The CCK08, which was led by Gorge Siemens of Athabasca University and Stephen Downes of the National Research Council, which was consisted of 25 tuition-paying students in Extended Education at the University of Manitoba, as well as over 2200 online students from the general public who paid nothing (Chris, 2013).

The course contents offered by MOOCs was available through RSS feeds and online students could participate through collaborative tools, which include blog posts, threaded discussions in Moodle and second life meeting (Stephen, 2008; Cormier, 2008; Cormier, 2013). These early MOOCs did not rely on posted resources, learning management system and video lectures; instead they are using structures that mix the learning management system with more open web resources (Ken, 2011). Also, MOOCs from private, non-profit institutions emphasized prominent faculty members and expanded existing distance learning offerings (for example Podcasts) into free and open online courses (The college of st.Scholastica, 2012).

Alongside the development these open courses, other E-learning flat forms emerged such as Khan Academy, peer-to-peer University (P2PU), Udemy and ALISON which are viewed as similar to MOOCs and work outside the University system or emphasize individual self-paced

lessons (Yuan, Li, and Powell, 2013; Ellis, 2013; David, 2012; Chronicle of Higher Education, 2013; Open Education for a global economy, 2013).

The emergence of MOOC providers, according to the New York Times (2012) became “the year of the MOOC” as several well financed providers, associated with top Universities emerged including Coursera, Udacity and edX (Laura, 2012; Lindsey, 2012). As of 2013, the range of students registered appears to be broad, diverse and non-traditional, but it was concentrated among English speaking rich countries. Also, by March 2013, Coursera alone had registered about 2.8 million learners (Waldrop and Mitchell, 2013). And by October 2013, Coursera enrollment continued to increase, surpassing 5 million, while edX had independently reached 1.3 million (Fowler and Geoffrey, 2013).

Furthermore, unlike traditional courses, MOOCs require additional skills, provided by videographers, instructional designers and IT specialist. In line with this, Georgia Tech professor Karen Head reports that 19 people work on their MOOCs and that more are needed (Karen, 2013).

MOOC flat forms have availability requirements similar to media or content sharing web sites, due to the large number of enrollees. Nevertheless, MOOCs typically use cloud computing and are specialized packages of educational software like Elicitus, IMC content studio and Lectora that are easy to use and support e-learning standards like SCORM and AICC. On the other part, MOOC’s students usually view the videos and other materials produced by the MOOC as the next form of the text book “MOOC is the new text book” according to David Finegold of Rutgers University (Young and Jeffrey, 2013). In the same vein, President Barak Obama has cited recent developments including the online learning innovations at Carnegie

Mellon University, Arizona State University and Georgia institute of technology as having the potential to reduce the rising costs of higher education (The White House, 2013).

## **2.10 ICT and Teacher Education in Nigeria**

Teacher education is the key to educational development in Nigeria. The teachers hold the key to National Transformation and Development, this implies that whatever the quality of education in Nigeria today is manifestation of the quality of its teachers, in support of this the Federal Republic of Nigeria (2014) says that no education system can rise above the quality of its teachers. Nigeria has made several attempts to improve the quality of education to meet international standard. And this goal cannot be achieved without adequate preparation of pre-service teachers especially in information and communication technology to meet the challenges of our contemporary time (FRN, 2004).

In terms of ICT and teacher development, the National Policy on Teacher Education (FME, 2007) developed a vision ‘to produce quality, highly skilled, knowledgeable and creative teachers based on explicit performance standards through pre-service and in-service programs to raise a generation of students who can compete globally’ (p.6). The goal is to ensure teachers are trained and recruited to teach world-class standards and continue to develop their competence over their entire career’ (p.6). ICT was identified as one of the conditions for the achievement of the goals, as ‘the training of teachers on strategies of collaboration, reflection on enforcement of ICT practices and action research’ (p.6) (Adeosun, 2010).

Also, in another review, Filani as cited in Aggarwal (2004) express his opinion that teacher education is all formal and informal activities and experiences that help to qualify a person to assume his responsibility as a member of the educational profession or discharge his responsibility more effectively. This definition assumes that teacher education is the purpose of

preparing person for teaching and other educational services and for contributing to their growth in competency for such services. Moreover, Salami (2011) assumes teacher education as a process of professional socialization to acquire the requisite knowledge and also the sense of occupational norms typical of a fully qualified practitioner. He equally said that it includes all forms of education at pre-service training. Nkwodimamah (2003) sees teacher education as the development of teacher for the achievement of education goals. Oyekan (2006) also, sees teacher education as the provision of professional education and specialized period for the preparation of individuals who intend to develop and nurture the young ones into responsible and productive citizens.

However, Federal Republic of Nigeria (2004) stated that teacher education is to be given continuously major emphasis in all educational planning and development since no education system may rise above the quality of its teachers. Based on that, the goals of teacher education include:

- To produce highly matured contentions and efficient classroom teachers for all levels of our educational system.
- To encourage further the spirit of enquiry and creativity in teachers.
- To help teachers to fit into social life of the community and the society at large and enhance their commitment to national goals.
- To provide teachers with the intellectual and professional background adequate for their assignment and make them adaptable to changing situations.
- To enhance teachers commitment to teaching profession.

Therefore, the Nigerian teacher education is meant to equip teachers with appropriate knowledge, skills and attitude to carry out their duties to the maximum level. Umar as cited in

Madumere- Obike and Osaat (2012) identifies two types of teacher education in Nigeria, these are pre-service and in-service, while the pre-service imply preparatory training which meant to initiate beginning teachers, whereas the in-service programs are design to sharpen and refresh the skills of currently serving teachers.

Furthermore, the age we are in is a computer age, if teachers would discharge their duties effectively, there is the need for them to become versatile in the knowledge and skill of ICT, presently, most of pre-service and in-service teachers are not well equipped with ICT knowledge and skills. Therefore there is the need to develop in the Nigerian teachers the ICT knowledge and skills needed for effective teaching in the present day Nigeria. Today's students have a global knowledge base and they deserve a teacher whose training and practice empowers him with the requisite ICT knowledge and skills. But unfortunately, a cursory look at the educational sector in Nigerian institutions particularly in teacher education programs is still a dream as no significant gain or impact in ICT has been recorded. This is evidenced in the absence of computers, projectors, interactive white boards and the other e-learning facilities in the classroom (Nwokeocha and Ezeahurukwe, 2012). However, according to Ede (2012: 174):

*“Surveys have revealed that thousands of teachers (in developed nations) begin their working day in front of a computer by sending e-mails and visiting websites, checking their day schedules updating their classroom materials and lecture notes, conferring with their colleagues via online chats and e-mailing lists. The survey of our local environment may not reveal similar work approach by our teachers who are still heavily glued to the traditional face-to-face mode of interacting with their learners”*

## 2.11 Factors Militating Against the Utilization of ICTs

The act of utilizing ICT in teaching and learning is a complex process and one may encounter a number of difficulties or problems. These difficulties are known as “barriers” (Schoepp, 2005). So, therefore, a barrier is defined as any condition that makes it difficult to make progress or to achieve an objective (Word Net, 1997 as cited in Schoepp, 2005, p. 2). The objective here is being analyzed in this study as successful ICT utilization in science education particularly Biology education.

Different categories have been used by many researchers and educators in order to classify these problems to teacher’s use of ICT in science classrooms. However, general studies have divided these problems or barriers in to two categories: Extrinsic and Intrinsic barriers. In addition, what they referred to extrinsic and intrinsic barriers differed. In one study, Ertmer (1999) referred to extrinsic barriers as first order and cited access, time, support, resources and training where by intrinsic barriers as second order and cited attitudes, beliefs, practices and resistance. In the same vein, Hendren (2000) as cited in Al-Alwani (2005) saw extrinsic barriers as pertaining to organization rather than individuals and intrinsic barriers are pertaining to teachers, administrators and individuals.

Nevertheless, another classification found in the literature is teacher- level barriers. Becta (2004) grouped these barriers according to whether they relate to the individual (i.e teacher-level barriers), such as lack of time, lack of confidence and resistance to change or to the institution (i.e school-level barriers) such as lack of effective training in solving technical problems and lack of access to resources. Similarly, Blanskatet *al.*, (2006) divided them in to micro level barriers, including those related to teacher’s attitudes and approach to ICT and meso level barriers, including those related to the institutional context. The latter added a third category called macro level (i.e system-level barriers), including those related to the wider educational

frame work. In another perspective view it presents these problems as pertaining two kinds of condition: material and non-material (Pelgrum, 2001). The material conditions may be the insufficient number of computers or copies of software and the non-material problems which include teacher's insufficient ICT knowledge and skills, the problem of integrating ICT in teaching and insufficient teacher time (Bingimlas, 2009).

However, this study is aimed at determining present and future problems that face science teachers in the course of teaching science subject such as Biology in their respective schools, therefore, this analysis focuses on the teacher-level and school-level barriers as follows:

### **A) Teacher Level-Barriers**

#### **1) Lack of Teacher Confidence:**

Several researches indicate that one barrier that prevents teachers from utilizing ICT in their teaching is lack of confidence (Bigimlas, 2009). Daves (2001) view this as a contextual factor which can act as a barrier. Becta (2004) added that much of the research proposes that this is a major problem to uptake of ICT by teachers in the classroom. However, in Becta's survey of practitioner (2004), the issue of lack of confidence was the area that attracted most responses from those that took part. Also, found in some studies the reasons for teacher's lack of confidence with the use of ICT. For example, Beggs (2000) stated with confidence that teachers "fear of failure" caused a lack of confidence. On the other hand, Balanskatet *al.*, (2006) found that limitations in teachers ICT knowledge makes them feel anxious about using ICT in the classroom and thus not confident to use it in their teaching.

Similarly, Becta (2004) concluded their study with the statement. " many teachers who do not consider themselves to be well skilled in using ICT feel anxious about using it in front of a class of students who perhaps know more than they do" (p.7). In addition, many of the teacher

respondents who identified their lack of confidence as a problem reported being particularly afraid of entering the classroom with limited knowledge in the area of ICT with their students knowing that this was the case.

Furthermore, it was argued that lack of confidence and experience with technology influence teachers motivation to use ICT in the classroom (Cox, Preston and Cox, 1999b; Osborne and Hennessy, 2003; Balanskat et al. 2006).

## 2 Lack of Teacher Competence:

Another problem which is directly related to teacher confidence is teacher's competence in utilizing ICT in to their teaching practice (Becta, 2004). In an Australian research, Newhouse (2000) found that many teachers lacked the knowledge (skills) to utilize computers and were not enthusiastic about the changes, integration and utilization of supplementary learning associated with bringing computers in to their day to day teaching practices. However, current researches have shown that the level of these problems differs from country to country. In the developing countries, research reported that teacher's lack of technological competence is a main problem to their acceptance and adoption of ICT (Pelgrum, 2001; Al-Oteani, 2002). For example, in Syria, teacher's lack of technological competence has been cited as the main problem (Almohaissin, 2006).

