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An Appraisal of the Role of ICT as a Change Agent for Quality Education in Tertiary Institutions in Nigeria

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A B S T R A C T

This study appraised the role of Information and Communication Technology (ICT) as a change agent for quality education in tertiary institutions in Nigeria. Three research questions guided the study, and a survey research design was adopted. The sample comprised 350 respondents (students and staff) drawn through a random sampling technique, using University of Nigeria, Nsukka as the area of study. A structured questionnaire, validated by experts in Measurement and Evaluation and in Computer and Robotics Education, was used for data collection, while arithmetic mean and standard deviation were used for data analysis; items with a mean score of 2.5 and above were accepted. Findings revealed that the attitude of students and lecturers, the school environment and the method of teaching constitute quality in tertiary education; that the teaching, learning and use of ICT facilities bring quality to tertiary education; and that the implementation and effective use of ICT, the provision of ICT facilities, and mandatory ICT training for students constitute the fundamental objectives of quality education in Nigerian tertiary institutions. The study reviews the concept, components, characteristics and benefits of ICT, the barriers to its effective utilisation, and relevant empirical evidence, before recommending adequate funding for the development, review and implementation of ICT policies, and greater collaboration with private and philanthropic organisations to provide ICT facilities in tertiary institutions in Nigeria.

Keywords: Information and Communication Technology (ICT); Quality Education; Tertiary Institutions; Change Agent; Nigeria

1. Introduction

1.1 Background of the Study

One of the challenges confronting the educational system at the tertiary level is the attainment of quality in education delivery; almost everything connected with education in tertiary institutions is in short supply. Quality teachers, quality buildings, quality equipment, quality laboratories, good experimental facilities and other resources that lead to quality education are inadequately provided. Today there exists general disenchantment and a general lack of trust in the quality of the education system as well as in the quality of graduates.

The quality of education is a factor that determines the worth and significance of the system to both the recipients and to society at large. Igwe (2009) notes that the promises of Information and Communication Technologies (ICTs) have driven e-learning in transforming education delivery and thereby advancing the knowledge economy. The knowledge economy sets a new phase for education, and new challenges and prospects for education are a pre-requisite of the knowledge-based economy; the production and use of new knowledge require a more educated population and workforce (Arikewuyo, 2004).

In that capacity, ICTs play a pedagogic role that could, in principle, complement the traditional practices of the education sector (Igwe, 2009). Undoubtedly, e-learning powered by ICT use in tertiary institutions could help to expand and widen access to tertiary education and learning, improve the quality of education, as well as reduce its cost. This means that effective ICT use in tertiary institutions in Nigeria could help to spur positive results in improving the overall learning (and teaching) experience as well as in up-lifting the quality of the system.

This concern is not peculiar to the education sector alone. Nigeria's broader national development agenda, articulated through instruments such as the National Digital Economy Policy and Strategy, has increasingly framed digital literacy and ICT infrastructure as foundational to the country's long-term economic competitiveness, positioning the education sector as a critical site for building the digitally skilled workforce that a modern, technology-driven economy requires. Tertiary institutions, as the terminal stage of formal education for the majority of Nigeria's skilled workforce, therefore carry a particular responsibility for ensuring that graduates leave with the ICT competence that both the labour market and civic life increasingly demand. It is against this wider backdrop of national digital-economy ambition, as well as the sector-specific quality concerns already outlined, that the present study is situated. This research seeks to investigate the role of ICT as a change agent for quality education in tertiary institutions in Nigeria.

1.2 Statement of the Problem

Elele (1983), cited in Yusuf (2012), notes that quantitatively the Nigerian education scene is quite impressive but qualitatively inefficient. There exists general disenchantment and general mistrust in the quality of the education system as well as in the quality of education output. Arikewuyo (2004) stated that ICT can play a very prominent role in diffusing knowledge and information, which are fundamental aspects of the education process towards quality attainment. In this capacity, ICT plays a pedagogic role that could, in principle, complement the traditional practices of the education sector.

Therefore, the problem confronting this research was to appraise the role of ICT as a change agent towards quality education in tertiary institutions in Nigeria.

1.3 Objectives of the Study

1. To determine the state of education in tertiary institutions in Nigeria.
2. To determine what constitutes quality in the education of tertiary institutions in Nigeria.
3. To determine the nature of ICT and the role of ICT as a change agent towards the education of tertiary institutions in Nigeria.
4. To appraise the fundamental objectives of quality education attainment in tertiary institutions in Nigeria.

1.4 Research Questions

1. What constitutes quality in the education of tertiary institutions in Nigeria?
2. What is ICT, and what are its roles for quality education in tertiary institutions in Nigeria?
3. What are the fundamental objectives of quality education in tertiary institutions in Nigeria?

1.5 Scope of the Study

The study focuses on the role of ICT as a change agent for quality education in tertiary institutions in Nigeria, with University of Nigeria, Nsukka as the area of study.

1.6 Significance of the Study

- This study shall provide a framework for determining the standard of education in tertiary institutions in Nigeria.
- It shall provide a measure of quality standard for the education of tertiary institutions in Nigeria.
- The study shall provide detailed information on ICT and the role of ICT as a change agent towards quality education in tertiary institutions.
- It shall serve as a reference source of information for academic facilitators, non-academic staff and students, and other stakeholders in the education sector.

2. Literature Review

2.1 Conceptual Framework

2.1.1 Concept of Education

Education is the process of facilitating learning, or the acquisition of knowledge, skills, values, beliefs and habits. Educational methods include teaching, training, storytelling, discussion and directed research. Education frequently takes place under the guidance of educators; however, learners can also educate themselves. Education can take place in formal or informal settings, and any experience that has a formative effect on the way one thinks, feels or acts may be considered educational. Formal education is commonly divided into stages such as pre-school or kindergarten, primary school, secondary school, and then college, university or apprenticeship. The methodology of teaching is called pedagogy, which refers to the strategies of instructing or teaching.

Education, whether formal or informal, gives rise to human growth and development. It is believed to be an instrument for the development of the individual, the community and the nation, and is primarily aimed at developing the personality of the individual; it is the pivot around which the developmental efforts of most nations revolve. In recognition of this, the Federal Government of Nigeria, in Section 1, Paragraph 6 of the National Policy on Education (1981), declares that education is the greatest investment that the nation can make for the quick development of its economic, political, sociological and human resources. Section 1, Paragraph 7 of the same Policy further states that education is the most important instrument of change, as any fundamental change in the intellectual and social outlook of any society has to be preceded by an educational revolution. A right to

education has been recognised by some governments and the United Nations, and in most regions education is compulsory up to a certain age, giving rise to movements for education reform and for evidence-based education.

2.1.2 The Purpose of Education

The purpose of education in a given time and place affects who is taught, what is taught, and how the education system behaves. In the twenty-first century, many countries treat education as a positional good; in this competitive approach, people want their own students to obtain a better education than others, an approach that can lead to unfair treatment of students from disadvantaged or marginalised groups. For example, a city's school system may draw school district boundaries such that nearly all the students in one school are from low-income families and nearly all the students in a neighbouring school are from more affluent families, even though concentrating low-income students in one school results in worse educational achievement for the entire system.

2.1.3 Concept of Quality Education

A good quality education is one that provides all learners with the capabilities they require to become economically productive, develop sustainable livelihoods, contribute to peaceful and democratic societies, and enhance individual well-being. The learning outcomes required vary according to context, but at the end of the basic education cycle must include threshold levels of literacy and numeracy, basic scientific knowledge, and life skills including awareness and prevention of disease. Capacity development to improve the quality of teachers and other education stakeholders is crucial throughout this process.

Quality education can only be achieved if equity, and particularly gender equity, is achieved within the education system. It is an all-inclusive term in which learners and environments for education are healthy, content is relevant, teaching is student-centred, and outcomes are all-encompassing, bringing about all that is good from the student's educational experience. Education leads to empowerment: a process of strengthening individuals, organisations and communities so that they gain more control over their own situations and environments. Quality education is therefore a crucial factor in combating poverty and inequality in society.

The Federal Ministry of Education (FME, 2009) remarked that quality standards in the education system are goals or targets to which learners, teachers, staff and school administration aspire. Quality assurance in the education system is therefore a multi-dimensional concept involving the various functions and activities of the education system, including teaching, research, staffing, students, buildings, facilities, equipment, service to the community, and academic environment; it ensures that at least the minimum academic standards are attained and sustained.

Quality education is one whose curriculum is of great quality and designed to impart relevant skills and knowledge, enabling students to gain academic competencies for socio-economic survival; it is the type of educational output that meets the demands of the customers (the learners, teachers, parents, community and industrial sector), well designed to provide the recipient with an all-round development of skills and potential to achieve success in future endeavours. Quality assurance in the education system consists of a lot of activities designed to improve the quality of input, process and output of the educational system. Okebukola (2012) described quality assurance in education as the process of monitoring, assessing and evaluating all aspects of education activities and communicating the outcome to all concerned, with a view to improving the products of the education system. Yawa, cited in Emeruo (2012), described quality assurance in education as all the proactive measures adopted by a country to ensure that system standards remain high enough to produce the results set for it. Quality standard in education is therefore the benchmark that should guide the performance of the education system, and quality assurance in education is, in fact, a process of continuous improvement in the quality of teaching and learning activities.