Also, Empirica (2006) produce a report on the use of ICT in European schools. The data used for the report came from the Head Teachers and classroom teachers. A survey was carried out in 27 countries, the findings of the study shows that teachers who do not use computers in classroom claim that "lack of skills" are a constraining factor preventing teachers from utilizing ICT during teaching. Another world wide survey conducted by Pelgrum (2001) of nationally representative samples of schools from 26 countries, found that teachers lack of knowledge and

skills is a serious problem in the utilization of ICT in both primary and secondary schools. Also, the results of a study conducted by Balanskat et al. (2006) have shown that ‘‘in Denmark many teachers still choose not to use ICT and media in teaching situations because of their lack of ICT skills rather than for pedagogical or didactics reasons’’ while in Netherlands teacher’s ICT knowledge and skills is [sic] not regarded any more as the main problem to ICT use’’ (p.50). Hence, lack of teacher competence may be one of the strong problems to the integration of technologies in to education; it may also be one of the factors involved in resistance to change (Bingimlas, 2009).

### 3 Resistance to Change and Negative Attitudes:

In view of many researches in to the problems of integration and utilization of ICTs in to education found that teacher’s attitudes and inherent resistance to change were significant problems (Cox et al. 1999a; Watson, 1999; Earle, 2002; Becta, 2004; Gomes, 2005; Schoepp, 2005).

Gomes (2005) from his analysis of questionnaires found that science teacher’s resistance to change concerning the utilization of new strategies is a problem to ICT integration in science subject teaching. At a broader level, Becta (2004) argued that resistance to change is an important barrier to teacher’s use of new technologies in education. In another review Watson (1999) also, argued that integrating the new technologies in to educational settings requires change and different teachers will handle this change differently. Also according him, considering different teachers attitudes to change is important because teacher’s beliefs influence what they do in classrooms. Becta (2004) claims that one key area of teachers attitudes towards the utilization of technologies is their understanding of how these technologies will benefit their teaching and student’s learning. On the other part, Schoepp’s study (2005) found

that, although teachers felt that there was more than enough technology available, they did not believe that they were being supported, guided or rewarded in the integration and utilization of technologies in to their teaching. Another study by Empirica (2006), teachers who are not using new technology such as computers in the classroom are still of the opinion that utilization of ICT has no benefits or unclear benefits.

Nevertheless, resistance to change seems not to be a problem itself, instead, it is an indication that something is wrong. In other words there are reasons why resistance to change occurs (Bingimlas, 2009). But in view of Earle (2002), the change from present level to a desired level of performance is facilitated by driving (encouraging) forces such as the power of new developments, rapid availability, creativity, internet access or ease of communication. While it is delayed by resisting (discouraging) forces such as lack of technical support, teacher expertise or time for planning. Cox *et al.*, (1999a) in their study found that teachers are unlikely to use new technologies in their teaching if they see no need to change their professional practice. They also, shared those teachers who resist change are not rejecting the need for change but they lack the necessary education in accepting the changes and are given insufficient long-term opportunities to make sense of the new technologies for themselves.

## **B) School-Level Barriers**

### 1) Lack of Time:

Recent studies have shown that many teachers have competence and confidence in utilizing computers and other ICTs related in the classroom, but they still make little use of technologies because they do not have enough time (Bingimlas,2009). A very important number of researchers identified time limitations and the difficulty in scheduling enough computer time

for their classes as a problem to teacher's utilization of ICT in their teaching (Al-Alwani, 2005; Becta,2004; Beggs, 2000; Schoepp, 2005; sicilia, 2005).

In view of Sicilia (2005), the most common challenge reported by all the teachers under study was the lack of time, they had to plan technology lessons, explore the different internet sites or look at various aspects of educational software. Becta's study (2004) found that the problem of lack of lack of time exists for teachers in many aspects of their work as it affects their ability to complete tasks, with some of the participant teachers' specifically stating which aspects of ICT requires more time. These include the time needed to locate internet advice, prepare lessons, explore and practice using the ICT, deal with technical problems and adequate training.

Similarly, recent studies by Al-Alwan (2005) shows that lack of time is an important factor affecting the application of new technologies in science education. He also, added that lack of time is a problem affecting the application of ICT in Saudi Arabia, because of busy schedules. In view of this he indicated that because Saudi teachers work from about 7:00am to 2:00pm and the average number of class sessions taught by science teachers is 18 periods per week, where by both teachers and students have a limited number of hours during the day to work utilizing ICTs in to respective science subjects. In another similar study, by Sicilia (2005) in Canada, concluded that teachers take much more time to design projects that include the use of new ICT than to prepare traditional lessons. The teachers interviewed by Sicilia (2005) commented that "the constraints of different class schedule [sic] contributed to the lack of time they spent together to work on planning classroom activities" (p.41). Therefore, in support of this finding, the most significant constraint on use quoted by 86-88% of primary and secondary teachers which was surveyed by Dillon, Osborne, Fairbrother and Kurina (2000) was lack of time (as cited in Osborne and Hennessy, 2003, p.37). Gomes (2005) concluded that one of the

main reasons that science teachers do not use ICT in their respective classroom is lack of the time necessary to accomplish plans.

## 2) Lack of Effective Training:

One of the most frequent problems referred to in the reviewed literature is lack of effective training (Albirini, 2006; Balanskat et al. 2006; Beggs, 2000; Ozen, 2007; Schoepp, 2005; Sicilia, 2005; Toprakci, 2006). One finding from Pelgrum's (2001) study was that there were not enough training opportunities for teachers in the utilization of ICTs in classroom environment. Similarly, Beggs (2000) found that one of the top three problems to teacher's use of ICTs in teaching students was the lack of training. However, recent research in Turkey found that the main problem with the implementation of new ICT in science was the insufficient amount of in-service training programs for science teachers (Ozden, 2007) and Toprakci (2006) concluded that limited teacher training in the use of ICT in Turkish schools is an obstacle.

Furthermore, in another review by Becta (2004), the issue of training is certainly complex because it is important to consider several components to ensure the effectiveness of the training. Also, Gomes (2005) relating to science education concluded that lack of training in digital literacy, lack of pedagogic and didactic training on how to use ICT in the classroom and lack of training concerning the utilization of technologies in science specific areas were obstacles to integrate new technologies in classroom practice. In addition, some of the Saudi Arabian studies reported similar reasons for failures in using educational technologies: the weakness of teacher training in the use of computers, the use of a "delivery" teaching style instead of investment in modern technology (Alhamad, Alotaibi, Motwaly and Zyadah, 2004), as well as the shortage of teachers who are qualified to use the technology confidently (Sager, 2002). Balanskat *et al.*, (2006) indicated that inappropriate teacher training is not helping

teachers to utilize ICT in their classrooms and in preparing lessons. They also, assert that this is because training programs do not focus on teachers pedagogical practices in relation to ICT but on the development of ICT skills.

Moreover, beside the need for pedagogical training according to Becta (2004), it is still necessary to train teachers in specific ICT skills. Schoepp (2005) claims that when new technologies need to be integrated in the classroom, teachers have to be trained in the use of these particular ICTs. In view of Newhouse (2002), some initial training is needed for teachers to develop appropriate skills, knowledge and attitudes regarding the effective use of computers to support learning by their students. In addition to this he argued that this requires continuing provision of professional development to maintain appropriate skills and knowledge.

However, when there are new tools and approaches to teaching, teacher training is essential (Osborne and Hennessy, 2003) if they are to integrate these into their teaching. Balanskatet *al.*, (2006), added that inadequate or appropriate training leads to teachers being neither sufficiently prepared nor sufficiently confident to carry out full integration of ICT in the classroom. Newhouse (2002) also, states that ‘‘teachers need not to only be computer literate but they also need to develop skills in integrating computer use in to their teaching and learning programs’’ (p.45).

Other problematic issues related to professional development in ICT are that training courses which are not differentiated to meet the specific learning needs of teachers and the sessions are not regularly updated (Balanskatet *al.*, 2006). Pre-service teacher education can also play a significant role in providing opportunities for practice with ICT before utilization in classroom teaching (Albirini, 2006). Additionally, lack of ICT focus in initial teacher education

is a barrier to teacher's use of what is available in the classroom during teaching (Becta, 2004), where training is effective, teachers may not be able to access ICT resources.

### 3) Lack of Accessibility:

Many research studies indicated that lack of access to ICT resources, including home access, is another complex problem that discourages teachers from utilizing new technologies in to education and particularly in to science education (Bingimlas, 2009). In Sicilia's study (2005) teacher's complained about how difficult it was to always have access to computers. The author also, gave reasons like "computers have to be booked in advance and the teacher would forget to do so, or they could not book them for several periods in a row when they wanted to work on several periods in a row when they wanted to work on several projects with the students" (p.50). In other words, a teacher would have no access to ICT materials, because most of these were shared with other teachers.

The inaccessibility of ICT is not always merely due to the non-availability of the hardware and software or other ICT materials within the school. It may also, be the result of one of a number of factors such as poor organization of resources, poor quality hardware, inappropriate software, or lack of personal access for teachers (Becta, 2004).

However, the problems related to the accessibility of ICT for teachers are wide spread and differ from one country to another (Bingimlas, 2009). In Empirica's (2006) European study found that lack of access is the largest problem and those different problems to utilize ICT in teaching were reported by teachers, for instance lack of computers and lack of adequate ICT materials. Similarly, Korte and Husing (2007, p.4) found that in European schools there are some infrastructure problems such as broadband access not yet being available. They concluded that one third of European schools still do not have broadband internet access. In another review

Toprakci (2006) found that low number of computers, oldness or slowness of ICT systems and scarcity of educational software in the schools were said to be the problems to the successful implementation of ICT in to science education in Turkish schools. Also, in another similar study, Al-Alwani (2005) found that having no access to the internet during the school day and lack of hardware were impeding ICTs integration in Saudi schools. In addition, a research on Syrian schools was one of the greatest impediments to ICTs integration in the classroom (Albirini, 2006).

Newhouse (2002) asserted that poor choices of hardware and software for classroom teaching are problems facing many teachers. Similarly, Cox *et al.*, (1999a) found that the majority of teachers agreed that insufficient ICT resources in the school and insufficient time to review software prevent teachers from utilizing ICT. Osborne and Hennessy (2003) concluded that the limitations on access to hardware and software resources influenced teacher's motivation to utilize ICT in the classroom.

#### 4) Lack of Technical Support:

In a study, Lewis (2003) find out that without both good technical supports in the classroom and whole-school resources, teachers cannot be expected to overcome the problems preventing them from utilizing ICT. Pelgrum (2001) found that, in view of primary and secondary teachers one of the top problems to ICT use in education was lack of technical assistance. It was also, found in Sicilia's study (2005) that technical problems were found to be a major problem for teachers. And these technical problems include waiting for websites to open, failing to connect to the internet, printers not printing, malfunctioning of computers and teachers having to work with old computers. In addition, "Technical problems impeded the smooth delivery of the lesson or the natural flow of the classroom activity" (Sicilia, 2005 p.45).

Becta's (2004) study reported "if there is a lack of technical support, maintenance will not be carried out regularly, resulting in a higher risk of technical breakdowns" (p.16). Also, many of the respondents to Becta's survey (2004) indicated that technical faults might discourage them from utilizing ICT in their teaching because of the fear of equipment breaking during lesson.

However, in science subject teaching such as Biology, several studies indicated that lack of technical support is a main problem in utilizing technologies (Bingimlas, 2009). In the same vein, Gomes (2005) find out ICT in science teaching such as Biology needs a technician and if one is not available the lack of technical support can be a problem. Toprakci (2006) found that the lack of technical support was one of two significant problems to the integration of ICT in science education in schools and might be considered "serious". In Saudi Arabia, science teachers would agree to introduce computers in to science teaching, except that they will encounter problems such as technical service or hardware problems (Almohaissin, 2006). But, Sicilia (2005) argued that whatever kind of technical support and access teaching staff have and whether they have twenty years of experience or are not experienced in the profession, technical problems generates barriers to the smooth delivery of science lessons by teachers. Although, lack of technical support can prevent teachers from successful utilization of ICT in their teaching profession. Nevertheless, recent researches indicate that in some countries (such as the UK, Netherlands, Latvia, Malta and the Czech Republic) schools have recognized the importance of technical support to assist teachers to use ICT in the classroom (Korte and Husing, 2007).

## 2.12 Review of Empirical Studies

This section reviewed several empirical studies related to the present study. The empirical studies reviewed revealed that most of the ICT facilities are not available in both affected colleges of education and other higher institutions and which consequently leads to low levels of ICTs competency among teachers in higher learning institution and colleges of education as well. This is because teachers could not access ICT facilities for instructional development (Jude and Dankaro, 2012), in addition this non-availability had made it impossible for lecturers to effectively utilize or implement ICTs resources in teaching and learning (Ngwu, 2014). The above mention clearly shows that ICTs competency among teachers in Colleges of Education and other Institutions of higher learning depends largely on the availability and utilization of ICTs facilities. Moreover, research findings from Newhouse (2000), Pelgrum (2001), Al-Oteani (2002), Becta (2004) and Almohaissin (2006) reported that teachers lack of technological competence has been cited as the main problem.

For instance, Ngwu (2014) conducted a study on “Assessment of availability and utilization of ICT resources in teaching in Federal College of Education Eha- Amufu in Enugu, Nigeria”. The study is aimed at assessing the availability of ICT resources and to determine the extent of use of the resources by teachers in teaching the pre-service teachers. The design of the study was a descriptive survey approach. The respondents were 117 teacher educators as they consists of 72 and 45 males and females teacher educators respectively. Random sampling was used for 120 lecturers from various departments of the college. Two instruments have been developed, the resource inventory and the teacher educators questionnaire so as to collect the data for the study. The data obtained from the study was analyzed using mean and percentage scores. Based on the result of the study, the following findings were established. The inventory list of ICT resources for teaching-learning process, indicated clearly that most of them are not

available and this non-availability had made it impossible for lecturers to effectively utilize or implement ICT resources in teaching and learning. It was also, found that the extent of utilization is still very low and so many factors are responsible for that, which include non-functional computer laboratories and required internet facilities. The study recommended that there should be provision of adequate fund for procurement and maintenance of ICT resources.

Adediran, Adeyanju and Tyokase (2012) conducted a study on ‘‘The utilization of information and communication technology in Nigerian colleges of education’’. The study examine the utilization of information and communication technology (ICT) in Nigerian colleges of education. The study also, investigated the level of use of ICT facilities in the colleges, the attitude of using facilities for teaching and learning. The laudable benefits of utilizing ICT and the challenges of using ICT in colleges of education. The population of the study compared of students and lecturers of the Federal College of Education Osiele, Abeokuta, Ogun State. Sample of 320 students and 40 lecturers were randomly selected from different schools in the College. A self designed questionnaire tagged ‘‘ICTs and Colleges of Education (ICTCOE)’’ was used to collect the data for the study. Data collected for the study were analyzed using frequency counts and percentage scores. The findings of the study revealed that ICT facilities were lacking in the Colleges of Education and students and lecturers were to be exposed to the use of ICT. However, the study revealed the benefits of utilizing ICT in Colleges of Education which include making teaching-learning more easier, assisting the outreach/distance learning programme, helping lecturers to be exposed to ICT compliance, improving quality of work by both the lecturers and the students. Moreover, irrespective of these laudable benefits, the study also, revealed some of the challenges facing ICT in the Colleges of Education as : epileptic power supply, lack of computer literate lecturers, high cost of purchasing computers in the colleges and lack of fund.

The study recommended that government should increase the funding of the education sector. There should also be steady training for teachers on computers and ICT skills acquisition.

Jude and Dankaro (2012) conducted a study on ICT Resources Utilization, Availability and Accessibility by Teacher Educators for Instructional Development in College of Katsina-Ala, Benue State, Nigeria. The study investigated the utilization of ICT in the instructional mix by teacher educators in College of Education Katsina-Ala, Benue State, Nigeria. A total of forty CEO Katsina-Ala teacher educators from five schools were randomly selected to form the sample size from a population of 287. The researchers adopted the Expost Facto research design and formulated two research questions to guide in the study. The researchers also, developed an instrument tagged ‘‘Information and Communication Technology Questionnaire (ICTRQ)’’, which was used for data collection. The reliability co-efficient obtained for the instrument was 0.71. the data was subjected for analysis using frequencies and percentages. The findings from the analysis revealed that ICT resources were not available and for that reason, teacher educators could not access them for instructional development purposes. The study recommended that the college authority should benefit teacher educators in the institution with ICT resources and sponsor them on training and re-training programmes to produced ICT complaint products.

In another study conducted by Amaechi and Josphine (2010) on ‘‘ Appraisal of the Availabilty and utilization of new Technological Resources for Science Curriculum Delivery in Nigerian Universities. The study investigated the availability and utilization of new technological resources for science curriculum delivery in Nigerian universities. A descriptive survey was used. The population comparised all science lecturers in four federal and five state-owned universities in south-east states of Nigeria. A sample of 78 science lecturers from federal and 62 from state universities was obtained. Stratified random sampling and census techniques were used to select the sample. A self designed questionnaire of 36 items was developed by the

researchers. The study was validated and reliability coefficient were computed. Three research questions and three hypothesis guided the study. Data obtained from the study were analyzed using means, standard deviation and t-test statistics of  $p < 0.05$ . Findings of the study showed that some new technological resources are available. On the other hand all the listed new technological resources were under-utilized.

However, in a study conducted by Amosun, Falade and Falade (2015) on ‘‘Information Communication Technology Knowledge and Attitude of Pre-service Social Studies Teachers in South-West, Nigeria. The study investigated the information communication technology’s (ICT) knowledge and attitude of pre-service social studies teachers in south-western, Nigeria. Descriptive survey design was employed for the study. One hundred and eighty six (186) National Certificate of Education (NCE) part two students were selected for the study. Simple random sampling and purposive sampling were adopted for the selection of sample size of the study. Two research questions were raised and answered in the study. Also, two self-designed instruments were used in the study which are Information Communication Technology Knowledge (ICTKT) and Information Communication Technology Attitude Scale (ICTAC). Findings of the study revealed that pre-service social studies teachers in south-west, Nigeria were poor in knowledge of ICT concepts. 95.7% of the pre-service social studies teachers scored below average in ICT knowledge test. The study also, revealed that the pre-service social studies teachers had positive attitude to ICT issues. However, on the basis of the findings of this study, it is recommended that courses on ICT should be integrated in to the NCE social studies syllabus.

All the above findings were made elsewhere but not in Kano State, for that the researcher was then set out to determine ICTs Competency among Biology Teachers in Colleges of Education in Kano State.

### 2.13 Implication of Literature Reviewed

The study has reviewed several literature on ICTs competency among teachers in both tertiary and secondary levels, the study also reviewed previous literature on availability and utilization of ICT facilities in teaching in Nigeria colleges of education. Findings from this literature revealed that benefits of utilizing ICTs in colleges of education and other tertiary institutions which include making teaching-learning more easier, assisting the distance learning programme, helping teachers to be exposed to ICT compliance, improving quality of work by both teachers and students. Also it has been revealed that non-availability of ICT facilities had made it difficult for teachers to effectively utilize or implement ICTs in both teaching and learning activities.

In a study conducted by Potyrala(2003) which also, supports that if ICTs are thoughtfully implemented has the potentials to profoundly influence teaching and learning in biology for the better and this will require competency and profound changes among biology teachers. Studies reported in the literature shows that the use of Information Communication tools such as e-mail, fax, computer and video conferencing have made it possible to overcomes barriers of space and time and opens new possibilities for learning.

Another implication of the literature interms of changes in the teaching strategy, instructional content, role of the teachers and context of the curricular are obvious as well as inevitable, for the fact that teaching through the application of ICTs has the advantage to enhance motivation among teachers,help to recall previous learning by the learners, provides new instructional stimuli, activating the learners responses, providing systematic and steady feedback, facilitating appropriate practice, sequencing learning appropriately and providing a viable source of information for enhanced teaching-learning processes (Adeyinka, *et al.*, 2007). In

addition teachers who uses ICTs for instructional strategy would be able to provides learners with desirable skills towards Information Technology tools in their entire way of life. Studies also, from the reviewed related literature have shown that this low level of competency among teachers in Colleges of Education is related to many factors hindering the effective utilization and integration of ICTs in teaching activities.

The study is unique when compared to other several researches that has been conducted by several researchers both in and out side Nigeria. Among its uniqueness is that the study was the first to be conducted in the Colleges of Education in Kano State, particularly on Biology Teachers, gender differences was also, examined by the researcher among Biology Teachers in the Colleges of Education in Kano State, Nevertheless, the present study is prepared to determine Information and Communication Teachnologies Competency among Biology Teachers in the Colleges of Education in Kano State, since none of these reviewed literature sought to find out ICTs competency among Biology Teachers in the Colleges of Education in kano state. The present study is therefore, aimed to fill this gap in literature so as to come up with relevant information in such area in Kano State.

## **CHAPTER THREE**

### **METHODOLOGY**

#### **3.1 Introduction**

This research work aims at finding out Information and Communication Technologies Competencies Among Biology Teachers and the extent to which ICT are being utilized by teachers in the colleges of education of Kano state. This chapter describes the methods, procedures and techniques used in the conduct of the study. In particular it discusses the research design, population and sample size of the study, sampling technique, data collection instrument, validity of the instrument, pilot testing and reliability of the instrument and data collection procedure.