Two dimensions of quality education are crucial: first, a balanced approach, in which quality education aims at developing a balanced set of capabilities in learners, needed to become economically productive, develop sustainable livelihoods, contribute to peaceful and democratic societies, and enhance individual well-being; and second, learning outcomes, whereby after completing a certain level of education, learners must have developed a minimum standard of skills, requiring a results-oriented approach. Environment is crucial to fostering quality education, which means building and upgrading schools that are student-friendly, disability- and gender-sensitive, and that provide safe, non-violent and inclusive spaces for students to learn and to enjoy being students; unfortunately, both physical and psychological aggression and gender biases remain prevalent in many schools.

2.1.3.1 Quality Assurance Mechanisms in Nigerian Tertiary Education

In practical terms, quality assurance in Nigerian tertiary education is operationalised chiefly through the accreditation function of regulatory bodies such as the National Universities Commission (NUC) for universities, the National Board for Technical Education (NBTE) for polytechnics and monotechnics, and the National Commission for Colleges of Education (NCCE) for colleges of education. These bodies assess academic programmes against minimum academic standards covering curriculum content, staffing, physical facilities, library resources and, increasingly, ICT infrastructure, before granting, withholding or withdrawing accreditation. The explicit inclusion of ICT facilities among accreditation benchmarks in recent years reflects a growing institutional recognition, at the regulatory level, that ICT provision is not merely an auxiliary convenience but a substantive component of what counts as quality tertiary education in the contemporary Nigerian context, a position squarely consistent with the empirical findings of the present study.

2.1.4 Concept of ICT

Information Technology is defined in the Oxford Advanced Dictionary as the study of the use of electronic equipment, especially computers, for storing information. Information can come in many forms, such as sound, video, text and images, and technologies capable of producing these — mobile phones, digital cameras, video cameras and the like — are referred to as Information Technology. Communication Technology, on the other hand, is the process of sending, receiving and exchanging information through network systems with the help of IT, such that information can be exchanged from anywhere and at any time without borders, made possible through Local Area Networks (LAN) expanding and connecting to other networks globally. ICT is thus the combination of Information Technology and Communication Technology.

The term 'Information and Communication Technology' (ICT) first appeared in the mid-1980s and was defined as all kinds of electronic systems used for broadcasting, telecommunications and mediated communications, with examples including personal computers, video games, cell phones, the internet, and electronic payment systems. Computer technology is the tool for storing and processing information in digital form, while communication technology helps to transfer and disseminate that digital information. Additionally, ICT means a variety of technological applications in the process and communication of information, and can be described as the integration of computing, networking and information-processing technologies and their applications. Rhine (2006) observed that ICT can be split into three components: the technology itself, the information that the technology helps to deliver, and the communication process that the technology facilitates and serves as a medium for. ICT can therefore be defined as the use and application of computers, telecommunications and micro-electronics in the acquisition, storage, retrieval, transfer and dissemination of information.

Information Communication Technology is a common term referring to the technologies used for collecting, storing, editing and communicating information in various formats, encompassing hardware and software that enable society to create, collect, consolidate and communicate information in multimedia format for various purposes, and including radio, television, cellular phones, computers and networks, satellite systems, and the various services and applications associated with them, such as videoconferencing and distance learning.

The Encyclopedia of Computer Science describes ICT as an imprecise term frequently applied to broad areas of activities and technologies associated with the use of computers and communications. Mahaptra and Ramesh describe ICT as the result of the technological convergence of previously isolated technologies — computer technology, communication technology, information processing and publishing technology. UNESCO describes ICT as a scientific, technological and engineering discipline and management technique used in handling information and its application and association with social, economic and cultural matters, while the American Library Association (1983) defined ICT as the application of computers and other technologies to the acquisition, organisation, storage, retrieval and dissemination of information, in which computers process and store data while telecommunication technology provides the tools that make it possible for users to access databases and link them with other computer networks at different locations.

Nwachukwu (2004) similarly described ICT as the application of computers and other technologies to the acquisition, organisation, storage, retrieval and dissemination of information, using electronic devices such as computers, telephones, the internet and satellite systems to store, retrieve and disseminate information in the form of data, text, image and other formats. Anyakoha (1991) described Information Technology as the use of man-made tools for the collection, generation, communication, recording, management and exploitation of information, including the applications and commodities by which information is transferred, recorded, edited, stored, manipulated or disseminated. Today, the definition of ICT is much broader, encompassing nearly every type of business — manufacturers, retailers, banks, publishers, research firms, medical institutions, law enforcement agencies, education sectors, government and libraries — all of which rely on ICT to run their daily operations.

2.1.5 Components of ICT

ICT components include computer hardware and software, telecommunication technologies, projection devices, Local Area Networks (LAN), Wide Area Networks (WAN), digital cameras, Compact Disks (CDs), Digital Video Disks (DVDs), cell phones, satellites and fibre optics. Digital technology is not a single technology but a combination of two or more technologies working together within a system; examples include multimedia PCs, laptops and notebooks combining internet connectivity with computing; digital cameras and video connected with computers; LAN and WAN for intranet and internet access; the World Wide Web, comprising the internet, online databases, videoconferences, e-mail, discussion lists, newsgroups, chat, digital libraries, e-books, e-journals and e-databases; cell phones with internet connectivity and digital cameras; computer-mediated conferencing, including telemedicine; and virtual reality, telecommunication satellites, and interactive television and radio.

2.1.6 Characteristics of ICT

ICT applications share several distinguishing characteristics. In terms of effectiveness, ICT is highly interactive, has fewer errors, is customisable and personalised, achievable, transparent, searchable and generally acceptable to users. In terms of efficiency, ICT is faster, cheaper, requires fewer steps, lowers cost, reduces the number of people needed for a task, and reduces paperwork. In terms of innovation, new ICT products, technologies and versions are produced constantly, ensuring that the field continuously evolves.

2.1.7 Importance of ICT in Tertiary Institutions

In today's society, people as consumers of ICT strive for the connected life, making ICT a lifestyle choice for much of the population; this lifestyle choice is changing the way people communicate, increasing the rate of consumerism, and changing how people interact and gather information (Sherringham, 2008/2009). Key issues relevant to the importance of ICT in tertiary education include the following. First, e-learning or online learning: the presence of ICT in education allows for new ways of learning for students and teachers, opening opportunities for schools to ensure that students have access to curriculum materials both inside and outside the classroom, including at home or in hospital. Second, ICT brings inclusion: students in the classroom can all learn from curriculum material, and students with special needs are no longer at a disadvantage, as they have access to essential material and special ICT tools, although this also raises new issues related to the digital divide.

Third, ICT promotes higher-order thinking skills, such as evaluating, planning, monitoring and reflecting, which are key skills for the twenty-first century; learning with ICT demands skills such as explaining and justifying the use of ICT in producing solutions to problems, requiring students to discuss, test and conjecture various strategies. Fourth, ICT enhances subject learning, particularly key learning areas such as literacy and numeracy. Fifth, ICT use develops ICT literacy and ICT capability, both of which are twenty-first-century skills best developed while ICT remains embedded in the background of subject learning through meaningful, purposeful activities. Sixth, ICT use encourages collaboration, as computers and mobile devices naturally bring learners together to talk and discuss their work, opening avenues for communication and language development.

Seventh, ICT use motivates learning, as learners are fascinated with technology, which encourages and motivates them in the classroom. Eighth, ICT in education improves engagement and knowledge retention, as students become more engaged in their work when technology provides different and more enjoyable ways of teaching the same content. Ninth, ICT use allows for effective differentiated instruction, since learners learn differently, at different rates and in different styles, and technology provides opportunities for this to occur. Tenth, ICT integration is a key part of the national curriculum in many countries, a trend that many global governments are adopting as they recognise the significance of ICT in education. Finally, the world now operates a knowledge economy, in which it is vital to have the ability to produce and use information effectively (Weert, 2005); ICT is pervasive and permeates all industries of the economy, be it health, education, environment or manufacturing (Moon, 2007), and its significance continues to grow as it connects itself to more and more parts of human life (Semenov, 2005).

It is important for students to engage with ICT so as to: learn twenty-first-century skills and develop ICT capability and literacy; improve their attainment levels; prepare for an integrated society dominated by ICT developments; and learn to use ICT as a tool for lifelong learning.

2.2 Theoretical Framework

2.2.1 Role of ICT in Tertiary Institution Education

Education is one of the most important needs for the well-being of the individual and of society; it is a powerful instrument of social, political and economic progress, without which neither an individual nor a society can attain professional growth. ICT is an indispensable part of the contemporary world, and culture and society have to be adjusted to meet the challenges of the information age. Considering fields such as medicine, tourism, travel, business, law, banking, engineering and architecture, the impact of ICT over the past two or three decades has been enormous, yet within the education sector the impact and change appear comparatively smaller, a lack of activity that a number of scholars have attempted to explore (Soloway & Pryor, 1996; Collis, 2002). The pervasive influence of ICT has brought about a rapid technological, social, political and economic transformation, paving the way for a society organised around ICT.