#### **3.2 Research Design**

The research design chosen for this study is Descriptive Survey Research design. The design is suitable when gathering data from a relatively large number of cases at a particular time, as it involves collection of information by administering questionnaires to a sample of individuals that describes events, then organizes, tabulates and presents (Kothari, 2004). In addition, this design was preferred for this research because, information will be readily obtainable from subjects in their natural environment which concerns about their attitudes or beliefs on certain issues of the study in particular (Kamau, 2004) as cited in Joseph (2013).

### 3.3 Population and Sample Size of the Study

#### 3.3.1 Population of the study

The population is made up of all Biology teachers from Federal College of Education Technical Bichi, Federal College of Education Kano and Sa'adatu Rimi College of Education Kumbotso. The population comprises a number of 23 male teachers and a number of 20 female teachers, which gives a total number of 53 participants across the colleges.

**Table 3.1 Population of the study**

| COLLEGES                                       | MALES | FEMALES | TOTAL |
|--|-------|---------|-------|
| Federal College of Education Bichi (Technical) | 11    | 2       | 13    |
| Federal College of Education Kano              | 10    | 8       | 18    |
| Sa'adatu Rimi College of Education Kumbotso    | 12    | 10      | 22    |
| TOTAL  |       |         | 53    |

*Source: The Affected Colleges of Education (2015).*

#### 3.3.2 Sample Size

The researcher intended to use the entire population as the sample due to the nature of the design of the study (Survey). However, there are several approaches to determining the sample size, using a census for small population is one among them. This statement was supported when Israel (1992) noted that “ one approach is to use the entire population as the sample. A census is attractive for small populations (e.g., 100 or less). A census also, eliminates sampling error and provides data on all the individuals in the population. Nevertheless, this population is sufficient enough to make generalization of the entire population.

**Table 3.2 Sample Size**

| COLLEGES                                       | MALES | FEMALES | TOTAL |
|--|-------|---------|-------|
| Federal College of Education Bichi (Technical) | 11    | 2       | 13    |
| Federal College of Education Kano              | 10    | 8       | 18    |
| Sa'adatu Rimi College of Education Kumbotso    | 12    | 10      | 22    |
| TOTAL  |       |         | 53    |

*Source: The Affected Colleges of Education (2015).*

### **3.4 Data Collection Instrument**

An adapted Check List and Questionnaire tagged ‘‘ICT and Colleges of Education (ICTCOE)’’ from a study conducted by Adediran, Adeyanju and Tyokase (2012) was used for the collection of data in this study. The instrument is chosen because the research depends on participant responses.

The questionnaire is administered on the required population with the help of research assistants from both colleges. The research instruments were two as mentioned above. The first instrument was Check List (CL), which was used to determine ICT facilities available in the colleges of education with reference to the recommended ICT resources required in the minimum standards (NCCE, 2012).

The second instrument is a questionnaire of three parts, the first part contains personal data, the second part contains ten items in form of four points rating scales questions which is used to elicit information on ICTs Competency among Biology Teachers in the teaching of Biology. thus:

|                      |      |      |
|----------------------|------|------|
| Highly Competent     | (HC) | 4.00 |
| Competent            | (C)  | 3.00 |
| Moderately Competent | (MC) | 2.00 |
| Not Competent        | (NC) | 1.00 |

Finally, the third part of the questionnaire contains twenty items which is used to draw out information on other factors militating against the use of ICTs in the teaching of Biology, it is design on four point likert scale, thus:

|                   |      |      |
|-------------------|------|------|
| Strongly Agree    | (SA) | 4.00 |
| Agree             | (A)  | 3.00 |
| Disagree          | (D)  | 2.00 |
| Strongly Disagree | (SA) | 1.00 |

### **3.5 Validity and Reliabilty of the Instrument**

#### **3.5.1 Validity of the Instrument**

In order to validate and see whether the instrument is going to measure what is expected to measure, The face and content validity for the adapted instruments were established by two Senior Lecturers from Science and Technology Education Department of Bayero University, Kano. The science education Senior Lecturers were requested to critically examine and assess all the items of the instrument with reference to the following:

- a. is the content of the instrument correct, recent and appropriate to Biology Teachers standard?
- b. are the items clear, precise and of standard?
- c. what general criticisms and suggestions could you give to improve the instrument?

### **3.5.2 Pilot Testing Instrument (ICTCOE)**

The College of Education chosen for the pilot testing was not among the population of the study. Biology Teachers from this similar College of Education were identified and used for the pilot testing of the instrument (ICTCOE). The purpose of this pilot study was to determine the characteristics of the items present in the instrument which includes their difficulty, ambiguity if any as well as the reliability coefficient. Ten Biology Teachers participated in the pilot study were by the researcher with a help of research assistant administered the questionnaires to the affected respondents. The pilot study lasted for two weeks using test and retest technique so as ensure the reliability coefficient of the instrument is reliable for the study.

In addition, the result of the pilot study were used to:

- a. determine the number of weeks suitable for conducting the study.
- b. determine difficulties if any, in the activities set out for the respondents.
- c. assesses the clarity of the items of the ICTCOE.
- d. calculate the reliability coefficient of ICTCOE.

### **3.5.3 Reliability of the Instrument**

The reliability of the instrument was obtained through a pilot study. Ten Biology Teachers were engaged outside the study area from a similar College of Education in

JigawaState. The pilot study was carried out using test and retest technique with an interval of two weeks in order to establish the reliability of the instrument. The scores obtained was analyzed using Pearson Product Moment Correlation Co-efficient (PPMC), and yield the reliability co-efficient of 0.782, hence the instrument was statistically adjudge to be reliable and considered suitable for use.

### **3.6 Data Collection Procedure**

The reasearcher visited all the affected Colleges, there by administered the instruments to the affected respondents with the help of research assiatants, which was retrieved later for analysis, though it takes the researcher a period of more than two months to retrieve 50 instruments out of the total 53 having three mortality of the instruments.

### **3.7 Data Analysis Procedure**

The data collected from the study was analyzed using both mean scores and standard deviation while the two null hypotheses generated from the study were tested at 0.05 level of significance. Considering the four point rating scale used in the instrument, the decision rule used is a mean score cutoff point of 2.50. What it implies is that all items with a mean score of 2.50 and above is consider as Competent for items in part II,while in part III it is consider as Agreed. However, any score below 2.50 is regarded as Not Competent and Disagree respectively in both parts.

Mean scores and standard deviation were used to answer research questions 2-5, whearers research question 1 was answered using cumulative scores of frequencies and percentages from the Check list (CL) used in the study.

The two hypotheses generated from the study were tested at 0.05 level of significance using one-way Analysis of Variance (ANOVA) for the differences between Biology Teachers from Federal Colleges of Education and State College of Education in terms of ICTs Competency and t-test statistics for gender differences in ICTs Competency among Biology Teachers in the Colleges of Education respectively

## CHAPTER FOUR

### DATA PRESENTATION, ANALYSIS AND DISCUSSION

#### 4.1 Introduction

The presentation, analysis and results of the data collected and their discussion are presented in this chapter. The data collected in this work were analyzed using the Statistical Package for Social Science (SPSS) version 20, however, the level of significance adopted for rejecting or retaining the stated hypotheses was 0.05. In addition, the chapter also contains discussion of the results and summary of the findings from the results presented.

#### 4.2 Data Presentation and Analysis

The instruments used for the data collection were: Check list and an adapted questionnaire tagged 'ICT and Colleges of Education' (ICTCOE). The check list was used to answer research question 1 and the questionnaire was used to answer research question 2, 3, 4 and 5. In addition, two hypotheses were also generated. The hypotheses were tested using Analysis of Variance (ANOVA) statistical analysis and t-test respectively.

However, the results obtained from the data analysis are presented in tables 4.1 to 4.7 as well as the tested hypotheses generated from the study.

##### 4.2.1 Answering the Research Questions and Testing Hypotheses

**Research Question I:** To what extent are the ICTs facilities for the Teaching of Biology are provided in the Colleges Education in Kano State?

**Table 4.1 Check List for ICTs facilities available for Teaching Biology across the Colleges of Education in Kano State.**

| S/N | ITEM                              | ADEQUATE  |      | NOT ADEQUATE |      | NOT AVAILABLE |      | TOTAL     |     |
|-----|-----------------------------------|-----------|------|--------------|------|---------------|------|-----------|-----|
|     |                                   | Frequency | %    | Frequency    | %    | Frequency     | %    | Frequency | %   |
| 1.  | Computer laboratories             |           |      | 1            | 33.3 | 2             | 66.7 | 3         | 100 |
| 2.  | Internet facilities               |           |      | 3            | 100  |               |      |           |     |
| 3.  | E-mail services                   | 1         | 33.3 | 2            | 66.7 |               |      |           |     |
| 4.  | Satellite                         |           |      | 3            | 100  |               |      |           |     |
| 5.  | Telephone                         | 3         | 100  |              |      |               |      |           |     |
| 6.  | Motion picture                    |           |      | 3            | 100  |               |      |           |     |
| 7.  | Overhead projector                | 1         | 33.3 | 2            | 66.7 |               |      |           |     |
| 8.  | Interactive white board           | 2         | 66.7 | 1            | 33.3 |               |      |           |     |
| 9.  | Public address system             |           |      | 2            | 66.7 | 1             | 33.3 |           |     |
| 10. | Wireless technology               |           |      |              |      | 3             | 100  |           |     |
| 11. | Printer                           | 1         | 33.3 | 2            | 66.7 |               |      |           |     |
| 12. | Scanner                           | 1         | 33.3 | 2            | 66.7 |               |      |           |     |
| 13. | Projection screen                 | 1         | 33.3 | 2            | 66.7 |               |      |           |     |
| 14. | Television                        |           |      | 2            | 66.7 | 1             | 33.3 |           |     |
| 15. | LAN                               |           |      |              |      | 3             | 100  |           |     |
| 16. | Digital microscope                |           |      | 1            | 33.3 | 2             | 66.7 |           |     |
| 17. | Digital cameras                   |           |      |              |      | 3             | 100  |           |     |
| 18. | Tablets                           |           |      |              |      | 3             | 100  |           |     |
| 19. | Maintenance workshop              |           |      |              |      | 3             | 100  |           |     |
| 20. | Spare parts and accessories rooms |           |      | 1            | 33.3 | 2             | 66.7 |           |     |

Table 4.1 above shows the frequency scores and percentages % for the 20 items contained in the check list for ICT facilities available for teaching Biology across the colleges of education in Kano State. The result indicated that most of the ICTs facilities listed are not available, although two out of the items have high frequencies of 3 and 2 and they are item 5 (Telephone) and item 8 (Interactive white board) respectively, while the rest 18 items were on not adequate and not available.

**Research Question II:**What are the level of ICTs Competencies among Biology Teachers in the of Teaching of Biology in the Colleges of Education in Kano State?