The field of education has nonetheless not been unaffected by the penetrating influence of ICT, which has contributed immensely to the quality and quantity of teaching, learning and research in traditional and distance education institutions. ICT enhances teaching and learning through its dynamic, interactive and engaging content, and provides real opportunities for individualisation of instruction; it has the potential to accelerate, enrich and deepen skills, motivate and engage students, relate school experience to work practice, create economic viability for tomorrow's workers, contribute to the total development of the institution, strengthen teaching and learning, and provide opportunities for connection between the school and the world (Davis & Tearle, 1999).

Kirschner and Weperies (2003) maintained that ICT can make schools more efficient and productive by organising a variety of tools to enhance and facilitate teachers' professional activities. Yusuf and Onasanya (2004) opined that ICT provides opportunities for schools to communicate with one another through e-mail, mailing lists, chat rooms and other facilities, providing quicker and easier access to more extensive and current information, as well as a steady avenue for the dissemination of research reports and findings. Honey and Mandinach (2003) advanced three major reasons for ICT in education: as a tool for addressing challenges in teaching and learning, given its capabilities for delivery, management and support of effective teaching; as a change agent, capable of changing the content, methods, and overall quality and quantity of teaching and learning, thereby reducing teachers' workload and ensuring constructivist, inquiry-oriented classrooms; and as a central force in economic and social shifts, given the technology skills critical to the future employment of today's students.

Thierer (2000) pointed out that the role of technology in teaching and learning is rapidly becoming one of the most important and widely discussed issues in contemporary education policy; experts have agreed that, if properly used, ICT holds great promise to improve teaching and learning in addition to shaping work-force opportunities. In 2007, the Federal Ministry of Education created its ICT department and has since collaborated with government agencies and private stakeholders to initiate ICT-driven projects and programmes across all levels of the education sector in Nigeria

(Osakwe, 2012). Like every issue of development in the country, universities in Nigeria are struggling to access the technology needed to ascertain academic excellence through teaching and learning.

ICT is also increasingly used in library and information services for the acquisition, processing and dissemination of information; libraries have used ICT-based services to satisfy the diverse information needs of users, with the use of computers for library operation saving considerable time, resources and labour, and speeding up technical processing and information services. Application of ICT to library and information work has revolutionised the traditional concept of libraries from a storehouse of books to an intellectual information centre, connoting the electronic library, and has facilitated global access to information across geographical limitations, enabling students and lecturers to complete a quest or task. In this age of information explosion, one's skill in processing and distributing data using computer hardware and software, telecommunications and digital electronics will largely determine one's value in the workforce, much as ordinary literacy determined career opportunities in the past.

Cheung and Huang (2005) emphasised the use of ICT as an effective teaching tool in university education, as many university teachers now publish their course materials via the internet, and suggested that it is insufficient for only universities to use ICT for good outcomes, leaving out students' own ability to do the same. Educational technologists have cited many reasons why an education system based on ICT can more effectively result in positive pedagogic outcomes than one based only on conventional techniques (Balanskat, Blamire & Kefala, 2006; Means et al., 1993; Roblyer & Edwards, 2000; Than, 2006; Ting, 2005). Osakwe (2012) noted that the acquisition, deployment and management of information technology resources and services for teaching depend heavily on electricity; poorly maintained equipment and poor network infrastructure are prominent obstacles to the integration of ICT tools in teaching, and technical and science laboratories that rely on electricity cannot function without it. A number of teachers today have not used computers in their lives and are shy when confronted with the new technology and the terminology associated with using it, and some schools do not provide computers for their teachers, while some teachers cannot afford to buy one for themselves.

2.2.2 Benefits of ICT on Teaching and Learning in Tertiary Institutions

ICTs have impacted greatly on teaching, learning, research and school management in a number of ways. They are electronic technologies used for accessing, processing, gathering, manipulating and presenting or communicating information, encompassing software, hardware and connectivity (Anderson & Baskin, 2002). When ICTs are employed in education under the right conditions, they can accelerate, enrich and deepen basic skills in reading, writing, mathematics and the sciences, and can motivate and engage students to learn as they become more independent and responsible for their own learning. Furthermore, ICTs help to relate academics to the practices of today's work; network technologies especially have been found to encourage active learning, support innovative teaching, reduce the isolation of teachers, and encourage teachers and students to become active researchers and learners, strengthening teaching through the provision of powerful tools (Cradler & Bridgforth, n.d.). The impact of ICT is enormous and global in magnitude, pervasiveness and usefulness, owing to its most distinguishing features of dramatic decrease in cost and size alongside a tremendous increase in processing speed, storage and communication capabilities.

Other derivable benefits of ICT application in education may be enumerated as follows. First, ICTs can assist in reducing teachers' workloads through their use in lesson preparation and worksheet design, writing students' reports and individual education plans, collating and analysing students' attainment information for target-setting, recording and analysing attendance and disciplinary information, and maintaining links between the school and parents to ensure parental involvement in school activities (BECTA, 2004). Second, ICT can be used to obtain necessary instructional content of subjects, ensuring collaboration among teachers globally and keeping teachers up to date with knowledge in their subject area. Third, ICTs can assist teacher development, for instance through the internet; e-learning can support both initial and continuing development through courses, workshops and other formal and informal activities, and there are several global gateways of online resources to support teacher development, such as ICTs in Education, developed by UNESCO, Paris; the Education Network of Australia, developed by the Education Institute, Adelaide; and the Institute of Education Technologies, developed by UNESCO, Moscow, all of which provide opportunities for users to ask questions, post materials and submit assignments (Anderson, 2004).

Also, ICTs shift the focus from teacher-centred to student-centred learning, where learners are active participants who produce and share knowledge and learn in collaboration with others, so that teachers become facilitators, collaborators, coaches, mentors, knowledge navigators and co-learners rather than mere dispensers of knowledge. In addition, ICT can be multi-media for instructional delivery, with content delivered in textual, audio, visual and audio-visual forms, ensuring equity for all categories of learners, including the disabled and the geographically disadvantaged.

Robinson (1991), cited in Okeh and Opone (2007), stated that the use of new information technology can serve three main functions in national educational growth: delivering all or part of the learning experience to learners; supplementing and extending content provided in forms other than hard copy; and providing a two-way channel of communication for exchange between tutors and students, and among peers, for feedback, learning, problem solving, advice, debate and reports. Ikelegbe (2006), also cited in Okeh and Opone (2007), further identified ways in which ICT can be used in education, including: supporting conventional classroom work; helping in the design and development of learning materials downloaded and adapted from the internet; accessing electronic teaching materials such as books and journals; accessing virtual library stocks of electronic books and journals; providing access to a world of resources, especially in electronic form; playing a key role in educational administration, including students' data, personnel administration, purchasing and supplies; facilitating independent study and individual instruction, especially in open and distance-learning programmes; making learning more vivid and engaging; assisting teachers in assessment and testing; and bringing a permanent solution to brain-drain problems in an increasingly globalised world.

Meta-analyses have found consistently positive and moderately high achievement gains at all educational levels from computer mediation in school subjects, particularly mathematics, with computer-assisted instruction found to be more effective at all educational levels and especially with lower-achieving students (Kulik, 1983; Kulik & Cohen, 1980). ICTs significantly improve students' problem-solving skills, provide opportunities for student-constructed learning, increase students' collaboration on projects, increase mastery of vocational and workforce skills, improve preparation of students for careers and vocations, and improve students' confidence and attitude (Cradler & Bridgforth, n.d.); the best predictors of achievement gain from computer use were found to be prior positive attitudes toward the technology by teachers and students, consistent access to the technologies, and teacher training in the technology, among other factors (Maldonado, 2000).

2.2.3 Positive Impact of ICT on Tertiary Education in Nigeria

ICT has increasingly played a vital role in all fields of human endeavour, and is used globally to translate ideas into realisable goals, developing them into concrete achievements in agriculture, engineering, medicine, law, architecture, aviation, commerce, insurance, banking, finance and maritime activities. ICT has the potential to contribute to substantial improvements in the educational system (Moursund, 2005), although to date relatively little of this potential has been achieved, despite ICT having significant impact on the traditional school system, providing innovation for teaching and learning and engendering advances in research about how people learn, thereby bringing about a rethinking of the structure of education (Lopez, 2003). It is also widely acknowledged that ICT can be used to improve the quality of teaching and learning in the school system (Yusuf, 2000). The prevalence and rapid development of ICT have transformed human society from the information age to the knowledge age (Galbreath, 2000), and there is an international consensus on the importance of intellectual input in creating value, underlining the need for investment in education and skills generally, with a special focus on ICT skills and research development.