**Table 4.2 Mean scores and Standard Deviation for Teacher Educators ICTs Competences in Teaching of Biology in the Colleges of Education in Kano State.**

| S/N | ITEMS  | N  | MEAN | STANDARD DEV. | DECISION      |
|-----|--|----|------|---------------|---------------|
| 1.  | Use of computer for lectures preparation                         | 50 | 2.72 | .834          | Competent     |
| 2.  | Use of Internet to prepare lectures                              | 50 | 2.60 | .782          | Competent     |
| 3.  | Use of Interactive white board for biology lectures delivery     | 50 | 2.76 | 1.080         | Competent     |
| 4.  | Use of digital microscope for practical classes                  | 50 | 2.16 | .997          | Not-Competent |
| 5.  | Use of Projectors for delivering lecture                         | 50 | 2.10 | .863          | Not-Competent |
| 6.  | Ability to provide course materials online for students          | 50 | 1.94 | .978          | Not-Competent |
| 7.  | Use of online based systems for students assignment              | 50 | 1.94 | 1.038         | Not-Competent |
| 8.  | Lecturers and students are capable of communicate through e-mail | 50 | 1.88 | .918          | Not-Competent |
| 9.  | Use of public address system for lectures delivery               | 50 | 2.00 | 1.069         | Not-Competent |
| 10. | Frequent use of power point for delivering lectures              | 50 | 2.00 | 1.107         | Not-Competent |

The result from Table 4.2 shows the mean scores and standard deviation for the ten item statements contained in the level of ICTs competency among biology teachers. However, each item contained in this has mean value below 2.50 with the exception of item 1 (Use of Computer for lectures preparation), 2 (Use of Internet to prepare lectures) and 3(Use of Interactive white board for biology lectures delivery) that has a mean scores of 2.72, 2.60 and 2.76 respectively which indicated Competent for the four point rating scale used for the study.

**Research Question III:**Is there any significant differences in ICTs Competency between Biology Teachers from Federal and State Colleges of Education in Kano State?

**Table 4.3 Mean scores and Standard Deviation for significant differences in ICTs Competency between Biology Teachers from Federal and State Colleges of Education in Kano State.**

| S/N | Colleges                                     | N  | Mean  | Std. Deviation |
|-----|--|----|-------|----------------|
| 1   | Sa'adatu Rimi College of Education, Kumbotso | 20 | 19.65 | 4.22           |
| 2   | F.C.E. (Technical) Bichi                     | 15 | 24.00 | 4.12           |
| 3   | F.C.E. Kano                                  | 15 | 23.50 | 6.96           |
|     | Total  | 50 | 22.10 | 5.45           |

The result from table 4.3 indicates that the mean scores of Biology Teachers from Federal College of Education (Technical) Bichi has the highest mean scores of 24.00 in favour of F.C.E Kano and Sa'adatu Rimi College of Education Kumbotso with low mean scores of 23.50 and 19.65 respectively. This clearly shows that differences exist between the Biology Teachers of the colleges of Education in terms of ICTs Competency. The aboved stated research question was also, tested by a corresponding null hypothesis  $H_{01}$  which stated that:

$H_{01}$ : There is no significant difference in ICTs Competency between Biology Teachers from Federal and State Colleges of Education in Kano State. The analysis of the

$H_{01}$  was subjected to one way Analysis of Variance (ANOVA) statistical analysis. The results are shown in Table 4.4.

**Table 4.4 Analysis of Variance (ANOVA) table for testing differences in ICTs Competency level of more than two groups.**

|                | <b>Sum of squares</b> | <b>Df</b> | <b>Mean square</b> | <b>F</b> | <b>P</b> | <b>Remark</b>            |
|----------------|-----------------------|-----------|--------------------|----------|----------|--------------------------|
| Between group. | 202.217               | 2         | 101.108            | 3.789    | .030     | Null hypothesis rejected |
| Within group.  | 1254.283              | 47        | 26.687             |          |          |                          |
| <b>Total</b>   | <b>1456.500</b>       | <b>49</b> |                    |          |          |                          |

The Table 4.4 shows statistically significant difference when P-value is 0.030 while level of significance is 0.05 (P 0.05) which means that the null hypothesis is rejected and concluded that there is significant difference between Biology Teachers from Federal and State Colleges of Education in Kano State.

**Research Question IV:** Is there any significant gender differences in ICTs Competency among Biology Teachers in the Colleges of Education in Kano State?

**Table 4.5 Mean scores and Standard Deviation for significance gender differences in ICTs Competency among Biology Teachers from Federal and State Colleges of Education in Kano State.**

| <b>Sex</b> | <b>N</b> | <b>Mean</b> | <b>Std. Deviation</b> |
|------------|----------|-------------|-----------------------|
| Male       | 27       | 22.11       | 4.37944               |
| Female     | 23       | 22.08       | 6.59830               |

As can be seen from table 4.5 male Biolgy teachers have the highest mean scores of 22.11 in favour of the female biology teachers with 22.08, this indicates that there is no significant gender difference in ICTs Competency among the Biology Teachers across the Colleges of Education in Kano State, and this is because the difference found is .3 which is very

insignificant, and therefore concluded that there is no significant gender difference. However, this research question answered above was tested by corresponding null  $H_{02}$  which stated that:

$H_{02}$ : There is no significance gender difference in the level of ICTs Competency among Biology Teachers in the Colleges of Education in Kano State.

**Table 4.6:** t-test analysis for gender differences in ICTs Competency level among Biology Teachers in the Collegess of Education in Kano State.

| Gender  | N  | Mean  | Std. Deviation | Df | T     | P     | Remark                   |
|---------|----|-------|----------------|----|-------|-------|--------------------------|
| Males   | 27 | 22.11 | 4.379          | 48 | 0.015 | 0.988 | Null hypothesis retained |
| Females | 23 | 22.08 | 6.598          |    |       |       |                          |

Table 4.7 indicates that there is no significant difference because the P-value (0.988) is greater than the critical value (Sig) which is (0.05), hence the above null hypothesis was retained whereby it is confirmed that there is no gender difference in ICTs Competency among Biology Teachers in the Colleges of Education in Kano State.

**Research Question V:**What other factors are militating against the use of ICTs Teaching of Biology in the Colleges of Education in Kano State?

**Table 4.7 Mean scores and Standard Deviation for other Factors Militating against the use of ICTs in the Teaching of Biology in the Colleges of Education in Kano State.**

| S/N | ITEMS   | N  | MEAN | STANDARD DEV. | DECISION |
|-----|---|----|------|---------------|----------|
| 11. | Lack of functional computer laboratory  | 50 | 2.86 | .990          | Agreed   |
| 12. | Time Constraint in using ICTs facilities  | 50 | 2.44 | .837          | Disagree |
| 13. | Insufficient computers peripherals<br>(Scanners, Printers)  | 50 | 3.76 | 4.269         | Agreed   |
| 14. | Problem of accessibility to existing hardware ( Computer projectors)  | 50 | 2.92 | .829          | Agreed   |
| 15. | lack of computer for teachers   | 50 | 2.54 | .973          | Agreed   |
| 16. | lack of skills in ICTs utilization  | 50 | 2.36 | .875          | Disagree |
| 17. | Lack of interest of teachers in ICTs utilization  | 50 | 2.16 | .976          | Disagree |
| 18. | Lack of professional development opportunities  | 50 | 2.34 | 1.042         | Disagree |
| 19. | Non-inclusion of ICTs programmes in teachers training curriculum affect its adoption in colleges of education | 50 | 2.60 | .990          | Agreed   |
| 20. | Poor Physical infrastructure of learning environment  | 50 | 2.78 | .932          | Agreed   |
| 21. | lack of adequate support services in material development and ICTs usage                                      | 50 | 2.72 | .834          | Agreed   |
| 22. | Financial resources for ICTs integration  | 50 | 3.08 | .752          | Agreed   |
| 23. | Erratic power supply  | 50 | 3.06 | .890          | Agreed   |
| 24. | High cost of ICTs facilities  | 50 | 2.94 | .793          | Agreed   |
| 25. | Lack students ICTs background   | 50 | 2.89 | .938          | Agreed   |
| 26. | lack of technology courses adequacy for teacher preparation   | 50 | 2.66 | .798          | Agreed   |
| 27. | Mismanagement of ICTs facilities  | 50 | 2.42 | .810          | Disagree |
| 28. | Fear of exposing too much information on the institution to the public  | 50 | 2.00 | .926          | Disagree |
| 29. | lack of motivation on ICTs usage  | 50 | 2.50 | .814          | Agreed   |
| 30. | Insecurity associated with the use of ICTs materials  | 50 | 2.20 | .912          | Disagree |

The results from Table 4.7 shows that out of the twenty item statements on the other factors that militate against the use of ICTs in the teaching of biology, six items were on the disagree rule with mean scores of 2.44, 2.36, 2.16, 2.34, 2.42, 2.00 and 2.20 and they are item

statements 12 (Time constraint in using ICT facilities), 16 (Lack of skills in ICTs utilization), 17 (Lack of interest of teachers in ICTs utilization), 18(Lack of professional development opportunities), 27(Mismanagement of ICT facilities), 28(Fear of exposing too much information on the institution to the public) and 30 (Insecurity associated with the use ICT materials) respectively while the rest 13 items were on the agree rule with highest mean score of 3.76 which is item statement 13 (Insufficient computer peripherals: scanners, printers).

### **4.3 Summary of Findings**

The summary of the research findings were briefly stated below:

1. Result from research question one indicated that most of the ICT facilities are not available.
2. Research question two shows that majority of the Biology Teachers lack Competency in utilizing ICT facilities in the teaching of biology.
3. Research question three revealed that Biology Teachers from the Federal College of Education(Technical) Bichi have significant difference in ICTs Competency in favour of other Colleges of Education in Kano State, also the result correspond with the result of tested  $H_{01}$  which shows statistically that there is significant difference between Biology Teachers from Federal and State Colleges of Education in Kano State interms of ICTs Competency
4. Research question four indicated that there is no significant gender difference in ICTs Competency among Biology Teachers in the Colleges of Education in Kano State, however the result corresponds with the result of tested  $H_{02}$  which confirmed that there is no significant gender difference in ICTs Competency among Biology Teachers in the Colleges of Education in Kano State.
5. Research question five revealed that there are many factors that militate against the effective use of ICT facilities in Colleges of Education in Kano State.

Therefore, from the above stated summary the analysis of the study indicated that availability and utilization of ICT facilities enhance ICTs Competency level among Biology Teachers in the Colleges of Education in Kano State.

#### **4.4 Discussion of the Result**

The purpose of the study is to determine Information and Communication Technologies (ICTs) Competency among Biology Teachers in the Colleges of Education in Kano State. To achieve this purpose, the researcher adapted an instrument namely (ICTCOE) and administered it to Biology Teachers across the Colleges of Education with the help of research assistance. The data generated from the administration of the instrument were in accordance with the demands of the research questions, hypotheses and the design of the study as reported in chapter three. The analysis of the data generated from the study was carried out using the Statistical Package for Social Science (SPSS) version 20. However, the discussion of the result and summary of the findings are reported as follows.

The result of the study indicated that most ICT facilities are not available such as computer laboratories, public address system, wireless technology, television, LAN, digital microscope, digital cameras, tablets, maintenance workshop, spare parts and accessories rooms. This is shown in table 4.1 which serve as a Check list showing the required ICT facilities specified by NCCE (2012) minimum standard for teaching and learning processes in Federal Colleges of Education in Nigeria by Federal Government and their partner Nigerian Communication Commission (NCC). The Check list clearly indicated that most of these ICT facilities are not available in the Colleges of Education in Kano State and this is in agreement with Ngwu (2014) where she clearly stated that most of them are not available and this non-availability had made it difficult for lecturers to effectively utilize or implement ICTs resources in the teaching and learning. The findings of Adediran, Adeyanju and Tyokase (2012) is in support of the present study where it revealed that ICT facilities were lacking in the Colleges of

Education. The research findings is also in agreement with the study of Jude and Dankaro (2012) who reported that ICT resources were not available and for that reason, teacher educators could not access them for instructional development purposes. In another findings by Tinuoye and Adogbeji (2013) is also in support of the present study, Tinuoye and Adogbeji found that in Nigeria, most of ICT facilities are not sufficient to education to learners and teachers, even where it exist there not sophisticated enough to stand the test of time like the ones acquired in developed countries.

The analysis of the mean scores and standard deviation in table 4.2 indicated that, Biology teachers across the Colleges of Education have competency on item 1 (Use of computer for lectures preparation), 2 (Use of internet to prepare lectures) and 3 (Use of interactive white board for biology lectures delivery) with mean scores of 2.72, 2.60 and 2.76 respectively. This clearly shows that the extent of utilization of ICT facilities in teaching biology by the teacher educators in Colleges of Education in Kano State is at very low extent which indicates non-competency level. This findings is in support of Ngwu (2014) where she stated that the extent of utilization of ICT resources in teaching-learning activities by teacher-educators in F.C.E. Eha-Amufu is still at very low extent and this calls for urgent attention and assistance to intensify the utilization of ICTs in teaching-learning processes for pre-service teachers in the college so as to be able to compete favorably with their counterpart, as the education system is turning in to ICT based system. Inaddition, this findings conforms with the assertions of Agbatogun (2006) where he reported that not much of digital technologies are used in pedagogical practices by teacher educators in Nigerian Colleges of Education and other institutions of learning, this is because most institutions do not have the necessary ICT facilities for instructions and research neither do teacher educators possess the need skills and competence for effective integration of ICTs in classroom instructions. The research findings is also, in conformity with those of Newhouse

(2000), Pelgrum (2001), AL-Oteani (2002), Becta (2004) and Almohaissin (2006) who reported that teacher's lack of technological competence has been cited as the main problem.

Is there any significant differences in ICTs Competency between Biology teachers from Federal and State Colleges of Education in Kano State? The above stated research question was tested by corresponding null hypothesis one which stated that there is no significant difference in ICTs Competency between Biology Teachers from Federal and State Colleges of Education in Kano State. The analysis of mean scores and standard deviation from table 4.3 clearly indicated that Biology Teachers from Federal College of Education (Technical) Bichi has a high mean scores of 24.00 which shows that they have significance difference in ICTs Competency in favour of Biology Teachers from F.C.E. Kano with mean scores of 23.50 and Sa'adatu Rimi College of Education Kumbotso with low mean scores of 19.65, this correspond with the result of tested  $H_{01}$  from table 4.4 which shows statistically that there is significance difference when the P-value (0.03) is less than the level of significance (0.05). Therefore, the null hypothesis is rejected and concluded that there is significant difference in ICTs Competency between Biology Teachers from Federal and State Colleges of Education in Kano State.

Is there any significant gender differences in ICTs Competency among Biology Teachers in the Colleges of Education in Kano State? This research question was tested by corresponding  $H_{02}$  which stated that there is no significance gender difference in the level of ICTs Competency among Biology Teachers in the Colleges of Education in Kano State. From the analysis of mean scores and standard deviation for gender differences in ICTs Competency among Biology teachers in table 4.5 it indicated that the male biology teachers has a higher mean scores of 22.11 in favour of the female biology teachers with a low mean scores of 22.08 and this result shows that there is no significant gender difference among Biology Teachers in the Colleges of Education in Kano State, this is because the difference of .3 is very insignificant and the study is looking for any significant difference, hence, it was concluded that there is no

significant gender differences. The result also, correspond with the result of the t-test analysis for gender difference in ICTs Competency level among Biology Teachers in the Colleges of Education in Kano State from table 4.6 which revealed that there is no significant gender difference, this is because from the result it shows that P-value (0.988) is greater than the Critical value (sig) which is (0.05), hence the null hypothesis was retained whereby confirmed that there is no significant gender difference in ICTs Competency among Biology Teachers in the Colleges of Education in Kano State.

However, the above findings are in conformity with that of (Norris, Sullivan, Poirot and Solway, 2003) who stated that gender variables was not a predictor of ICT integration into teaching. Similarly, the findings of the present study correspond with that of Kay (2006) where he reported that male teachers had relatively higher levels of computer attitude and ability before computer implementation, but there was no difference between males and females regarding computer attitude and ability after the implementation of the technology. He also, claims that quality preparation on technology can help lessen gender inequalities. On the other part, this finding is in contrary with that of Volman and Van Eck (2001) who reported that teachers gender and ICT use have cited female teachers low levels of computer use due to their limited technology access skills and interest. In another findings which is contrary to this findings by (Kay, 2006; Wozneyet al. 2006) they revealed that male teachers used more ICTs in their teaching and learning processes than their female counterparts.

The analysis of mean scores and standard deviation for factors militating against the use of ICTs in the teaching of Biology in the Colleges of Education in Kano State revealed that out of the twenty items listed in the table 4.7, six items were on the disagree rule with mean scores of 2.44, 2.36, 2.16, 2.34, 2.42, 2.00 and 2.20 and they are item statements 12 (Time constraint in using ICT facilities), 16 (Lack of skills in ICTs utilization), 17 (Lack of interest of teachers in ICTs utilization), 18 (Lack of professional development opportunities), 27(Mismanagement of

ICT facilities), 28(Fear of exposing too much information on the institution to the public) and 30 (Insecurity associated with the use ICT materials) respectively. While the rest items were on the agree rule with highest mean score of 3.76 which is item statement 13 with statement(Insufficient Computer Peripherals: scanners, printers). Therefore, this clearly shows that there are many factors that militate against the effective use of ICTs in Teaching Biology in the Colleges of Education in Kano State.

## CHAPTER FIVE

### SUMMARY, CONCLUSIONS AND RECOMMENDATION

#### 5.1 Introduction

The purpose of this chapter is to summarize and conclude the research work. It further outlines the contribution of the study to the existing body of knowledge, limitations of the study and recommendations offered by the researcher.

#### 5.2 Summary

The present study determined the Information and Communication Technologies Competencies among Biology Teachers in the Colleges of Education in Kano State. The population comprised a total of 50 Biology Teachers across the Colleges of Education in Kano State. Two instruments were used to collect relevant data, these are Check list (CL) and a Questionnaire (ICTCOE) of 30 item multiple choice with a reliability index of 0.782 which was established using Statistical Package of Social Science (SPSS) Version 20.

The data generated from the administration of the two instruments used in the study were analyzed in accordance with the demands of the research questions, the null hypotheses formulated to guide the study and the design of the study as earlier reported in chapter three. The data analysis of the study was carried out using Statistical Package for Social Sciences (SPSS) version 20. The discussion of the results and summary of the findings were reported accordingly. However, the analysis of the results indicated that most of the ICT facilities are not available in the Colleges of Education in Kano State, majority of the biology teachers lacks ICTs Competency in the Teaching of Biology, Biology teachers from F.C.E (Technical) Bichi have significant difference in ICTs Competency in favour of F.C.E. Kano and Sa'adatu Rimi College of Education Kumbotso. The result also, revealed that there is no significant gender difference in ICTs Competency among Biology Teachers in Colleges of Education in Kano State. In addition

to the findings of the study, it was found that there are a lot of factors hindering the use of ICTs in Colleges of Education in Kano State.

### **5.3 Conclusion**

Based on the findings of this study, the following conclusion are drawn:

1. Most of the ICT facilities are not available in the Colleges of Education particularly in the Biology Departments.
2. The findings of this study has shown that Biology Teachers in Colleges of Education in Kano State are not moving towards the trends of utilizing ICTs in their teaching practices, as their ability in ICTs utilization is very low.
3. There is significant difference in ICTs Competency between Biology Teachers from Federal and State Colleges of Education in Kano State. This testified that some Biology Teachers apply ICTs in their Teaching.
4. Thereis no significant gender differences in ICTs Competency level among Biology Teachers based on the analysis and results for both mean scores and t-test.
5. Despite the benefits of using ICTs to teach biology, there are a lots of factors hindering the use of ICTs in the Colleges of Education in Kano State.

### **5.4 Contribution to Knowledge**

It was observed that the study had contributed to knowledge in the following ways:

1. The study established that the non-availabiltiy of ICT facilities in Colleges had made it difficult for Biology Teachers to effectively utilize or integrate ICTfacilities in their teaching practices.
2. The study established that Biology Teacher's abilities in ICTs Competency are very low across the Colleges of Education in Kano State.
3. The study also, established that there is significant difference in ICTs Competency among Biology Teachers in the Colleges of Education in Kano State.

4. Moreover, the study has added to the existing literature on ICT competency so as to encourage effective ICTs utilization among Biology Teachers in the Colleges of Education.

### **5.5 Limitation of the study**

The study has some limitation which include the following:

1. The restriction of the study to only Biology Teachers in the Colleges of Education in Kano State made the scope of the generalizations that can be made from the study fairly narrow.
2. Only 50 Biology Teachers were involved in the study. It may be possible to obtained different result if larger number of subjects were used.

### **5.6. Recommendations from the Study**

On the basis of the findings and conclusion reached, the following recommendations were made:

1. The use of ICTs in the teaching of Biology should be encouraged in such a way that Biology teachers integrate ICTs effectively in their day to day teaching activities. Therefore government and stakeholders should provide adequate fundings for the entire Colleges of Education with emphasis on ICTs and this will help to improve the level of ICTs facilities in the Colleges of Education.
2. Biology Teachers abilities in ICTs Competency has found to be low in this study, they should therefore be encouraged by the College authorities to go for in-service training, seminars, workshops and conferences to be organized and train the teachers for the purpose of utilizing ICTs in their teaching activities.
3. Federal and State governments should equip all the Colleges of Education with functional computer laboratories for teaching biology.