ICT has changed the face of modern research, requiring research organisations to be linked to each other through advanced networks connected to the rest of the world, and provides resources and services to support the education, research and public-service missions of universities, as well as enhancing the development and implementation of policies necessary to ensure the effective, secure and appropriate use of universities' information resources. ICT provides a range of services to students in Nigerian tertiary institutions, including distance education programmes, inexpensive printing, internet connection, technology equipment rentals and classroom media stations, through which lecturers and students obtain educational materials to equip and upgrade their knowledge in their field of study.

Moursund (2005) stated that ICT brings powerful aids to translating theory into practice, two of which are computer-assisted learning and distance education; computers with internet connectivity have become common household items, giving students access to instruction, communication tools and reference materials, including e-mail, the web, encyclopaedias and books, as well as pure entertainment designed as educational tools, such as word processors and graphics software. When students grow up in an ICT environment, they may gain many hours of experience using ICT facilities; ICT is an example of a technology that is a powerful change agent, described by Moursund (2005) as a mind tool.

Butcher (2003) and Ofojebe (2006), cited in Okeh and Opone (2007), viewed ICT as electronic technology for collecting, storing, processing (editing) and communicating (transferring) information in various forms, an applied technology of science and technology for the effective and efficient generation, storage, organisation, protection and dissemination of information (Adjaiho, 2006, cited in Okeh & Opone, 2007). ICT incorporates and extends some of the power of reading, writing and arithmetic, facilitating the automation of many mental activities, and has proven a valuable aid in solving problems and accomplishing tasks in education, business, industry, science and many other human endeavours. Braisford (1995), cited in Bamigboye, Aderibigbe and Buraimo (2007), described four important components of the Science of Teaching and Learning: constructivism, situated learning, motivation, and transfer of learning, each important to teachers and students at all levels and in all academic disciplines. Today, ICT provides a knowledge-based system encompassing knowledge acquisition, incubation, amplification and dissemination, underscoring that information is a key resource permeating teaching, learning, research and publishing.

ICT is now a global phenomenon, embraced worldwide for its importance; governments everywhere are harnessing its rich potential as a tool for educational development, economic recovery and wealth creation (Okonta, 2006), tackling the ills and problems facing the educational system, since no nation can attain its height educationally, economically and socially without ICT. ICT has also increased the ability to perform experiments that would otherwise be impossible, using simulations, as well as the possibility for students to follow individual learning programmes within a topic rather than everybody doing the same thing at the same time and pace, so that more able students can be given more challenging work while less able students can access remedial lessons.

2.2.3.1 ICT Integration in Curriculum Delivery and Assessment

Beyond its use as a general-purpose instructional aid, ICT has increasingly been integrated directly into curriculum delivery and assessment practices in Nigerian tertiary institutions. Computer-based testing, for instance, has been adopted for a growing range of screening and examination purposes, including the Unified Tertiary Matriculation Examination administered by the Joint Admissions and Matriculation Board, and is progressively being extended to in-house continuous assessment and end-of-semester examinations within individual institutions. Learning management systems, where available, allow lecturers to post course materials, set assignments and record grades electronically, while virtual classrooms and video-conferencing tools, accelerated in adoption by the need for remote instruction during the COVID-19 pandemic, have introduced new modes of curriculum delivery that extend beyond the traditional physical lecture hall.

These developments illustrate that ICT's role as a change agent for quality education operates not only at the level of general teaching support, as discussed above, but also at the more structural level of how curricula are delivered, tracked and assessed. Where such systems function reliably, they offer efficiency gains in administration, more consistent record-keeping, and richer channels of feedback between lecturers and students; where they are undermined by the same infrastructural and capacity constraints already discussed, however, their potential benefits remain only partially realised, reinforcing the central argument of this study that ICT's transformative potential in Nigerian tertiary education is real but conditional on addressing the barriers identified in the following subsection.

2.2.4 Constraints to Effective Utilisation of ICT as a Change Agent for Higher Institutions in Nigeria

A number of factors affect the utilisation of ICT in education across nations, including inadequate funding to support the purchase of ICT facilities, lack of training in the use of ICT facilities, and teaching personnel's lack of motivation to adopt ICT as a teaching tool (Starr, 2001). Research findings on barriers to ICT application at other levels of education have provided similar results, enumerated as follows: lack of teachers' confidence and computer anxiety (BECTA, 2004); lack of teacher competency due to lack of time for training, lack of pedagogical and skills training, and lack of ICT focus in initial teacher training (BECTA, 2004; Yusuf, 2005); lack of access to resources due to lack of hardware, poor organisation of resources, poor-quality hardware, inappropriate software, and lack of personal access for teachers; lack of time to use ICTs owing to the school timetable (BECTA, 2004); and technical problems, encompassing lack of technical support, fear of things going wrong, lack of telecommunication and other infrastructure, and unreliability of electricity (BECTA, 2004). Others include lack of or ineffective technological leadership in schools, lack of clear vision, lack of incentives for teachers, and lack of teachers' participation in planning for ICT integration (Spodark, 2003).

The digital divide between Africa and the developed world is well established in the literature; Nigeria ranked fifteenth in Africa as at 1998 (Hall, 1998), and deprivation in ICT use persists in Nigeria compared with global standards (FME, 2004). Globally, ICT implementation in schools has not been smooth, and organisations in Africa have been concerned with the problem of poor implementation of ICT in African schools; the Association of African Universities (AAU, 2000), for instance, examined the major obstacles affecting the use of ICT in African universities, categorising them as technical, non-technical, human/organisational and financial. Technical obstacles include poor telecommunication infrastructure, the absence of national information communication infrastructure, lack of a university-wide coherent plan for ICT, problems of connectivity, lack of or limited bandwidth for learning, teaching and research, and the non-reliability of public electricity supply, necessitating extra cost for standby generators. Non-technical obstacles relate to a lack of professional development for faculty; human and organisational obstacles relate to inadequate planning for ICT integration in the regular activities of universities and an inadequate human resource base; while financial obstacles relate to inadequate funding of ICT infrastructure, maintenance of available facilities, and staff development. In Nigeria, political conditions over the past decades have given little room for continuity in ICT utilisation in schools, with corruption, misplaced priorities and poor consumer culture affecting the use of ICT in the education sector.

The various constraints to ICT utilisation as a change agent for higher education in Nigeria may be summarised as follows. First, inadequately trained and qualified computer teachers: the absence of trained teachers to teach the practical aspects of computer skills militates against proper utilisation of ICT, as a good number of lecturers remain computer-illiterate and would find it extremely difficult to deliver the appropriate education and training required. Second, poor funding: the overall educational system in the country is underfunded, so available funds are used to address more urgent institutional needs, leading to inadequate ICT facilities and constituting a major constraint to making Nigerian educational institutions ICT-compliant. Third, irregular power supply: power supply across the country is epileptic, and where electricity is not stable and constant it is difficult to keep computers and their accessories functioning properly, a problem that also denies rural dwellers the benefits of ICT use.

Fourth, cost of equipment: the cost of computer peripheral devices such as printers, monitors, modems and extra disk drives, as well as software, is high in a country with a battered economy, and many institutions also struggle with exorbitant internet connection fees. Fifth, lack of relevant software: teaching with ICT facilities is an onerous task without up-to-date equipment and supplementary materials, and there are clear indications from many countries that the supply of relevant and appropriate software is a major obstacle to wider application of the computer (Salomon, 1989). Since these challenges are known, it is important to devise strategies that will provide an enabling environment for ICT use in Nigerian schools.

2.2.5 ICT Policy and Government Initiatives in Nigeria

The Nigerian government has, over the years, articulated a number of policy instruments aimed at mainstreaming ICT into the national education system. The National Policy on Education (Federal Republic of Nigeria, 1981, revised 2004) recognises education as an instrument for effecting national development, and successive revisions of the policy have increasingly emphasised computer literacy and ICT competence as core objectives of the curriculum at all levels. The Federal Ministry of Education's creation of an ICT department in 2007 marked a further step in this direction, formalising collaboration between government agencies, development partners and private-sector stakeholders to drive ICT-related projects and programmes across the education sector (Osakwe, 2012).

At the tertiary level, the National Universities Commission (NUC) has issued minimum ICT infrastructure benchmarks for universities, covering staff–computer and student–computer ratios, campus networking, and the deployment of e-learning platforms, in recognition of the centrality of ICT to academic quality assurance. Nonetheless, the translation of these policy pronouncements into consistent, adequately funded implementation on the ground remains uneven across the system, a gap that this study's findings on the constraints to ICT utilisation help to illuminate.

2.2.6 e-Learning and Distance Education in Nigerian Tertiary Institutions

E-learning, broadly defined as the delivery of learning content and interaction through electronic media, has become an increasingly prominent feature of tertiary education in Nigeria, particularly as institutions seek to expand access, reduce the cost of learning, and reach students in distant or underserved locations. Some Nigerian universities have developed dedicated e-learning platforms, virtual libraries, and distance-learning programmes, while others rely on more modest arrangements such as e-mail-based correspondence and downloadable course materials. Where properly implemented, e-learning has been shown to widen access to tertiary education, support flexible and self-paced study, and provide a channel through which students who cannot attend regular classes — whether due to distance, disability or other constraints — may still participate meaningfully in academic programmes.

However, the effectiveness of e-learning in the Nigerian context continues to be constrained by the same infrastructural and human-capacity limitations that affect ICT utilisation more broadly: unreliable electricity supply, limited bandwidth, high data costs, and uneven digital literacy among both staff and students. Addressing these constraints is therefore central not only to conventional face-to-face ICT-supported instruction, but also to the broader promise of e-learning as a vehicle for expanding access to quality tertiary education in Nigeria.

2.2.7 Comparative Perspective: ICT in Developed and Developing Countries

The trajectory of ICT integration in education differs markedly between developed and developing economies. In countries such as the United States and the United Kingdom, sustained investment in infrastructure, teacher training and digital content has produced comparatively mature ecosystems of ICT-supported teaching and learning, generating a correspondingly large body of empirical research on both the benefits and the barriers to ICT adoption in education. In developing countries, including Nigeria, ICT adoption in education has generally lagged behind, constrained by weaker infrastructure, more limited funding, and competing developmental priorities. This gap underscores the importance of context-specific research such as the present study, which examines how the general benefits of ICT documented in the wider literature manifest — and are constrained — within the particular institutional and infrastructural realities of Nigerian tertiary education.

2.2.8 Theoretical Models Underpinning ICT Adoption in Education

Beyond the discipline-specific literature reviewed above, two broader theoretical models are commonly invoked to explain how and why ICT is adopted, or fails to be adopted, within educational institutions, and both are relevant to interpreting the findings of the present study. Rogers' Diffusion of Innovation theory conceives of technology adoption as a social process unfolding through identifiable stages — knowledge, persuasion, decision, implementation and confirmation — and unfolding at different rates among different categories of adopters, from innovators and early adopters through to a late majority and laggards. Applied to Nigerian tertiary institutions, this theory helps to explain why ICT adoption has been markedly uneven across universities: institutions such as Obafemi Awolowo University and the University of Nigeria, Nsukka, functioning as relatively early adopters with well-developed campus networks, while many others remain at earlier stages of the diffusion curve, constrained by the very factors of funding, infrastructure and personnel training identified above.

Davis' Technology Acceptance Model (TAM), for its part, holds that an individual's intention to use a given technology is shaped principally by perceived usefulness and perceived ease of use. This model offers a useful lens on the attitudinal dimension of this study's findings: where lecturers and students perceive ICT tools as both useful for teaching and learning and reasonably easy to use, adoption and positive attitudes tend to follow, whereas persistent technical difficulties, unreliable power supply and inadequate training — all identified as constraints in the literature reviewed above — depress perceived ease of use and, by extension, dampen the willingness of staff and students to embrace ICT-supported instruction, regardless of its underlying pedagogic merit. These theoretical perspectives are consistent with, and help to explain, the empirical pattern of broad agreement combined with moderate variability observed in the survey results reported in Section 4.

2.3 Empirical Studies

At the tertiary level of education, Okhiria (2007) noted that the National Universities Commission (NUC) in Nigeria has recommended at least one computer to every four students, and one PC to every two lecturers below the grade of Lecturer I, one PC per senior lecturer, and one notebook per reader or professor; the NUC has gone further to establish e-learning platforms fitted with twenty smart boards in twelve federal universities to promote the use of ICT in teaching and learning. The majority of Nigerian universities have not achieved this recommended system ratio for their faculties, although some have made notable strides in campus-wide networking and e-learning course delivery. Institutions such as Obafemi Awolowo University (OAU) and the University of Nigeria, Nsukka, boast some of the best-developed ICT systems in the country, with personal VSAT access to the internet and campus-wide intranet services, while the University of Jos has blazed a trail for content development and e-learning in addition to campus networking (Liverpool et al., 2009).

Very few public higher institutions in the country are capable of meeting the ICT needs of their staff and students, so that many university lecturers and students resort to commercial cyber cafés in town for internet-connected computers, or buy private modems to connect to the internet. Private universities appear to be better off, as many of them, such as Covenant University, Afe Babalola University and the American University of Nigeria (AAUN), provide twenty-four-hour internet connectivity on their campuses, although their populations of lecturers and students are comparatively small; at AAUN, for instance, each student is provided a laptop with the cost factored into the fee structure, an arrangement not within the reach of

many students elsewhere. There are significant bodies of research relating to the obstacles of ICT integration in teaching and learning in developed countries such as the United States and the United Kingdom, whereas in developing countries like Nigeria, especially at the university level, such publications are few and scanty in scope. Such publications remain valuable information sources for countries wishing to improve and succeed in applying ICT tools to teaching and learning, making the present study apt, with lessons that can serve as useful guidelines for universities within the area covered and for the rest of the nation.

Beyond the university-wide infrastructural picture, several Nigerian studies have examined ICT utilisation at the level of individual disciplines and instructional practices, generally corroborating the pattern established above. Studies on ICT use in the teaching of science and mathematics subjects in Nigerian tertiary institutions have found that, while lecturers and students generally hold favourable attitudes toward ICT-supported instruction, actual classroom usage remains below expectation because of the same constraints of funding, power supply and technical support already discussed. Similarly, studies focused on library and information science departments have found that ICT adoption has transformed reference and information-retrieval services markedly faster than it has transformed classroom instruction itself, suggesting that the diffusion of ICT within tertiary institutions is uneven across functions and departments rather than occurring as a single, uniform process. Taken together, this body of empirical evidence supports the view that ICT's role as a change agent for quality education in Nigerian tertiary institutions is real but partial, contingent on the resolution of the infrastructural and capacity constraints identified in the theoretical framework above.

Funding interventions have also played an important role in shaping the empirical picture of ICT provision in Nigerian tertiary institutions. The Tertiary Education Trust Fund (TETFund), established to channel a designated education tax into the development of public tertiary institutions, has for some years included ICT infrastructure — computer laboratories, campus networking and e-library resources — among the categories of intervention available to universities, polytechnics and colleges of education. Where institutions have successfully accessed such intervention funds, the resulting improvements in ICT provision have generally mirrored the benefits identified in the wider literature: improved access to online resources, expanded computer-laboratory capacity, and better-supported e-learning initiatives. However, the scale of need across the more than two hundred public tertiary institutions in Nigeria continues to outstrip the funds available through such interventions, reinforcing this study's finding that adequate and sustained funding remains a fundamental objective still to be fully realised in the pursuit of quality, ICT-supported tertiary education nationwide.

2.4 Summary of Literature Review

The movement of the world toward digital media and information has made the role of ICT in education increasingly important, an importance that will continue to grow and develop through the twenty-first century. ICT is an indispensable part of the contemporary world, and culture and society have had to adjust to meet the challenges of the knowledge age. Undoubtedly, ICT has impacted on the quality and quantity of teaching, learning and research in tertiary educational institutions in Nigeria; the various constraints to ICT utilisation as a change agent for higher education must, however, receive prominent attention if ICT is to continue playing its lofty role as a change agent for Nigerian tertiary institutions.

3. Methodology

This section discusses the methods and procedures used for this study, under the following sub-headings: research design; area of the study; population of the study; sample and sampling technique; instrument for data collection; validation of the instrument; reliability of the instrument; method of data collection; and method of data analysis.

3.1 Research Design

The research design adopted for this study is the survey design. A survey design simply means a self-report study that requires the collection of quantifiable information (Gay, 2006); it can also be seen as an efficient way of gathering data to help address research questions. According to Nworgu (2006), a survey research is one in which a group of people or items is considered to be representative of the entire group, and it is a survey in the sense that the researcher did not influence any variable in the process of investigation. The survey research design is preferable in this study because it seeks to obtain information that describes an existing phenomenon by asking questions.

3.2 Area of the Study

The area of this study is University of Nigeria, Nsukka, located in Nsukka Local Government Area of Enugu State, Nigeria. The University hosts a wide range of faculties and departments, including the Department of Computer and Robotics Education, and provides an appropriate setting for appraising the role of ICT as a change agent for quality education in tertiary institutions in Nigeria.

3.3 Population of the Study

The population comprised selected departments within University of Nigeria, Nsukka. Three departments were chosen out of all the departments in the University. The total number of students who participated in the study was 300, while the staff population was 50, giving a combined population of 350, as summarised in Table A.

Table A – Distribution of the study population.

Category	Number	%
Students	300	85.7
Staff	50	14.3
Total	350	100.0

3.4 Sample and Sampling Technique

The sample of the study consisted of a total of 350 students and staff of University of Nigeria, Nsukka. The researchers selected the respondents through a random sampling technique; identification particulars of prospective respondents were written on pieces of paper, which were folded and kept in a container. After thorough reshuffling, one of the researchers, without looking into the container, picked a piece of paper, unfolded it, recorded the name or identification number of the respondent, folded it again and set it aside. This process was repeated until the required number of respondents had been drawn.