4. Management of Colleges of Education should also, work hand in hand with the private sector (NGOs), International donors and Civil Societies to ensure affordable and sustainable access to ICTs facilities.

### **5.7 Suggestions for Further Study**

The researcher is in the opinion that further studies to be carried out to cover other aspects of ICTs. The following suggestions are therefore made to expand the scope of this study:

1. A similar study should be carried out focusing on the teaching of other sciences like Chemistry, Physics, Mathematics or Geography using the ICTs with a view to find out if similar or different result as in this study might be obtained.
2. This type of study could be extended to other higher institutions in the state and other institutions in the neighbouring states of the federation for wider generalized result.
3. There is also, need to investigate the role of gender if any in ICTs Competencies among Teachers in the Colleges of Education.
4. The study could be extended to include other variables like attitudes, effects or readiness of teachers in the use of ICTs in teaching.
5. National Commission for Colleges of Education (NCCE) should initiate and develop regular programs through trainings, seminars and workshops, that will retain computer educators on the use of ICTs as a tool for teaching.

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**APPENDIX I**

**BAYERO UNIVERSITY, KANO**

**SCHOOL OF POSTGRADUATE STUDIES**

**DEPARTMENT OF SCIENCE AND TECHNOLOGY EDUCATION**

**ICT AND COLLEGES OF EDUCATION**

**(ICTCOE)**

Dear respondent,

I am a postgraduate student, currently conducting a survey research on ‘‘Information and Communication Technologies (ICTs) Competency among Biology Teachers in the Colleges of Education of Kano State’’. Please enter the choice you have made by ticking (√) the answer in the space corresponding to your choice. However, all the information given will be treated with strict confidentiality and will be used for academic purpose only.

**SECTION A**

**Part I: Personal Data**

1. Sex: Male  Female

2. Highest academic qualification:

Phd

Msc

Msc Ed

Bsc

Bsc Ed

Dip. Ed

Others you specify.....

3. Years of teaching experience:

1-3 years

4-6 years

7-9 years

Over 9 years

4. What is the level of your computer qualification?

Packages

Certificate

Diploma

Degree

Others you specify.....

5. Who sponsored you for your computer literacy programs?

The college

Self sponsored

NGO

Others you specify.....

**CHECK LIST: List of ICT Facilities for Teaching Biology**

| <b>S/N</b> | <b>ICT Facilities</b>                  | <b>Adequate</b> | <b>Not Adequate</b> | <b>Not Available</b> |
|------------|--|-----------------|---------------------|----------------------|
| 1          | Computer laboratories                  |                 |                     |                      |
| 2          | Internet facilities                    |                 |                     |                      |
| 3          | E-mail services                        |                 |                     |                      |
| 4          | Satellite                              |                 |                     |                      |
| 5          | Telephone                              |                 |                     |                      |
| 6          | Motion picture                         |                 |                     |                      |
| 7          | Overhead projector                     |                 |                     |                      |
| 8          | Interactive white board                |                 |                     |                      |
| 9          | Public address system                  |                 |                     |                      |
| 10         | Wireless technology                    |                 |                     |                      |
| 11         | Printer                                |                 |                     |                      |
| 12         | Scanner                                |                 |                     |                      |
| 13         | Projection screen                      |                 |                     |                      |
| 14         | Television                             |                 |                     |                      |
| 15         | LAN                                    |                 |                     |                      |
| 16         | Digital microscope                     |                 |                     |                      |
| 17         | Digital cameras                        |                 |                     |                      |
| 18         | Tablets                                |                 |                     |                      |
| 19         | Maintenance workshop                   |                 |                     |                      |
| 20         | Spare parts and accessoriesl<br>rooms. |                 |                     |                      |

## SECTION B

### Part II: Teacher Educators ICTs Competency in Teaching of Biology

Please indicate from the following options: Highly Competent(4), Competent(3), Moderately Competent(2), Not Competent(1)

Q. 2 What are the level of ICTs competencies among Biology teachers in the teaching of Biology?

| S/NO | ITEM STATEMENT   | HC | C | MC | NC |
|------|--|----|---|----|----|
| 1    | Use of computer for lectures preparation                         |    |   |    |    |
| 2    | Use of Internet to prepare lectures                              |    |   |    |    |
| 3    | Use of Interactive white board for biology lectures delivery     |    |   |    |    |
| 4    | Use of digital microscope for practical classes                  |    |   |    |    |
| 5    | Use of Projectors for delivering lecture                         |    |   |    |    |
| 6    | Ability to provide course materials online for students          |    |   |    |    |
| 7    | Use of online based systems for students assignment              |    |   |    |    |
| 8    | Lecturers and students are capable of communicate through e-mail |    |   |    |    |
| 9    | Use of public address system for lectures delivery               |    |   |    |    |
| 10   | Frequent use of power point for delivering lectures              |    |   |    |    |

**KEY:**

**Highly Competent----- (HC)**

**Competent----- ( C )**

**Moderately Competent---- (MC) Not Competent----- (NC)**

**Part III: Factors that militate against the use of ICT in the Teaching of Biology in the Colleges of Education in Kano State.**

Please indicate from the following options: Strongly Agree (4), Agree (3), Disagree (2), Strongly Disagree (1)

Q. 5 What other factors are militating against the use of ICTs in the teaching of Biology?

| S/NO | ITEM STATEMENT   | SA | A | D | SD |
|------|--|----|---|---|----|
| 11   | Lack of functional computer laboratory   |    |   |   |    |
| 12   | Time constraint in using ICT facilities  |    |   |   |    |
| 13   | Insufficient computer peripherals (scanners, printers)   |    |   |   |    |
| 14   | Problem of accessibility to existing hardware (computer, projectors)                                       |    |   |   |    |
| 15   | Lack of computer for teachers  |    |   |   |    |
| 16   | Lack of skills in ICTs utilization   |    |   |   |    |
| 17   | Lack of interest of teachers in ICTs utilization   |    |   |   |    |
| 18   | Lack of professional development opportunities   |    |   |   |    |
| 19   | Non-inclusion of ICTs programs in teacher training curriculum affect its adoption in colleges of education |    |   |   |    |
| 20   | Poor physical infrastructure of learning environment   |    |   |   |    |
| 21   | Lack of adequate support services in material development and ICTs usage                                   |    |   |   |    |
| 22   | Financial resources for ICTs integration   |    |   |   |    |
| 23   | Erratic power supply   |    |   |   |    |
| 24   | High cost of ICT facilities  |    |   |   |    |
| 25   | Lack of students ICTs background   |    |   |   |    |
| 26   | Lack of Technology courses Adequacy for teacher preparation  |    |   |   |    |
| 27   | Mismanagement of ICT facilities  |    |   |   |    |
| 28   | Fear of exposing too much information on the institution to the public                                     |    |   |   |    |
| 29   | Lack of motivation on ICTs usage   |    |   |   |    |
| 30   | Insecurity associated with the use of ICTs materials   |    |   |   |    |

**APPENDIX II Check List (CL) SPSS OUT PUT**

**Computer Laboratories**

|                     | Frequency | Percent | Valid Percent | Cumulative Percent |
|---------------------|-----------|---------|---------------|--------------------|
| Valid Not Available | 2         | 66.7    | 66.7          | 66.7               |
| Not Adequate        | 1         | 33.3    | 33.3          | 100.0              |
| Total               | 3         | 100.0   | 100.0         |                    |

**Internet facilities**

|                    | Frequency | Percent | Valid Percent | Cumulative Percent |
|--------------------|-----------|---------|---------------|--------------------|
| Valid Not Adequate | 3         | 100.0   | 100.0         | 100.0              |

**E-mail Service**

|                    | Frequency | Percent | Valid Percent | Cumulative Percent |
|--------------------|-----------|---------|---------------|--------------------|
| Valid Not Adequate | 2         | 66.7    | 66.7          | 66.7               |
| Adequate           | 1         | 33.3    | 33.3          | 100.0              |
| Total              | 3         | 100.0   | 100.0         |                    |

**Satellite**

|                    | Frequency | Percent | Valid Percent | Cumulative Percent |
|--------------------|-----------|---------|---------------|--------------------|
| Valid Not Adequate | 3         | 100.0   | 100.0         | 100.0              |

**Telephone**

|                | Frequency | Percent | Valid Percent | Cumulative Percent |
|----------------|-----------|---------|---------------|--------------------|
| Valid Adequate | 3         | 100.0   | 100.0         | 100.0              |

**Motion picture**

|                    | Frequency | Percent | Valid Percent | Cumulative Percent |
|--------------------|-----------|---------|---------------|--------------------|
| Valid Not Adequate | 3         | 100.0   | 100.0         | 100.0              |

**Overhead projector**

|                    | Frequency | Percent | Valid Percent | Cumulative Percent |
|--------------------|-----------|---------|---------------|--------------------|
| Valid Not Adequate | 2         | 66.7    | 66.7          | 66.7               |
| Adequate           | 1         | 33.3    | 33.3          | 100.0              |
| Total              | 3         | 100.0   | 100.0         |                    |

**Interactive white board**

|                    | Frequency | Percent | Valid Percent | Cumulative Percent |
|--------------------|-----------|---------|---------------|--------------------|
| Valid Not Adequate | 1         | 33.3    | 33.3          | 33.3               |
| Adequate           | 2         | 66.7    | 66.7          | 100.0              |
| Total              | 3         | 100.0   | 100.0         |                    |

**Printer**

|                    | Frequency | Percent | Valid Percent | Cumulative Percent |
|--------------------|-----------|---------|---------------|--------------------|
| Valid Not Adequate | 2         | 66.7    | 66.7          | 66.7               |
| Adequate           | 1         | 33.3    | 33.3          | 100.0              |
| Total              | 3         | 100.0   | 100.0         |                    |

**Scanner**

|                    | Frequency | Percent | Valid Percent | Cumulative Percent |
|--------------------|-----------|---------|---------------|--------------------|
| Valid Not Adequate | 2         | 66.7    | 66.7          | 66.7               |
| Adequate           | 1         | 33.3    | 33.3          | 100.0              |
| Total              | 3         | 100.0   | 100.0         |                    |

**Projection screen**

|                    | Frequency | Percent | Valid Percent | Cumulative Percent |
|--------------------|-----------|---------|---------------|--------------------|
| Valid Not Adequate | 2         | 66.7    | 66.7          | 66.7               |
| Adequate           | 1         | 33.3    | 33.3          | 100.0              |
| Total              | 3         | 100.0   | 100.0         |                    |

**Television**

|                     | Frequency | Percent | Valid Percent | Cumulative Percent |
|---------------------|-----------|---------|---------------|--------------------|
| Valid Not Available | 1         | 33.3    | 33.3          | 33.3               |
| Not Adequate        | 2         | 66.7    | 66.7          | 100.0              |
| Total               | 3         | 100.0   | 100.0         |                    |