In determining an appropriate sample size for a defined population, researchers commonly apply Taro Yamane's simplified formula for proportions, expressed as $n = N / [1 + N(e)^2]$, where n is the sample size, N is the population size, and e is the acceptable sampling error. This formula, alongside the random sampling procedure described above, guided the determination of the 350 respondents used in this study.

3.5 Instrument for Data Collection

The instrument used for data collection was a structured questionnaire designed by the researchers. The items on the questionnaire were set out in two sections — A and B. Section A of the questionnaire contained questions on the personal data of respondents (department, level, gender and educational qualification), while Section B addressed the research questions, on which respondents were requested to tick (√) their response on a modified four-point scale. The response categories, indicating the level of agreement or disagreement, were: Strongly Agree (SA), Agree (A), Disagree (D) and Strongly Disagree (SD).

Table B – Distribution of questionnaire items by research question.

Research Question	Items	Item Numbers
RQ 1 – Quality indicators	4	1 – 4
RQ 2 – ICT and its role	4	5 – 8
RQ 3 – Fundamental objectives	4	9 – 12

Table B shows that the twelve-item questionnaire was evenly distributed across the three research questions, with four items addressing each research question, so as to give balanced coverage to each of the constructs under investigation.

3.6 Validation of the Instrument

Validation of the instrument for content and for the study was carried out by two lecturers in the Department of Computer and Robotics Education and the project supervisor, all of University of Nigeria, Nsukka. They were required to vet the instrument for its relevance to the study, clarity and appropriateness; their recommendations were gainfully incorporated into the final version of the instrument administered to the sample.

3.7 Reliability of the Instrument

The reliability of the instrument was established using the test–retest method. Three hundred and fifty copies of the questionnaire were administered to respondents at University of Nigeria, Nsukka; after two weeks, the same questionnaire was re-administered to the same respondents in order to ascertain the reliability of the instrument used.

3.8 Method of Data Collection

The researchers administered the 350 copies of the questionnaire directly to the respondents and waited for them to complete the instrument. After completion, the researchers recovered all 350 copies of the questionnaire.

3.9 Method of Data Analysis

In analysis, the data collected from respondents were tabulated and analysed statistically using the arithmetic mean. For the basis of conclusion, any mean score of 2.5 and above was accepted, while any mean score below 2.5 was rejected. The formulae used in the analysis of results are stated below:

$\bar{X} = \Sigma fx / \Sigma f \qquad SD = \sqrt{[\Sigma f(x - \bar{x})^2 / \Sigma f]}$

where f is the frequency of responses to each item, X is the score obtained from the questionnaire, Σ denotes summation, and N is the total number of respondents. In order to minimise instrumentation bias during implementation, the researchers computed the results using both the mean and the standard deviation; items with a mean score of 2.5 and above were regarded as an expression of acceptance, while items below the mean score of 2.5 were rejected.

3.10 Ethical Considerations

Participation in the study was voluntary, and respondents were informed of the purpose of the research before completing the questionnaire. No respondent was required to disclose their name, and all personal data collected in Section A of the instrument were used solely for descriptive classification and not for individual identification. Respondents were assured of the confidentiality of their responses, and data were aggregated for analysis and reporting purposes only, consistent with standard ethical practice for low-risk survey research involving adult respondents in an educational setting.

4. Results and Discussion

This section presents the analysis and interpretation of the data collected from the 350 respondents in respect of the three research questions that guided the study.

4.1 Research Question 1: What constitutes quality in the education of tertiary institutions in Nigeria?

Table 1 – Responses on factors that constitute quality in the education of tertiary institutions in Nigeria.

S/N	Items	SA	A	D	SD	TR	FX	X	SD.	Decision
1	Will the attitude of students towards learning bring quality in the education of tertiary institutions in Nigeria?	200	101	39	10	350	1191	3.4	0.8	Accepted
2	Will the attitude of lecturers in teaching constitute quality in the education of tertiary institutions in Nigeria?	201	110	32	7	350	1205	3.5	0.7	Accepted
3	Can the school environment constitute quality in the education of tertiary institutions in Nigeria?	225	110	8	7	350	1253	3.6	0.6	Accepted
4	Can the method of teaching constitute quality in the education of tertiary institutions in Nigeria?	205	95	30	20	350	1185	3.4	0.9	Accepted

Table 1 shows that the responses on items 1–4 were all accepted, with mean scores of 3.4, 3.5, 3.6 and 3.4 respectively, and standard deviations ranging from 0.6 to 0.9, indicating a fairly consistent pattern of agreement among respondents. This indicates that the attitude of students and lecturers, and the school environment, are factors that can bring about and improve the quality of education in tertiary institutions in Nigeria.

4.2 Research Question 2: What is ICT, and what is its role for quality education in tertiary institutions in Nigeria?

Table 2 – Responses on ICT and its role in the education of tertiary institutions in Nigeria.

S/N	Items	SA	A	D	SD	TR	FX	X	SD.	Decision
5	Does the teaching and learning of ICT bring about quality in the education of tertiary institutions in Nigeria?	202	104	31	13	350	1195	3.4	0.8	Accepted
6	ICT brings quality in the education of tertiary institutions in Nigeria.	205	110	8	7	350	1253	3.6	0.7	Accepted

S/N	Items	SA	A	D	SD	TR	FX	X	SD.	Decision
7	Can the use of ICT facilities for teaching and learning constitute quality in the education of tertiary institutions in Nigeria?	205	95	25	25	350	1185	3.4	0.9	Accepted
8	Will an effective use of ICT in tertiary institutions in Nigeria foster or promote learning?	220	105	20	5	350	1240	3.5	1.0	Accepted

Table 2 shows that the responses on items 5–8 were all accepted, with mean scores of 3.4, 3.6, 3.4 and 3.5 respectively, and standard deviations between 0.7 and 1.0. This indicates that the teaching and learning of ICT, and the use of ICT facilities for teaching and learning, contribute to bringing quality to Nigeria's tertiary institutions.

4.3 Research Question 3: What are the fundamental objectives of quality education in tertiary institutions in Nigeria?

Table 3 – Responses on the fundamental objectives of quality education in tertiary institutions in Nigeria.

S/N	Items	SA	A	D	SD	TR	FX	X	SD.	Decision
9	Implementation and effective use of ICT in teaching and learning will promote quality in the education of tertiary institutions in Nigeria.	205	100	30	15	350	1195	3.4	0.8	Accepted
10	Use of ICT facilities fastens or makes learning easier.	205	105	30	10	350	1217	3.5	0.8	Accepted
11	Provision and availability of ICT facilities in tertiary institutions will bring quality education in tertiary institutions of Nigeria.	200	112	20	18	350	1194	3.4	0.8	Accepted
12	It should be mandatory that all students in tertiary institutions in Nigeria learn ICT as a course before graduation.	225	80	27	18	350	1212	3.5	0.8	Accepted

Table 3 shows that the responses on items 9–12 were all accepted, with mean scores of 3.4, 3.5, 3.4 and 3.5 respectively, all recording a standard deviation of 0.8. This indicates that the implementation and effective use of ICT will promote quality education, that ICT facilities make learning easier, that their provision constitutes quality education, and that mandatory ICT training for students before graduation is desirable.

4.4 Detailed Statistical Workings

For completeness and to allow independent verification, the item-level computations of the mean and standard deviation underlying Tables 1–3 are presented below. In each case, x represents the rating scale point (4 = Strongly Agree, 3 = Agree, 2 = Disagree, 1 = Strongly Disagree), f is the frequency of respondents selecting that point, and $\bar{x}$ is the item mean.

Item 1 — Mean = 1191/350 = 3.4; SD = √(222.2/350) = √0.63 = 0.79 ≈ 0.8

S/N	x	f	fx	$x - \bar{x}$	$(x - \bar{x})^2$	$f(x - \bar{x})^2$
1	4	200	800	0.6	0.36	7.2
2	3	101	303	-0.4	0.16	16.16
3	2	39	78	-1.4	1.96	76.44
4	1	10	10	-2.4	5.76	57.6
		350	1191			222.2

Item 2 — Mean = 1205/350 = 3.4; SD = √(193/350) = √0.55 = 0.74 ≈ 0.7

S/N	x	f	fx	$x - \bar{x}$	$(x - \bar{x})^2$	$f(x - \bar{x})^2$
1	4	201	804	0.6	0.36	72.36

S/N	x	f	fx	x − x̄	(x − x̄)²	f(x − x̄)²
2	3	110	330	-0.4	0.16	17.6
3	2	32	64	-1.4	1.96	62.72
4	1	7	7	-2.4	5.76	40.32
		350	1205			193

Item 3 — Mean = 1253/350 = 3.6; SD = √(143.4/350) = √0.41 = 0.64 ≈ 0.6

S/N	x	f	fx	x − x̄	(x − x̄)²	f(x − x̄)²
1	4	225	900	0.4	0.16	36
2	3	110	330	-0.6	0.36	39.6
3	2	8	16	-1.6	2.56	20.48
4	1	7	7	-2.6	6.76	47.32
		350	1253			143.4

Item 4 — Mean = 1185/350 = 3.4; SD = √(263/350) = √0.75 = 0.87 ≈ 0.9

S/N	x	f	fx	x − x̄	(x − x̄)²	f(x − x̄)²
1	4	205	820	0.6	0.36	73.8
2	3	95	285	-0.4	0.16	15.2
3	2	30	60	-1.4	1.96	58.8
4	1	20	20	-2.4	5.76	115.2
		350	1185			263

Item 5 — Mean = 1195/350 = 3.4; SD = √(225/350) = √0.64 = 0.80 ≈ 0.8

S/N	x	f	fx	x − x̄	(x − x̄)²	f(x − x̄)²
1	4	202	808	0.6	0.36	72.72
2	3	104	312	-0.4	0.16	16.64
3	2	31	62	-1.4	1.96	60.76
4	1	13	13	-2.4	5.76	74.88
		350	1195			225

Item 6 — Mean = 1226/350 = 3.5; SD = √(171.5/350) = √0.49 = 0.70 ≈ 0.7

S/N	x	f	fx	x − x̄	(x − x̄)²	f(x − x̄)²
1	4	208	532	0.5	0.25	52
2	3	120	360	-0.5	0.25	30
3	2	12	24	-1.5	2.25	27

S/N	x	f	fx	x − x̄	(x − x̄)²	f(x − x̄)²
4	1	10	10	-2.5	6.25	62.5
		350	1226			171.5

Item 7 — Mean = 1180/350 = 3.4; SD = √(282/350) = √0.81 = 0.90 ≈ 0.9

S/N	x	f	fx	x − x̄	(x − x̄)²	f(x − x̄)²
1	4	205	820	0.6	0.36	73.8
2	3	95	285	-0.4	0.16	15.2
3	2	25	50	-1.4	1.96	49
4	1	25	25	-2.4	5.76	144
		350	1180			282

Item 8 — Mean = 1230/350 = 3.5; SD = √(367.2/350) = √1.05 = 1.02 ≈ 1.0

S/N	x	f	fx	x − x̄	(x − x̄)²	f(x − x̄)²
1	4	220	880	1.14	1.30	286
2	3	100	300	0.86	0.74	74
3	2	20	40	0.57	0.32	6.4
4	1	10	10	0.29	0.08	0.8
		350	1230			367.2

Item 9 — Mean = 1195/350 = 3.4; SD = √(235/350) = √0.67 = 0.82 ≈ 0.8

S/N	x	f	fx	x − x̄	(x − x̄)²	f(x − x̄)²
1	4	205	820	0.6	0.36	73.8
2	3	100	300	-0.4	0.16	16
3	2	30	60	-1.4	1.96	58.8
4	1	15	15	-2.4	5.76	86.4
		350	1195			235

Item 10 — Mean = 1205/350 = 3.4; SD = √(207/350) = √0.59 = 0.77 ≈ 0.8

S/N	x	f	fx	x − x̄	(x − x̄)²	f(x − x̄)²
1	4	205	820	0.6	0.36	73.8
2	3	105	315	-0.4	0.16	16.8
3	2	30	60	-1.4	1.96	58.8
4	1	10	10	-2.4	5.76	57.6
		350	1205			207

Item 11 — Mean = 1190/350 = 3.4; SD = √(232.8/350) = √0.67 = 0.82 ≈ 0.8

S/N	x	f	fx	x − x̄	(x − x̄)²	f(x − x̄)²
1	4	200	800	0.6	0.36	72
2	3	112	332	-0.4	0.16	17.92
3	2	20	40	-1.4	1.96	39.2
4	1	18	18	-2.4	5.76	103.68
		350	1190			232.8

Item 12 — Mean = 1212/350 = 3.5; SD = √(249.5/350) = √0.71 = 0.84 ≈ 0.8

S/N	x	f	fx	x − x̄	(x − x̄)²	f(x − x̄)²
1	4	225	900	0.5	0.25	56.25
2	3	80	240	-0.5	0.25	20
3	2	27	54	-1.5	2.25	60.75
4	1	18	18	-2.5	6.25	112.5
		350	1212			249.5

4.5 Discussion of the Findings

In Research Question 1, it was discovered that the attitude of students, the attitude of lecturers, the school environment and the method of teaching are factors that can constitute and improve the quality of education in tertiary institutions in Nigeria. This finding is in line with Igboabuchi, Ilorah and Azubuike (2010), who stated that an adequate learning environment that is properly managed will make effective teaching and learning possible; Nwachukwu (2009) similarly supported this by stating that adequate laboratories and classrooms are among the criteria for effective teaching and learning.

In Research Question 2, it was discovered that the teaching and learning of ICT in tertiary institutions of Nigeria can contribute to bringing quality to the education of tertiary institutions in Nigeria; that the use of ICT facilities for teaching and learning will bring quality to education in tertiary institutions; and that effective use of ICT in Nigerian tertiary institutions will foster and promote learning. These findings are in line with Odogo and Ugwuda (2018), who observed that most higher institutions currently lack ICT facilities for teaching and learning, which, according to them, makes the process of teaching and learning in tertiary institutions difficult.

Research Question 3 shows that implementation and effective use of ICT in teaching and learning will promote quality in the education of tertiary institutions in Nigeria; that the use of ICT facilities enables students to become self-reliant after graduation; that adequate provision and availability of ICT facilities can improve the quality of education in tertiary institutions in Nigeria; and that ensuring all students undergo ICT training before leaving higher institutions is desirable. These findings are in line with Nworgu and Oyim (2015), who observed that government and philanthropic organisations should make efforts to donate ICT facilities to tertiary institutions for adequate teaching and learning of various skills in ICT, and with Akudolu (2016), who suggested that the problem of power supply, lack of basic ICT skills, poor network infrastructure, high cost of ICT facilities and inadequate numbers of ICT facilities militate against the use of ICT in teaching and learning in higher institutions; solving these problems, therefore, constitutes a fundamental objective of quality education in tertiary institutions in Nigeria.

Taken together, the pattern of results across all three research questions is notable for its consistency: every one of the twelve items returned a mean score comfortably above the 2.5 acceptance threshold, with standard deviations clustering between 0.6 and 1.0, indicating that respondents' views, while broadly convergent, retained a modest spread reflecting differences in individual experience with ICT. This consistency lends weight to the study's central claim that ICT functions as a genuine, if presently constrained, change agent for quality education in Nigerian tertiary institutions, corroborating the theoretical position advanced by Honey and Mandinach (2003) that ICT operates simultaneously as a tool, a change agent and a central force in economic competitiveness within the education sector.

It is worth noting that the highest mean score recorded across the entire instrument (item 6, $\bar{x} = 3.6$) directly concerns the proposition that ICT brings quality to tertiary education, while the item recording the largest standard deviation (item 8, SD = 1.0) concerns whether effective ICT use fosters or promotes learning. The relatively wider spread on item 8 may reflect genuine variation in respondents' first-hand exposure to well-resourced, ICT-supported classrooms as against poorly resourced ones, a pattern consistent with the constraints to ICT utilisation — irregular power supply, inadequate funding, and shortage of trained personnel — identified in the literature review (Starr, 2001; BECTA, 2004; Akudolu, 2016). In other words,

respondents appear to agree in principle that ICT can and does improve the quality of tertiary education, while differing somewhat in how strongly they have observed that improvement in practice, a distinction consistent with the view that ICT's impact is real but unevenly realised across Nigerian tertiary institutions.

4.6 Summary of Major Findings

- The attitude of students and lecturers, the school environment and the method of teaching are factors that constitute and improve quality in the education of tertiary institutions in Nigeria.
- ICT brings quality to the education of tertiary institutions in Nigeria.
- Implementation and effective use of ICT in teaching and learning will promote quality in the education of tertiary institutions in Nigeria.
- Provision and availability of ICT facilities in schools will constitute quality education in tertiary institutions of Nigeria.
- Mandatory ICT training for students before graduation is desirable for sustaining quality education in tertiary institutions in Nigeria.

5. Conclusion and Recommendations

5.1 Conclusion

This study has sought to appraise the role of ICT as a change agent for quality education in tertiary institutions in Nigeria. The findings indicated that ICTs have significantly impacted educational practice in Nigeria, and that this impact would grow considerably in the years to come if the various problems hindering effective utilisation of ICT as a change agent for tertiary education are properly ameliorated. Undoubtedly, ICT would become a strong agent for change in many tertiary educational institutions in Nigeria.

5.2 Educational Implication of the Study

ICT has many roles in the teaching and learning of various courses in tertiary institutions in Nigeria; it makes teaching and learning easier and more interesting for both students and lecturers, enables lecturers and students to carry out research, and broadens the knowledge horizon of students and teachers alike. This means that ICT is very important in all tertiary institutions in Nigeria for teaching and learning, in order to promote the quality of the nation's education. The educational implication of the study is that tertiary institutions in Nigeria should adopt a variety of teaching methods and make adequate use of ICT materials for learning, so as to increase the quality of the nation's educational system.

5.3 Recommendations

Arising from the findings and conclusions of this study, the following recommendations are made.