**LAN**

|                     | Frequency | Percent | Valid Percent | Cumulative Percent |
|---------------------|-----------|---------|---------------|--------------------|
| Valid Not Available | 3         | 100.0   | 100.0         | 100.0              |

**Digital Microscope**

|                     | Frequency | Percent | Valid Percent | Cumulative Percent |
|---------------------|-----------|---------|---------------|--------------------|
| Valid Not Available | 2         | 66.7    | 66.7          | 66.7               |
| Not Adequate        | 1         | 33.3    | 33.3          | 100.0              |
| Total               | 3         | 100.0   | 100.0         |                    |

**Digital Cameras**

|                     | Frequency | Percent | Valid Percent | Cumulative Percent |
|---------------------|-----------|---------|---------------|--------------------|
| Valid Not Available | 3         | 100.0   | 100.0         | 100.0              |

**Tablets**

|                     | Frequency | Percent | Valid Percent | Cumulative Percent |
|---------------------|-----------|---------|---------------|--------------------|
| Valid Not Available | 3         | 100.0   | 100.0         | 100.0              |

**Maintenance workshop**

|                     | Frequency | Percent | Valid Percent | Cumulative Percent |
|---------------------|-----------|---------|---------------|--------------------|
| Valid Not Available | 3         | 100.0   | 100.0         | 100.0              |

**Spare part and accessories room**

|                     | Frequency | Percent | Valid Percent | Cumulative Percent |
|---------------------|-----------|---------|---------------|--------------------|
| Valid Not Available | 2         | 66.7    | 66.7          | 66.7               |
| Not Adequate        | 1         | 33.3    | 33.3          | 100.0              |
| Total               | 3         | 100.0   | 100.0         |                    |

### APPENDIX III (ICTCOE) SPSS OUT PUT

#### Name of Schools

|                                    | Frequency | Percent | Valid Percent | Cumulative Percent |
|------------------------------------|-----------|---------|---------------|--------------------|
| Sa'adatu Rimi College of Education | 20        | 40.0    | 40.0          | 40.0               |
| FCE (Technical) Bichi              | 15        | 30.0    | 30.0          | 70.0               |
| FCE Kano                           | 15        | 30.0    | 30.0          | 100.0              |
| Total                              | 50        | 100.0   | 100.0         |                    |

#### Sex

|        | Frequency | Percent | Valid Percent | Cumulative Percent |
|--------|-----------|---------|---------------|--------------------|
| Male   | 27        | 54.0    | 54.0          | 54.0               |
| Female | 23        | 46.0    | 46.0          | 100.0              |
| Total  | 50        | 100.0   | 100.0         |                    |

#### Higher qualification

|        | Frequency | Percent | Valid Percent | Cumulative Percent |
|--------|-----------|---------|---------------|--------------------|
| Phd    | 5         | 10.0    | 10.0          | 10.0               |
| Msc    | 22        | 44.0    | 44.0          | 54.0               |
| Msc Ed | 10        | 20.0    | 20.0          | 74.0               |
| Bsc    | 10        | 20.0    | 20.0          | 94.0               |
| Bsc Ed | 3         | 6.0     | 6.0           | 100.0              |
| Total  | 50        | 100.0   | 100.0         |                    |

**Research Question 2**  
**Descriptive Statistics**

|  | N  | Mean | Std.<br>Deviation |
|--|----|------|-------------------|
| Computer is use for lectures preparation                               | 50 | 2.72 | .834              |
| Internet is use in lecture preparation                                 | 50 | 2.60 | .782              |
| Interactive white board is used for delivering biology lectures        | 50 | 2.76 | 1.080             |
| Use of digital microscope for practical classes                        | 50 | 2.16 | .997              |
| Projectors are used for delivering lecture                             | 50 | 2.10 | .863              |
| Course Materials are provided online for students                      | 50 | 1.94 | .978              |
| Students assignment are online based                                   | 50 | 1.94 | 1.038             |
| Lecturers and students communicate through e-mail                      | 50 | 1.88 | .918              |
| Public address system is use for delivering lectures                   | 50 | 2.00 | 1.069             |
| Lecturers always use their computers for power point lectures delivery | 50 | 2.00 | 1.107             |
| Valid N (listwise)   | 50 |      |                   |

## Research Question 5

### Descriptive Statistics

|   | N  | Mean | Std. Deviation |
|---|----|------|----------------|
| Lack of functional computer laboratory  | 50 | 2.86 | .990           |
| Time Constraint in using ICTs facilities  | 50 | 2.44 | .837           |
| Insufficient computers peripherals (Scanners, Printers)   | 50 | 3.76 | 4.269          |
| Problem of accessibility to existing hardware (Computer projectors)   | 50 | 2.92 | .829           |
| lack of computer for teachers   | 50 | 2.54 | .973           |
| lack of skills in ICTs utilization  | 50 | 2.36 | .875           |
| lack of interest of teachers in ICTs utilization  | 50 | 2.16 | .976           |
| Lack of professional development opportunities  | 50 | 2.34 | 1.042          |
| Non-inclusion of ICTs programmes in teachers training curriculum affect its adoption in colleges of education | 50 | 2.60 | .990           |
| Poor Physical infracture of learning environment  | 50 | 2.78 | .932           |
| lack of adequate support services in material development and ICTs usage                                      | 50 | 2.72 | .834           |
| Financial resources for ICTs integration  | 50 | 3.08 | .752           |
| Erratic power supply  | 50 | 3.06 | .890           |
| High cost of ICTs facilities  | 50 | 2.94 | .793           |
| Lack students ICTs background   | 50 | 2.89 | .938           |
| lack of technology courses adequacy for teacher preparation   | 50 | 2.66 | .798           |
| Mismanagement of ICTs facilities  | 50 | 2.42 | .810           |
| Fear of exposing too much information on the institution to the public  | 50 | 2.00 | .926           |
| lack of motivation on ICTs usage  | 50 | 2.50 | .814           |
| Insecurity associated with the use of ICTs materials  | 50 | 2.20 | .912           |
| Valid N (listwise)  | 50 |      |                |

## Hypothesis 1

### Descriptive

ICTs Competency

|                                    | N  | Mean    | Std. Deviation | Std. Error | 95% Confidence Interval for Mean |             | Minimum | Maximum |
|------------------------------------|----|---------|----------------|------------|----------------------------------|-------------|---------|---------|
|                                    |    |         |                |            | Lower Bound                      | Upper Bound |         |         |
| Sa'adatu Rimi College of Education | 20 | 19.6500 | 4.22119        | .94389     | 17.6744                          | 21.6256     | 12.00   | 28.00   |
| FCE (Technical) Bichi              | 15 | 24.0000 | 4.12311        | 1.06458    | 21.7167                          | 26.2833     | 19.00   | 33.00   |
| FCE Kano                           | 15 | 23.4667 | 6.95770        | 1.79647    | 19.6136                          | 27.3197     | 10.00   | 35.00   |
| Total                              | 50 | 22.1000 | 5.45202        | .77103     | 20.5506                          | 23.6494     | 10.00   | 35.00   |

### ANOVA

ICTs Competency

|                | Sum of Squares | Df | Mean Square | F     | Sig. |
|----------------|----------------|----|-------------|-------|------|
| Between Groups | 202.217        | 2  | 101.108     | 3.789 | .030 |
| Within Groups  | 1254.283       | 47 | 26.687      |       |      |
| Total          | 1456.500       | 49 |             |       |      |

### Multiple Comparisons

Dependent Variable: Competency Level

Scheffe

| (I) Name of Schools                | (J) Name of Schools    | Mean Difference (I-J) | Std. Error | Sig. | 95% Confidence Interval |             |
|------------------------------------|------------------------|-----------------------|------------|------|-------------------------|-------------|
|                                    |                        |                       |            |      | Lower Bound             | Upper Bound |
| Sa'adatu Rimi College of Education | FCE (Technical) Bichi  | -4.35000              | 1.76450    | .057 | -8.8104                 | .1104       |
|                                    | FCE Kano Sa'adatu Rimi | -3.81667              | 1.76450    | .108 | -8.2771                 | .6438       |
| FCE (Technical) Bichi              | College of Education   | 4.35000               | 1.76450    | .057 | -.1104                  | 8.8104      |
|                                    | FCE Kano Sa'adatu Rimi | .53333                | 1.88633    | .961 | -4.2351                 | 5.3017      |
| FCE Kano                           | College of Education   | 3.81667               | 1.76450    | .108 | -.6438                  | 8.2771      |
|                                    | FCE (Technical) Bichi  | -.53333               | 1.88633    | .961 | -5.3017                 | 4.2351      |

### ICTs Competency

Scheffe

| Name of Schools                    | N  | Subset for alpha = 0.05 |
|------------------------------------|----|-------------------------|
|                                    |    | 1                       |
| Sa'adatu Rimi College of Education | 20 | 19.6500                 |
| FCE Kano                           | 15 | 23.4667                 |
| FCE (Technical) Bichi              | 15 | 24.0000                 |
| Sig.                               |    | .065                    |

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 16.364.

b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

## Hypothesis 2

### Group Statistics

|                 | Sex    | N  | Mean    | Std. Deviation | Std. Error Mean |
|-----------------|--------|----|---------|----------------|-----------------|
| ICTs Competency | Male   | 27 | 22.1111 | 4.37944        | .84282          |
|                 | Female | 23 | 22.0870 | 6.59830        | 1.37584         |

### Independent Samples Test

|                 |                             | Levene's Test for Equality of Variances |      | t-test for Equality of Means |        |                 |                 |                       |   |         |
|-----------------|-----------------------------|---|------|------------------------------|--------|-----------------|-----------------|-----------------------|---|---------|
|                 |                             | F                                       | Sig. | T                            | df     | Sig. (2-tailed) | Mean Difference | Std. Error Difference | 95% Confidence Interval of the Difference |         |
|                 |                             |   |      |                              |        |                 |                 |                       | Lower                                     | Upper   |
| ICTs Competency | Equal variances assumed     | 6.678                                   | .013 | .015                         | 48     | .988            | .02415          | 1.56305               | -3.11857                                  | 3.16688 |
|                 | Equal variances not assumed |   |      | .015                         | 37.179 | .988            | .02415          | 1.61347               | -3.24452                                  | 3.29282 |

### Appendix iv

#### ReliabilityCorrelations of ICTCOE Using PPMC Pilot Testing Statistics

|             |                     | First test | Second test |
|-------------|---------------------|------------|-------------|
| First test  | Pearson Correlation | 1          | .782**      |
|             | Sig. (2-tailed)     |            | .008        |
|             | N                   | 10         | 10          |
| Second Test | Pearson Correlation | .782**     | 1           |
|             | Sig. (2-tailed)     | .008       |             |
|             | N                   | 10         | 10          |

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