- Learning should become more relevant to stakeholders' needs: learning outcomes should become more deliberate and targeted, while learning opportunities should be diversified in terms of what is learnt and who should learn. Curriculum planners and institutional administrators should periodically review programme content to ensure it continues to reflect both the capabilities of available ICT infrastructure and the evolving needs of learners, employers and the wider society.
- The quality of programmes, as measured by fitness for purpose, should continue to grow, so that stakeholders perceive the various educational programmes as meeting their needs and expectations; ICTs should serve to provide the means for activities that realise the potential inherent in human resources. This implies deliberate investment not only in hardware but in the pedagogical training that enables lecturers to translate ICT access into genuinely improved teaching practice.
- Adequate funds must be provided to initiate, develop, promote, review and implement ICT policies in the education sector, so as to bring about improvement in ICT utilisation, including through computer apprenticeship courses taught in Nigerian tertiary institutions. Budgetary allocations for ICT should be treated as a recurrent, protected line item rather than a discretionary one, given the pace at which computing and networking technologies age and require replacement.
- Given the high cost of ICT equipment and materials, particularly in periods of economic recession, it becomes highly imperative for education stakeholders to engage industrial establishments, companies, politicians, businessmen and entrepreneurs, non-governmental organisations and the community at large to assist institutions in the provision of ICT equipment, materials, and well-furnished computer laboratories. Public–private partnerships of this kind, already evident in a number of Nigerian private universities, offer a practicable model that public institutions might adapt to their own circumstances.
- Institutions should invest in a stable and, where feasible, alternative power supply (including solar or hybrid solutions) for computer laboratories and ICT centres, given that irregular electricity was repeatedly identified in the literature, and implicit in the survey findings, as one of the most fundamental constraints to effective ICT utilisation in Nigerian tertiary education.

- Regular, structured ICT training and capacity-building programmes should be organised for both lecturers and non-teaching staff, so as to address the lack of confidence, competence and pedagogical training that the literature identifies as a persistent barrier to ICT integration, even where hardware itself is available.

5.4 Implications for Stakeholders

The findings of this study carry distinct implications for the different stakeholders in Nigerian tertiary education. For policymakers and regulatory bodies such as the National Universities Commission, the results reinforce the case for translating existing ICT policy pronouncements into binding, adequately funded implementation plans, with clear benchmarks and monitoring mechanisms, rather than aspirational guidelines alone. For institutional management, the findings suggest that improvements in the school environment and in ICT provision are not peripheral concerns but central levers for raising perceived and actual educational quality, meriting priority in institutional strategic planning and budgeting.

For lecturers, the study underscores the importance of positive attitudes toward ICT and of continuous professional development in ICT-supported pedagogy, given that attitude and competence, and not merely the availability of equipment, were shown in the literature to be strong predictors of effective ICT-supported teaching (Maldonado, 2000). For students, the findings affirm that engagement with ICT tools contributes meaningfully to their learning experience and future employability, providing a rationale for institutions to consider mandatory foundational ICT training as part of general studies requirements. Finally, for government and non-governmental development partners, the study provides empirical grounding, drawn directly from institutional stakeholders, for continued and expanded investment in ICT infrastructure as a means of advancing the quality of tertiary education across Nigeria.

5.5 Limitations of the Study

As with any survey-based enquiry, this study is subject to a number of limitations that should be borne in mind when interpreting its findings. The researchers found it difficult to obtain the relevant materials needed for the work, owing to insufficient books available for consultation in both departmental and school libraries, a constraint that necessarily limited the breadth of the literature that could be physically consulted within the time available for the study. Secondly, the researchers had to travel from time to time in order to meet their respondents, which involved considerable time, cost and, at points, personal risk, given the logistical challenges of moving between locations to administer and retrieve the questionnaire. Thirdly, it took considerable time and effort to convince respondents before they agreed to complete the questionnaires given to them, some of whom were initially reluctant to participate in an academic exercise from which they perceived no direct personal benefit.

In addition to these practical constraints, the study is limited in scope by its reliance on a single institutional setting and a cross-sectional survey design, meaning that its findings, while informative, cannot be assumed to generalise without qualification to every tertiary institution in Nigeria, particularly those operating under markedly different funding, infrastructural or geographic conditions. The use of self-reported perceptions, rather than direct observation of ICT-supported teaching practice or objective learning-outcome measures, is a further limitation common to survey research of this kind, and should be borne in mind in interpreting the strength of the associations reported.

5.6 Suggestions for Further Studies

Building on the findings, conclusions and limitations of this study, the following areas are suggested for further research.

- A study on the role of Information and Communication Technology (ICT) for effective teaching and learning in higher institutions of learning, extending the present survey to a wider range of institutions across different geopolitical zones of Nigeria, so as to test the generalisability of the findings reported here.
- The effect and use of computer-aided instruction in teaching and learning in tertiary institutions in Nigeria, employing quasi-experimental or longitudinal designs capable of establishing more direct causal links between ICT use and measured learning outcomes, rather than relying solely on respondents' perceptions.
- A comparative study of ICT infrastructure, funding mechanisms and utilisation patterns across public and private tertiary institutions in Nigeria, to establish more precisely which institutional and funding arrangements are most strongly associated with effective ICT-supported quality education.

5.7 Summary of the Study

This research was carried out on the topic 'An appraisal of the role of ICT as a change agent for quality education in tertiary institutions in Nigeria.' Three research questions were developed, addressing what constitutes quality in the education of tertiary institutions in Nigeria, what ICT is and its role for quality education in tertiary institutions, and the fundamental objectives of quality education in tertiary institutions in Nigeria. In reviewing the related literature, the researchers organised data under the conceptual framework, theoretical framework and empirical studies; under the conceptual framework, the researchers reviewed the concept of education, quality education and ICT, while the theoretical framework laid emphasis on the role, benefits and constraints of ICT in higher institutions in Nigeria. The empirical studies reviewed showed the roles of ICT in various tertiary institutions

in Nigeria. A random sampling technique was used to select the 350 respondents, a structured questionnaire was used to collect data, and arithmetic mean and standard deviation were used to analyse the data collected.

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Appendix A. Research Instrument

The structured questionnaire administered to the 350 respondents of this study is reproduced below, comprising a covering letter, Section A (personal data) and Section B (research-question items rated on a four-point scale of Strongly Agree (SA), Agree (A), Disagree (D) and Strongly Disagree (SD)).

Department of Computer and Robotics Education

University of Nigeria, Nsukka.

Dear Respondent,

We are final-year students of the above institution and department, currently carrying out a research study on the topic 'An appraisal of the role of ICT as a change agent for quality education in tertiary institutions in Nigeria.' Please feel free to help us obtain data by completing the questionnaire below; your answers will be treated with the utmost confidentiality, and we will be grateful if you give us accurate information. Thank you for your cooperation.

Yours faithfully, The Researchers

Section A: Personal Data

Instruction: Please tick (√) in the space provided as it applies to you.

- Name of Department: .....
- Level: .....
- Gender: Male [ ] Female [ ]
- Educational Qualification: TC II [ ] NCE [ ] OND/HND [ ] B.A/B.Sc/B.Ed [ ] M.Ed [ ] Ph.D [ ]

Section B: Questionnaire Items

Instruction: The following statements relate to the role of ICT as a change agent for quality education in tertiary institutions in Nigeria. Please tick (√) Strongly Agree (SA), Agree (A), Disagree (D) or Strongly Disagree (SD), as appropriate, against each statement.

Research Question 1: What constitutes quality in the education of tertiary institutions in Nigeria?

S/N	Items	SA	A	D	SD
1	Will the attitude of students towards learning bring quality in the education of tertiary institutions in Nigeria?				
2	Will the attitude of lecturers in teaching constitute quality in the education of tertiary institutions in Nigeria?				
3	Can the school environment constitute quality in the education of tertiary institutions in Nigeria?				
4	Can the method of teaching constitute quality in the education of tertiary institutions in Nigeria?				

Research Question 2: What is ICT, and what is its role for quality education in tertiary institutions in Nigeria?

S/N	Items	SA	A	D	SD
5	Does the teaching and learning of ICT bring about quality in the education of tertiary institutions in Nigeria?				
6	ICT brings quality in the education of tertiary institutions in Nigeria.				
7	Can the use of ICT facilities for teaching and learning constitute quality in the education of tertiary institutions in Nigeria?				
8	Will an effective use of ICT in tertiary institutions in Nigeria foster or promote learning?				

Research Question 3: What are the fundamental objectives of quality education in tertiary institutions in Nigeria?

S/N	Items	SA	A	D	SD
9	Implementation and effective use of ICT in teaching and learning will promote quality in the education of tertiary institutions in Nigeria.				
10	Use of ICT facilities fastens or makes learning easier.				
11	Provision and availability of ICT facilities in tertiary institutions will bring quality education in tertiary institutions of Nigeria.				
12	It should be mandatory that all students in tertiary institutions in Nigeria learn ICT as a course before graduation.				

End of questionnaire. The researchers thank all respondents for their time and cooperation.

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